15.04.2025

# PRIZIDAVA OŠ POLZELA – 1. FAZA IN 2. FAZA
## ELABORAT ENERGIJSKE UČINKOVITOSTI SKORAJ NIČ-ENERGIJSKE STAVBE

## 1 IZBOLJŠAVE TEHNIČNIH REŠITEV V FAZI PZI

Investitor, Občina Polzela, želi na Eko skladu j.s. kandidirati s PZI projektom novogradnje prizidave osnovne šole, za pridobitev nepovratnega sofinanciranja za gradnjo stavbe v kategoriji skoraj nič-energijskih stavb. V PZI fazi projektiranja so preverjene in prilagojene tehnične rešitve za ukrepe energijske učinkovitosti in uporabo obnovljivih virov energije, na način da izpolnijo skupek zahtev, ki so navedene v javnem pozivu za Eko sklada j.s., za sofinanciranje gradnje sNES lokalnih skupnosti (115SUB). Projektne rešitve so se nadalje optimirale za kandidiranje v ugodnem tj. mineralnem razredu za sofinanciranje.
Za izpolnjevanje zahtev za sofinanciranje novogradnje je potrebno izhodiščno PZI projektno dokumentacijo dopolniti oziroma uskladiti na način, da bo izkazovala izvedbeno aktualno stanje z opisanimi ukrepi energijske učinkovitosti in ukrepi rabe obnovljivih virov energije, v načrtih in tehničnih poročilih. V tem elaboratu navedeni tehnični ukrepi izkazujejo, da projektna dokumentacija za gradnjo izpolnjuje zahteve javnega poziva (115SUB). Za aktualne sisteme toplotne zaščite, za lastnosti zunanjega stavbnega pohištva, za napravo za prezračevanje ter generator toplote in hladu so predložena dokazila z lastnostmi, ki so upoštevane v izračunih v tem elaboratu.

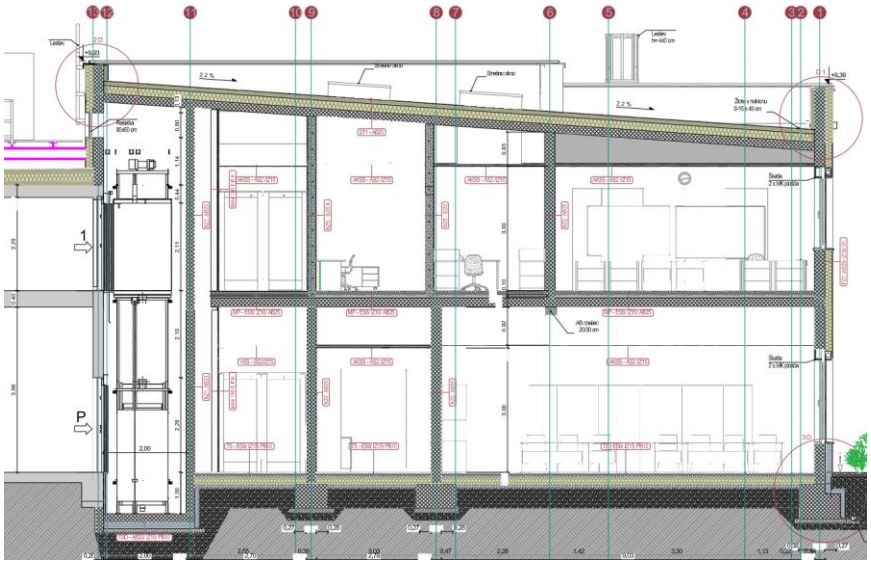
## 2 PREVERITEV PROJEKTIRANIH UKREPOV ZA NOVOGRADNJO

Preveritve tehničnih ukrepov za URE in OVE v novogradnji se nanašajo na izpolnjevanje naslednjih ključnih zahtev sofinancerja:

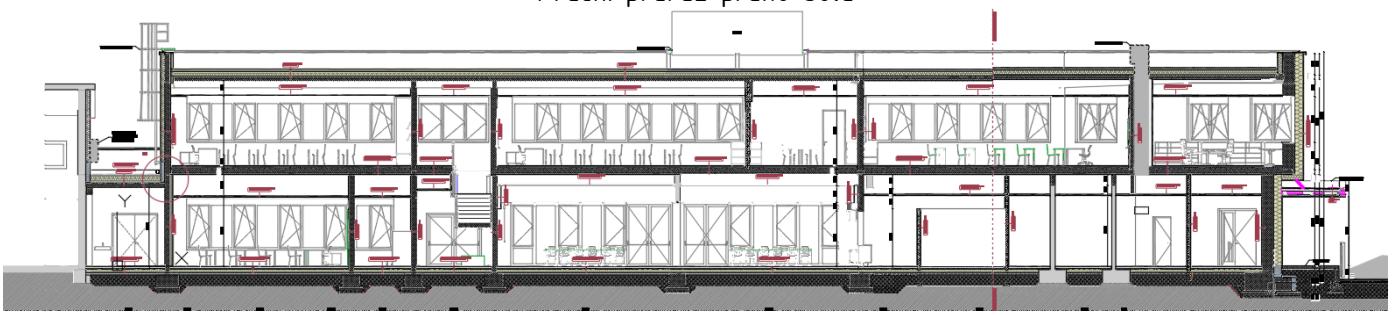
- S prilagojenimi sestavami zunanjega toplotnega ovoja stavbe se ohranja zahteva sofinancerja po nivoju visoke toplotne zaščite, ki ima ključnih sestavah vrednosti toplotne prehodnosti med 0,10 in 0,15 W/m$^2$K ter med 0,15 in 0,17 W/m$^2$K, za sklope meječe na zrak in na teren, kar je ustrezno nižje od mejnih vrednosti 0,15 / 0,17 W/m$^2$K.
- S sistemi toplotne zaščite je dosežen volumski delež 82% toplotnih izolacij v mineralnem razredu za prvo fazo gradnje ter 71% delež mineralnih izolacij za drugo fazo.
- V stavbnem ovoju bo vgrajeno pretežno PVC zunanje stavbno pohištvo, del zunanjih vrat z Alu profilacijo, strešna okna in polna zunanja vrata, ipd. s toplotno prehodnostjo manj kot mejna vrednost 0,90 W/m$^2$K.
- Energijska učinkovitost novogradnje, izračunana po metodi PHPP z robnimi pogoji sofinancerja, izkazuje rezultat pri potrebah ogrevanja za prvo fazo $Q_H$ = 12,8 kWh/m$^2$a oz. 4,1 kWh/m$^3$a ter računsko rabo energije za pohlajevanje in razvlaževanje, ki je ovrednotena na $Q_K$ = 2,8 kWh/m$^2$a oz. 0,9 kWh/m$^3$a. Rezultat za drugo fazo pri potrebah ogrevanja znaša $Q_H$ = 9,5 kWh/m$^2$a oz. 3,0 kWh/m$^3$a ter računsko

rabo energije za pohlajevanje in razvlaževanje, ki je ovrednotena na $Q_K$ = 3,9 kWh/m²a oz. 1,2 kWh/m³a Količina energije za ogrevanje in pohlajevanje je tako nižja od mejne vrednosti 6,0 kWh/m³a.

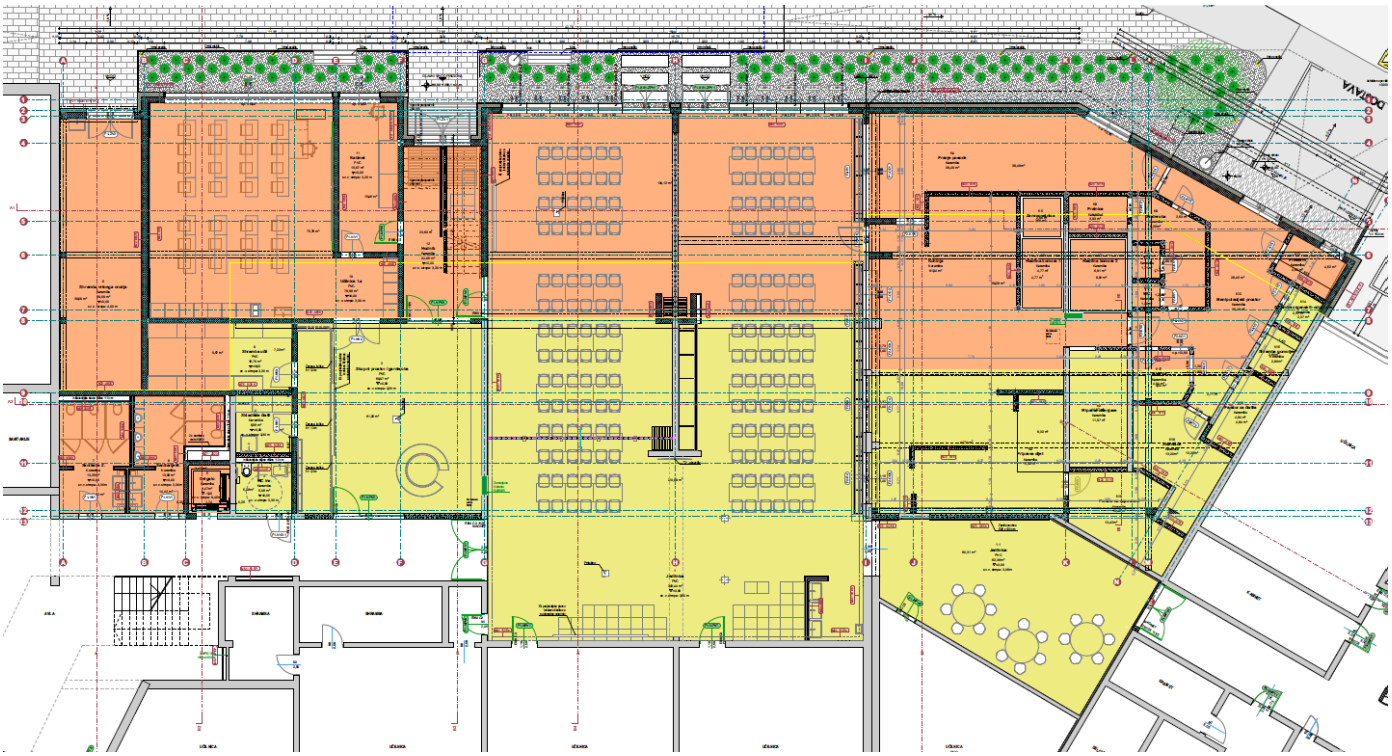
- Oskrba stavbe s toploto za ogrevanje je predvidena s pomočjo toplotne črpalke tipa zrak-voda in ZA pripravo sanitarne tople vode v kombinaciji s TČ voda-voda. Pohlajevanje se prav tako izvaja s pomočjo TČ, preko klimata in talnega pohlajevanja.
- Zaradi zasedenosti praktično vseh južno orientiranih strešin obstoječe stavbe, kjer je že nameščena sončna elektrarna, ter zaradi severno orientiranih strešin novogradnje, umestitev nove sončne elektrarne na strehi prizidka ni možna. Za potrebe oskrbe novogradnje se bo nahajala sončna elektrarna na sosednji stavbi vrtca, s katero bo novogradnja povezana preko skupnosti.
- Z kombinacijo delovanja teh naprav se smatra izpolnjen kriterij za razmernik ROVE, v dovedeni energiji za obratovanje tehničnih sistemov stavbe, ki je sicer ocenjen na najmanj 85%, kar je več kot mejna vrednost sofinancerja.
- V novi stavbi bo na lokaciji prve faze vgrajena večja prezračevalna naprava z vračanjem toplote 80,4%, ki bo pokrivala prostore obeh faz. Preostali del prezračevanja, predvsem za kuhinjski del in tehnologije, pa je vezan na naprave z vračanjem toplote v vrednosti manj kot 80%.
- Za izračun višine sofinanciranja je opredeljena površina prve faze, prezračevana preko klimata KN1, v vrednosti 496,19 m² ter v drugi fazi zgolj površina prostorov, prezračevanih preko klimata KN1, v vrednosti 254,62 m².



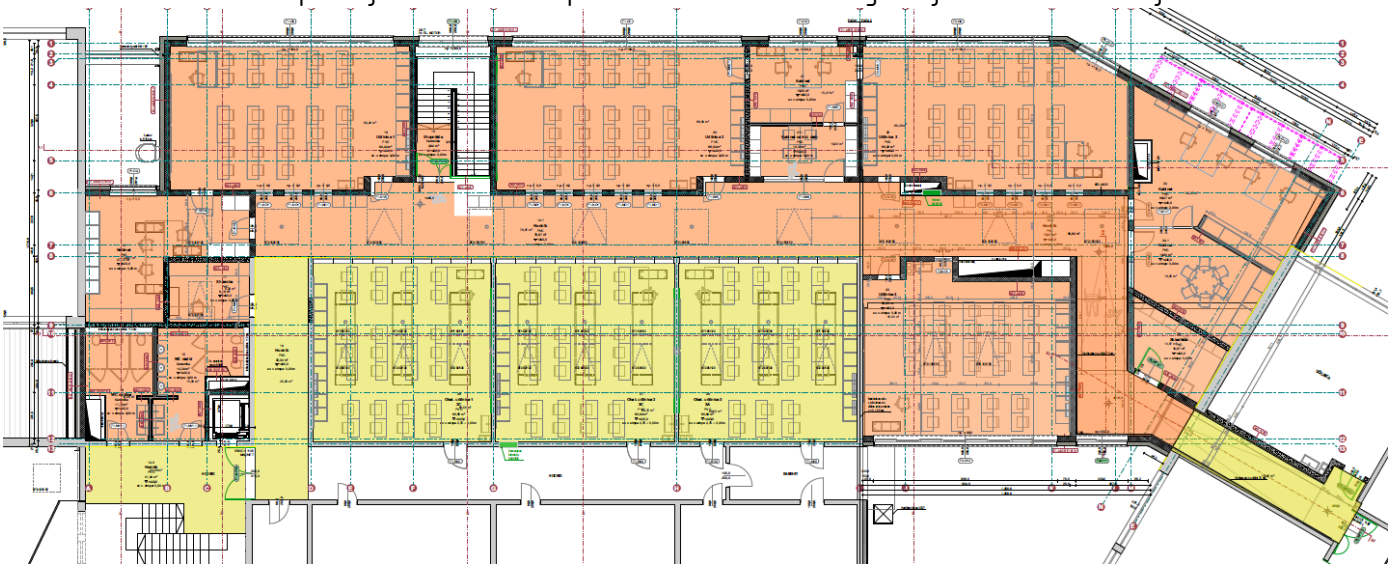
Prečni prerez preko šole



Vzdolžni prerez preko prizidave



Tloris pritličja o označenim površinskim delom novogradnje in rekonstrukcije



Tloris nadstropja o označenim površinskim delom novogradnje in rekonstrukcije

## 3 KONDICIONIRANA POVRŠINA IN PROSTORNINA NOVOGRADNJE

Za sofinanciranje gradnje sNES se upoštevajo prostori novogradnje, v prvi in drugi fazi. Gre za nove prostore pritličja in nadstropja, vse v javni funkciji. Notranji prostori v stavbnem ovoju morajo biti ustrezno kondicionirani tj. ogrevani ter energijsko učinkovito prezračevani glede na zahteve sofinancerja. Skupna neto površina znaša po popisu notranjih prostorov 1.737,5 $m^2$, neto prostornina pa 3.268,9 $m^3$.

Od te skupne površine je energijsko učinkovito prezračevanih, preko naprave KN1 z vračanjem toplote več kot 80%, prostorov 496,19 $m^2$ v prvi fazi ter 254,62 $m^2$ v drugi fazi.

# PRIZIDAVA OŠ POLZELA

**PRITLIČJE**

| Št. pr. | Prostor | Stanje | Tlak | Faza | Površina (m2) | Višina stropa (m) | Volumen (m3) | klimat, prezračevanje | ogrevalo |
|---|---|---|---|---|---|---|---|---|---|
| Tloris pritličja | | | | | | | | | |
| 1 | Jedilnica | Novogradnja | PVC | Sklop 1 | 133,73 | 3,50 | 468,06 | K3 KLIMAT POMIVANJE POSODE | T.O. |
| | Jedilnica | Rekonstrukcija | PVC | Sklop 1 | 210,99 | 3,50 | 738,47 | K1 KLIMAT OBJEKT | T.O. |
| 1.1 | Jedilnica | Rekonstrukcija | PVC | Sklop 1 | 62,38 | 3,08 | 192,13 | K1 KLIMAT OBJEKT | T.O. |
| 2 | Skupni prostor / garderoba | Rekonstrukcija | PVC | Sklop 1 | 60,97 | 3,30 | 201,20 | K1 KLIMAT OBJEKT | T.O. |
| 3 | WC inv. | Rekonstrukcija | Keramika | Sklop 1 | 4,94 | 3,30 | 16,30 | K1 KLIMAT OBJEKT | T.O. |
| 4 | Skladišče čistil | Rekonstrukcija | Keramika | Sklop 1 | 5,58 | 3,30 | 18,41 | K1 KLIMAT OBJEKT | T.O. |
| 5 | Dvigalo | Novogradnja | Keramika | Sklop 1 | 3,47 | 3,30 | 11,45 | K1 KLIMAT OBJEKT | T.O. |
| 6 | Sanitarije M. | Novogradnja | Keramika | Sklop 1 | 13,98 | 3,30 | 46,13 | K1 KLIMAT OBJEKT | T.O. |
| 7 | Sanitarije Ž. | Novogradnja | Keramika | Sklop 1 | 13,25 | 3,30 | 43,73 | K1 KLIMAT OBJEKT | T.O. |
| 8 | Shrambo vrtnega orodja | Novogradnja | Keramika | Sklop 1 | 39,09 | 4,00 | 156,36 | K1 KLIMAT OBJEKT | T.O. |
| 9 | Shramba učil | Rekonstrukcija | PVC | Sklop 1 | 7,22 | 3,30 | 23,83 | K1 KLIMAT OBJEKT | T.O. |
| | Shramba učil | Novogradnja | PVC | Sklop 1 | 9,57 | 3,30 | 31,58 | K1 KLIMAT OBJEKT | T.O. |
| 10 | Učilnica 1.a | Novogradnja | PVC | Sklop 1 | 76,98 | 3,30 | 254,03 | K1 KLIMAT OBJEKT | T.O. |
| 11 | Kabinet | Novogradnja | PVC | Sklop 1 | 15,67 | 3,30 | 51,71 | K1 KLIMAT OBJEKT | T.O. |
| 12 | Hodnik | Novogradnja | Keramika | Sklop 1 | 23,55 | 3,30 | 77,72 | K1 KLIMAT OBJEKT | T.O. |
| K1 | Kuhinja | Rekonstrukcija | Keramika | Sklop 2 | 41,06 | 3,1 | 127,29 | K2 KLIMAT KUHINJA | |
| | Kuhinja | Novogradnja | Keramika | Sklop 2 | 50,28 | 3,1 | 155,87 | K2 KLIMAT KUHINJA | |
| K2 | Priprava dijet | Rekonstrukcija | Keramika | Sklop 2 | 6,32 | 3,1 | 19,59 | K2 KLIMAT KUHINJA | |
| K3 | Priprava zelenjave | Rekonstrukcija | Keramika | Sklop 2 | 11,97 | 3,1 | 37,11 | K2 KLIMAT KUHINJA | |
| K4 | Pranje posode | Novogradnja | Keramika | Sklop 2 | 39,49 | 3,1 | 122,42 | K3 KLIMAT POMIVANJE POSODE | R.O. |
| K5 | Zamrzovalnica | Novogradnja | Keramika | Sklop 2 | 2,56 | 3,1 | 7,94 | | |
| K6 | Hladilna komora 1 | Novogradnja | Keramika | Sklop 2 | 4,77 | 3,1 | 14,79 | | |
| K7 | Hladilna komora 2 | Novogradnja | Keramika | Sklop 2 | 6,91 | 3,1 | 21,42 | | |
| K8 | Pralnica | Novogradnja | Keramika | Sklop 2 | 3,93 | 3,1 | 12,18 | K3 KLIMAT POMIVANJE POSODE | |
| K9 | Garderoba | Novogradnja | Keramika | Sklop 2 | 9,25 | 3,1 | 28,68 | K3 KLIMAT POMIVANJE POSODE | R.O. |
| K10 | Tuš | Novogradnja | Keramika | Sklop 2 | 1,71 | 3,1 | 5,30 | K3 KLIMAT POMIVANJE POSODE | R.O. |
| K11 | WC | Novogradnja | Keramika | Sklop 2 | 1,2 | 3,1 | 3,72 | K3 KLIMAT POMIVANJE POSODE | |
| K12 | Manipulacijski prostor | Rekonstrukcija | Keramika | Sklop 2 | 2,71 | 3,1 | 8,40 | K3 KLIMAT POMIVANJE POSODE | R.O. |
| | Manipulacijski prostor | Novogradnja | Keramika | Sklop 2 | 26,45 | 3,1 | 82,00 | K3 KLIMAT POMIVANJE POSODE | R.O. |
| K13 | Prevzem | Novogradnja | Keramika | Sklop 2 | 4,52 | 3,1 | 14,01 | NI PRISILNO PREZRAČEVANO | R.O. |
| K14 | Shramba organskih odpadkov | Rekonstrukcija | Keramika | Sklop 2 | 2,37 | 3,1 | 7,35 | K3 KLIMAT POMIVANJE POSODE | |
| K15 | Shramba gomoljev | Rekonstrukcija | Keramika | Sklop 2 | 2,80 | 3,1 | 8,68 | K3 KLIMAT POMIVANJE POSODE | |
| K16 | Prostor za čistila | Rekonstrukcija | Keramika | Sklop 2 | 4,64 | 3,1 | 14,38 | K3 KLIMAT POMIVANJE POSODE | |
| K17 | Pisarna | Rekonstrukcija | Keramika | Sklop 2 | 3,02 | 3,1 | 9,36 | K3 KLIMAT POMIVANJE POSODE | R.O. |
| | Pisarna | Novogradnja | Keramika | Sklop 2 | 1,92 | 3,1 | 5,95 | K3 KLIMAT POMIVANJE POSODE | R.O. |
| K18 | Skladišče | Rekonstrukcija | Keramika | Sklop 2 | 13,2 | 3,1 | 40,92 | K3 KLIMAT POMIVANJE POSODE | |
| K19 | Prostor za zaposlene | Rekonstrukcija | Keramika | Sklop 2 | 13,42 | 3,1 | 41,60 | K2 KLIMAT KUHINJA | T.O. |
| | | | | | **935,87** | | **3120,05** | | |

| | | | |
|---|---|---|---|
| 1 faza novogradnja | 329,29 | | 1140,77 |
| 1 faza rekonstrukcija | 352,08 | | 1190,34 |
| 2 faza novogradnja | 152,99 | | 474,27 |
| 2 faza rekonstrukcija | 101,51 | | 314,68 |
| | **935,87** | | **3120,05** |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **NADSTROPJE** | | | | | | | | | |
| 13 | Stopnišče | Novogradnja | Keramika | Sklop 1 | 3,94 | 0 | 0,00 | K1 KLIMAT OBJEKT | T.O. |
| 14 | Hodnik | Rekonstrukcija | PVC | Sklop 1 | 25,03 | 3,00 | 75,09 | K1 KLIMAT OBJEKT | T.O. |
| 14.1 | Hodnik | Novogradnja | PVC | Sklop 1 | 76,97 | 3,00 | 230,91 | K1 KLIMAT OBJEKT | T.O. |
| 14.2 | Hodnik | Rekonstrukcija | PVC | Sklop 2 | 18,47 | 3,00 | 55,41 | K1 KLIMAT OBJEKT | T.O. |
| | Hodnik | Novogradnja | PVC | Sklop 2 | 56,6 | 3,00 | 169,80 | K1 KLIMAT OBJEKT | T.O. |
| 14.3 | Hodnik | Rekonstrukcija | PVC | Sklop 1 | 21,34 | 3,00 | 64,02 | K1 KLIMAT OBJEKT | T.O. |
| 15 | WC dečki | Novogradnja | Keramika | Sklop 1 | 14,24 | 3,00 | 42,72 | K1 KLIMAT OBJEKT | T.O. |
| 16 | WC deklice | Novogradnja | Keramika | Sklop 1 | 11,74 | 3,00 | 35,22 | K1 KLIMAT OBJEKT | T.O. |
| 17 | Shramba | Novogradnja | PVC | Sklop 1 | 9,16 | 3,00 | 27,48 | K1 KLIMAT OBJEKT | T.O. |
| 18 | Kabinet | Novogradnja | PVC | Sklop 1 | 27,72 | 3,00 | 83,16 | K1 KLIMAT OBJEKT | T.O. |
| 19 | Učilnica 1 | Novogradnja | PVC | Sklop 1 | 64,44 | 3,00 | 193,32 | K1 KLIMAT OBJEKT | T.O. |
| 20 | Učilnica 2 | Novogradnja | PVC | Sklop 1 | 66,54 | 3,00 | 199,62 | K1 KLIMAT OBJEKT | T.O. |
| 21 | Kabinet | Novogradnja | PVC | Sklop 1 | 15,55 | 3,00 | 46,65 | K1 KLIMAT OBJEKT | T.O. |
| 21.1 | Kabinet za ind. delo | Novogradnja | PVC | Sklop 1 | 10,33 | 3,00 | 30,99 | K1 KLIMAT OBJEKT | T.O. |
| 22 | Učilnica 3 | Novogradnja | PVC | Sklop 2 | 68,28 | 3,00 | 204,84 | K1 KLIMAT OBJEKT | T.O. |
| 23 | Učilnica 4 | Novogradnja | PVC | Sklop 2 | 62,9 | 3,00 | 188,70 | K1 KLIMAT OBJEKT | T.O. |
| 24 | Kabinet | Novogradnja | PVC | Sklop 2 | 36,37 | 3,00 | 109,11 | K1 KLIMAT OBJEKT | T.O. |
| 24.1 | Kabinet | Novogradnja | PVC | Sklop 2 | 19,8 | 3,00 | 59,40 | K1 KLIMAT OBJEKT | T.O. |
| 25 | Skladišče | Novogradnja | PVC | Sklop 2 | 10,67 | 3,00 | 32,01 | K1 KLIMAT OBJEKT | T.O. |
| 26 | Obst. učilnica 1 | Rekonstrukcija | PVC | Sklop 1 | 60,55 | 3,20 | 193,76 | K1 KLIMAT OBJEKT | R.O. |
| 27 | Obst. učilnica 2 | Rekonstrukcija | PVC | Sklop 1 | 60,84 | 3,20 | 194,69 | K1 KLIMAT OBJEKT | R.O. |
| 28 | Obst. učilnica 3 | Rekonstrukcija | PVC | Sklop 1 | 60,64 | 3,20 | 194,05 | K1 KLIMAT OBJEKT | R.O. |
| | | | | | **802,12** | | **2430,95** | | |
| | | | | | | | | | |
| | 1 faza novogradnja | | | | 300,63 | | 890,07 | | |
| | 1 faza rekonstrukcija | | | | 228,4 | | 721,61 | | |
| | 2 faza novogradnja | | | | 254,62 | | 763,86 | | |
| | 2 faza rekonstrukcija | | | | 18,47 | | 55,41 | | |
| | | | | | **802,12** | | **2430,95** | | |
| **PRITLIČJE + NADSTROPJE** | | | | | | | | | |
| | | | | | | | | | |
| | 1 faza novogradnja P+N | | | | 629,92 | | 2030,84 | | |
| | 2 faza novogradnja P+N | | | | 407,61 | | 1238,13 | | |
| | | | | | **1037,53** | | **3268,97** | | |

## Energijsko učinkovito prezračevanje preko klimata KN1:

| | | | | | |
|---|---|---|---|---|---|
| **PRITLIČJE + NADSTROPJE** | | | | | |
| | | | | | |
| | 1 faza novogradnja P+N | | | | 496,19 |
| | 2 faza novogradnja P+N | | | | 254,62 |
| | | | | | **750,81** |

# 4 TOPLOTNI OVOJ STAVBE

V zunanjem stavbnem ovoju, katerega sicer konstrukcijsko prestavlja masivna (AB) gradnja, sicer prevladuje raba toplotnih izolacij mineralnega izvora (82% za prvo fazo in 71% za drugo fazo), pri čemer je fasadna izolacija ter izolacija strehe iz mineralne volne, prav tako del izolacije tal. Stavba za obe fazi kandidira za sofinanciranje v mineralnem razredu, saj je volumski delež polistirenov manjši od 30%.

1. FAZA

| | A | polistireni | mineralna | biološka | polistireni | mineralna | biološka |
|---|---|---|---|---|---|---|---|
| 01ud-Zunanja AB stena, fasada | 206,7 | | 0,22 | | 0,0 | 45,5 | 0,0 |
| 02ud-Zunanja AB stena, cokl | 32,59 | 0,22 | | | 7,2 | 0,0 | 0,0 |
| 03ud-Tlak na terenu, prostori | 452,8 | 0,08 | 0,12 | | 36,2 | 54,3 | 0,0 |
| 04ud-Tlak na terenu, kuhinja | 0,0 | 0,21 | | | 0,0 | 0,0 | 0,0 |
| 05ud-Vkopana AB stena | 31,26 | 0,22 | | | 6,9 | 0,0 | 0,0 |
| 06ud-Tla na terenu, jašek | 6,76 | 0,20 | | | 1,4 | 0,0 | 0,0 |
| 08ud-Poševna streha | 347,2 | | 0,35 | | 0,0 | 121,5 | 0,0 |
| 09ud-Ravna streha | 18,56 | | 0,44 | | 0,0 | 8,1 | 0,0 |
| 10ud-Previsni del | 12,9 | 0,02 | 0,27 | | 0,3 | 3,5 | 0,0 |
| | | | | | 0,0 | 0,0 | 0,0 |
| | | | | | | | |
| | | | | | 51,9 | 232,9 | 0,0 |
| | | | | | 18,2% | 81,8% | 0,0% |

2. FAZA

| | A | polistireni | mineralna | biološka | polistireni | mineralna | biološka |
|---|---|---|---|---|---|---|---|
| 01ud-Zunanja AB stena, fasada | 189,6 | | 0,22 | | 0,0 | 41,7 | 0,0 |
| 02ud-Zunanja AB stena, cokl | 26,95 | 0,22 | | | 5,9 | 0,0 | 0,0 |
| 03ud-Tlak na terenu, prostori | 0,0 | 0,08 | 0,12 | | 0,0 | 0,0 | 0,0 |
| 04ud-Tlak na terenu, kuhinja | 281,9 | 0,21 | | | 59,2 | 0,0 | 0,0 |
| 05ud-Vkopana AB stena | 12,55 | 0,22 | | | 2,8 | 0,0 | 0,0 |
| 06ud-Tla na terenu, jašek | 0 | 0,20 | | | 0,0 | 0,0 | 0,0 |
| 08ud-Poševna streha | 283,5 | | 0,42 | | 0,0 | 119,0 | 0,0 |
| 09ud-Ravna streha | 0 | | 0,44 | | 0,0 | 0,0 | 0,0 |
| 10ud-Previsni del | 10,04 | 0,02 | 0,27 | | 0,2 | 2,7 | 0,0 |
| | | | | | 0,0 | 0,0 | 0,0 |
| | | | | | | | |
| | | | | | 68,1 | 163,5 | 0,0 |
| | | | | | 29,4% | 70,6% | 0,0% |

Opis vseh ključnih sklopov toplotnega ovoja je podan v prilogah elaborata, skupaj s tehničnimi podatki za primere izolacij z ustreznimi toplotnimi karakteristikami, kar je potrebno upoštevati v novelaciji PZI načrta arhitekture. Glede na rešitve za ukrepe URE po izhodiščnem PZI so podane izboljšave, za izpolnitev zahtev za toplotno zaščito, iz javnega poziva za sofinanciranje.

| Assembly no. | Building assembly description | Interior insulation? |
|---|---|---|
| | Zunanja AB stena, fasada | |

Heat transmission resistance [m²K/W]

Orientation of building element: 2-Wall — interior $R_{si}$: 0,13

Adjacent to: 1-Outdoor air — exterior $R_{se}$: 0,04

| Area section 1 | λ [W/(mK)] | Area section 2 (optional) | λ [W/(mK)] | Area section 3 (optional) | λ [W/(mK)] | Thickness [mm] |
|---|---|---|---|---|---|---|
| notranji omet | 0,800 | | | | | 10 |
| AB stena | 2,040 | (več debelin) | | | | 180 |
| lepilo | 0,800 | | | | | 5 |
| kamena volna 034 | 0,034 | (Knauf Insulation FKD-N Thermal) | | povečana debelina sloja, boljša izolacija | | 220 |
| omet | 0,700 | | | | | 10 |
| | | | | | | |

Percentage of sec. 1: 100% — Percentage of sec. 2: — Percentage of sec. 3: — Total: 42,5 cm

U-value supplement: — W/(m²K)

**U-value: 0,148 W/(m²K)**

| Assembly no. | Building assembly description | Interior insulation? |
|---|---|---|
| | Zunanja AB stena, cokl | |

Heat transmission resistance [m²K/W]

Orientation of building element: 2-Wall — interior $R_{si}$: 0,13

Adjacent to: 1-Outdoor air — exterior $R_{se}$: 0,04

| Area section 1 | λ [W/(mK)] | Area section 2 (optional) | λ [W/(mK)] | Area section 3 (optional) | λ [W/(mK)] | Thickness [mm] |
|---|---|---|---|---|---|---|
| notranji omet | 0,800 | | | | | 10 |
| AB stena | 2,040 | (več debelin) | | | | 180 |
| hidroizolacija | 0,190 | | | | | 5 |
| EPS 031 | 0,031 | (Fragmat Neocokl) | | povečana debelina sloja, boljša izolacija | | 220 |
| omet | 0,700 | | | | | 10 |
| | | | | | | |
| | | | | | | |

Percentage of sec. 1: 100% — Percentage of sec. 2: — Percentage of sec. 3: — Total: 42,5 cm

U-value supplement: — W/(m²K)

**U-value: 0,135 W/(m²K)**

Assembly no. | Tlak na terenu, prostori | Interior insulation?

Heat transmission resistance [m²K/W]

Orientation of building element: 3-Floor — interior $R_{si}$: 0,17

Adjacent to: 2-Ground — exterior $R_{se}$: 0,00

| Area section 1 | λ [W/(mK)] | Area section 2 (optional) | λ [W/(mK)] | Area section 3 (optional) | λ [W/(mK)] | Thickness [mm] |
|---|---|---|---|---|---|---|
| talna obloga | 1,200 | | | | | 15 |
| cementni estrih | 1,600 | | | (v sloju estriha upoštevana višina čepkov s.p. 22mm) | | 90 |
| sistemska plošča za talno ogr. EPS 034 | 0,034 | (Fragmat Stirotermal Duo 20) | | (debelina sloja EPS plošče 20mm) | | 20 |
| PE folija | 0,190 | | | | | 0 |
| kamena volna 037 | 0,037 | (Knauf Insulation DF) | | povečana debelina sloja | | 120 |
| EPS 031 | 0,031 | (Fragmat Neo Super 100) | | prilagojeni materiali | | 60 |
| hidroizolacija | 0,190 | | | | | 5 |
| podložni beton | 2,040 | | | | | 100 |

Percentage of sec. 1: 100% | Percentage of sec. 2 | Percentage of sec. 3 | Total: 41,0 cm

U-value supplement: W/(m²K)

**U-value: 0,164** W/(m²K)

Assembly no. | Tlak na terenu, kuhinja | Interior insulation?

Heat transmission resistance [m²K/W]

Orientation of building element: 3-Floor — interior $R_{si}$: 0,17

Adjacent to: 2-Ground — exterior $R_{se}$: 0,00

| Area section 1 | λ [W/(mK)] | Area section 2 (optional) | λ [W/(mK)] | Area section 3 (optional) | λ [W/(mK)] | Thickness [mm] |
|---|---|---|---|---|---|---|
| talna obloga | 1,200 | | | | | 15 |
| cementni estrih | 1,600 | | | (v sloju estriha upoštevana višina čepkov s.p. 22mm) | | 100 |
| PE folija | 0,190 | | | | | 0 |
| EPS 034 | 0,034 | (Fragmat EPS 200) | | povečana debelina sloja | | 180 |
| XPS 036 | 0,036 | (Fragmat XPS) | | prilagojeni materiali | | 30 |
| hidroizolacija | 0,190 | | | | | 5 |
| podložni beton | 2,040 | | | | | 100 |
| | | | | | | |
| | | | | | | |

Percentage of sec. 1: 100% | Percentage of sec. 2 | Percentage of sec. 3 | Total: 43,0 cm

U-value supplement: W/(m²K)

**U-value: 0,155** W/(m²K)

Assembly no. | Vkopana AB stena | Interior insulation?

Heat transmission resistance [m²K/W]

Orientation of building element: 2-Wall — interior $R_{si}$: 0,13

Adjacent to: 2-Ground — exterior $R_{se}$: 0,00

| Area section 1 | λ [W/(mK)] | Area section 2 (optional) | λ [W/(mK)] | Area section 3 (optional) | λ [W/(mK)] | Thickness [mm] |
|---|---|---|---|---|---|---|
| notranji omet | 0,800 | | | | | 10 |
| AB stena | 2,040 | (več debelin) | | | | 180 |
| hidroizolacija | 0,190 | | | | | 5 |
| XPS 036 | 0,036 | (Fragmat XPS) | | povečana debelina sloja, boljša izolacija | | 220 |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |

Percentage of sec. 1: 100% | Percentage of sec. 2 | Percentage of sec. 3 | Total: 41,5 cm

U-value supplement: W/(m²K)

**U-value: 0,157** W/(m²K)

Assembly no. | Tla na terenu, jašek | Interior insulation?

Heat transmission resistance [m²K/W]

Orientation of building element: 3-Floor — interior $R_{si}$: 0,17

Adjacent to: 2-Ground — exterior $R_{se}$: 0,00

| Area section 1 | λ [W/(mK)] | Area section 2 (optional) | λ [W/(mK)] | Area section 3 (optional) | λ [W/(mK)] | Thickness [mm] |
|---|---|---|---|---|---|---|
| AB talna plošča | 2,040 | | | | | 200 |
| XPS 036 | 0,036 | (Fragmat XPS) | | | | 200 |
| hidroizolacija | 0,190 | | | | | 5 |
| podložni beton | 1,600 | | | | | 100 |
| | | | | | | |

Percentage of sec. 1: 100% | Percentage of sec. 2 | Percentage of sec. 3 | Total: 50,5 cm

U-value supplement: W/(m²K)

**U-value: 0,169** W/(m²K)

Assembly no. | Poševna streha, 1. faza | Interior insulation?

Heat transmission resistance [m²K/W]

Orientation of building element: 1-Roof — interior $R_{si}$: 0,10

Adjacent to: 1-Outdoor air — exterior $R_{se}$: 0,04

| Area section 1 | λ [W/(mK)] | Area section 2 (optional) | λ [W/(mK)] | Area section 3 (optional) | λ [W/(mK)] | Thickness [mm] |
|---|---|---|---|---|---|---|
| akustične plošče | 0,060 | (Knauf Armstrong) | | | | 13 |
| mineralna volna 039 | 0,039 | (Knauf Insulation Akustik Roll) | | | | 50 |
| mirujoči zrak | 6,120 | (več debelin plasti) | | | | 1000 |
| AB plošča | 2,040 | | | | | 200 |
| parna zapora | 0,190 | | | | | 2 |
| kamena volna 036 | 0,036 | (Knauf Insulation Smart Roof Thermal) | | | | 200 |
| kamena volna 038 | 0,038 | (Knauf Insulation Smart Roof Top) | | | | 100 |
| strešna folija | 0,190 | | | | | 2 |

Percentage of sec. 1: 100% | Percentage of sec. 2 | Percentage of sec. 3 | Total: 156,7 cm

U-value supplement: W/(m²K)

**U-value: 0,099** W/(m²K)

Assembly no. | Ravna streha | Interior insulation?

Heat transmission resistance [m²K/W]

Orientation of building element: 1-Roof — interior $R_{si}$: 0,10

Adjacent to: 1-Outdoor air — exterior $R_{se}$: 0,04

| Area section 1 | λ [W/(mK)] | Area section 2 (optional) | λ [W/(mK)] | Area section 3 (optional) | λ [W/(mK)] | Thickness [mm] |
|---|---|---|---|---|---|---|
| omet | 0,800 | | | | | 10 |
| AB plošča | 2,040 | | | | | 200 |
| parna zapora | 0,190 | | | | | 2 |
| kamena volna 036 | 0,036 | (Knauf Insulation Smart Roof Thermal) | | | | 200 |
| kamena volna 038 | 0,038 | (Knauf Insulation Smart Roof Top) | | | | 100 |
| kamena volna 040 | 0,040 | (Knauf Insulation Smart Roof Top CTF1) | | naklon od 2 do 25cm | | 135 |
| strešna folija | 0,190 | | | | | 2 |
| | | | | | | |

Percentage of sec. 1: 100% | Percentage of sec. 2 | Percentage of sec. 3 | Total: 64,9 cm

U-value supplement: W/(m²K)

**U-value: 0,085** W/(m²K)

| Assembly no. | | Interior insulation? |
|---|---|---|
| | Poševna streha - 2 faza | |

Heat transmission resistance [m²K/W]

Orientation of building element: 1-Roof — interior $R_{si}$: 0,10

Adjacent to: 1-Outdoor air — exterior $R_{se}$: 0,04

| Area section 1 | λ [W/(mK)] | Area section 2 (optional) | λ [W/(mK)] | Area section 3 (optional) | λ [W/(mK)] | Thickness [mm] |
|---|---|---|---|---|---|---|
| akustične plošče | 0,060 | (Knauf Armstrong) | | | | 13 |
| mineralna volna 039 | 0,039 | (Knauf Insulation Akustik Roll) | | ODEBELITI SLOJ IZOLACIJE | | 120 |
| mirujoči zrak | 6,120 | (več debelin plasti) | | | | 1000 |
| AB plošča | 2,040 | | | | | 200 |
| parna zapora | 0,190 | | | | | 2 |
| kamena volna 036 | 0,036 | (Knauf Insulation Smart Roof Thermal) | | | | 200 |
| kamena volna 038 | 0,038 | (Knauf Insulation Smart Roof Top) | | | | 100 |
| strešna folija | 0,190 | | | | | 2 |

| Percentage of sec. 1 | Percentage of sec. 2 | Percentage of sec. 3 | Total |
|---|---|---|---|
| 100% | | | 163,7 cm |

U-value supplement: W/(m²K)

**U-value: 0,084** W/(m²K)

| Assembly no. | | Interior insulation? |
|---|---|---|
| 10,9047619047619ud | Previsni del | |

Heat transmission resistance [m²K/W]

Orientation of building element: 3-Floor — interior $R_{si}$: 0,17

Adjacent to: 1-Outdoor air — exterior $R_{se}$: 0,04

| Area section 1 | λ [W/(mK)] | Area section 2 (optional) | λ [W/(mK)] | Area section 3 (optional) | λ [W/(mK)] | Thickness [mm] |
|---|---|---|---|---|---|---|
| talna obloga | 1,200 | | | | | 15 |
| cementni estrih | 1,600 | | | (v sloju estriha upoštevana višina čepkov s.p. 22mm) | | 90 |
| sistemska plošča za talno ogr. EPS 034 | 0,034 | (Fragmat Stirotermal Duo 20) | | (debelina sloja EPS plošče 20mm) | | 20 |
| PE folija | 0,190 | | | | | 0 |
| kamena volna 037 | 0,037 | (Knauf Insulation DF) | | povečana debelina sloja | | 50 |
| AB plošča | 2,040 | | | prilagojeni materiali | | 200 |
| kamena volna 034 | 0,034 | (Knauf Insulation FKD-N Thermal) | | povečana debelina sloja, boljša izolacija | | 220 |
| omet | 0,700 | | | | | 10 |

| Percentage of sec. 1 | Percentage of sec. 2 | Percentage of sec. 3 | Total |
|---|---|---|---|
| 100% | | | 60,5 cm |

U-value supplement: W/(m²K)

**U-value: 0,114** W/(m²K)

# 5 PREVERITEV UKREPOV NA STROJNIH INSTALACIJAH

Vsi notranji prostori novogradnje morajo biti kondicionirani na ustrezen način tj. morajo biti v celoti ogrevani in pa energijsko učinkovito prezračevani, z vračanjem toplote. Rešitve iz obstoječega PZI načrta morajo biti dopolnjene na način, da bo razvidno izpolnjevanje te zahteve sofinancerja.
Glavni vir za proizvodnjo toplote za ogrevanje, pripravo tople vode in za prezračevanje je toplotna črpalka tipa zrak-voda. Prostori novogradnje bodo pohlajevani za potrebe obratovanja izven ogrevalne sezone, delno preko sistema prezračevanja (DX hlajenje preko klimatov) ter delno preko sistema talnega pohlajevanja.

V PZI načrtu strojništva je predvidena vgradnja klimata za novogradnjo, kapacitete 10.500 $m^3/h$, ki ima definiran izkoristek vračanja toplote 80,4% tj. nad mejno vrednostjo sofinancerja (80%). Dokazilo za primer naprave z ustreznimi energijskimi lastnostmi se nahaja v prilogah elaborata.
Ostale prezračevalne naprave so vezane predvsem na področje kuhinje v drugi fazi gradnje in imajo izkoristek vračanja toplote nižji od 80% (varčna napa z vračanjem toplote, odsesovanje zraka pri pomivanju posode, itd.).

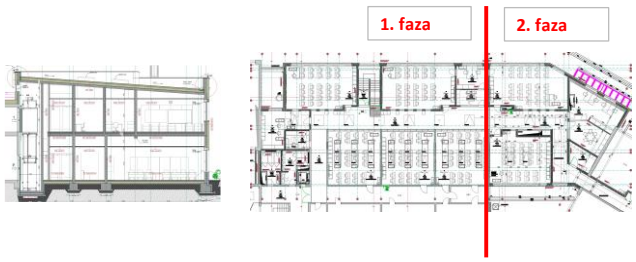
V noveliranih načrtu strojnih instalacij mora biti predvideno temperiranje vseh notranjih prostorov v obeh etažah, ki jih obdaja zunanji toplotni ovoj stavbe. Prav tako morajo biti prezračevani vsi ti notranji prostori, z napravami z vračanjem toplote zavrženega zraka, lahko v dovodnih conah, odvodnih conah ter v pretočnih conah. Prezračevanje se dopolnjuje tudi z uvedbo prezračevanja za vse pomožne prostore in komunikacije, prav tako za prezračevanje kuhinje in zalednega dela, vse preko klimata z vračanjem toplote.

# 6 IZRAČUNI ENERGIJSKIH KARAKTERISTIK NOVOGRADNJE

Za prilagojene projektne rešitve za ukrepe URE je potekala preverba tudi s pomočjo izračuna energijskih karakteristik novogradnje. Izračun je izdelan na osnovi predpisane računske metodologije, konkretno angleška verzija metode PHPP 9.6. Izračun je izdelan glede na robne parametre razpisovalca, spremljali pa so se izhodni podatki izračuna, pri čemer so evidentirane naslednje končne vrednosti:

- Vse neprosojne konstrukcije toplotnega ovoja imajo izračunano toplotno prehodnost $U<0,15 W/m^2K$, talne konstrukcije pa vrednosti $U<0,17 W/m^2K$, podane so izboljšave za izpolnitev zahtev sofinancerja.
- Zunanje stavbno pohištvo ima računsko uporabljene komponente z lastnostmi, ki so zajete iz predloženih merilnih poročil in certifikatov. Ti primeri imajo lastnosti, ki izpolnjujejo zahteve sofinancerja.
- Prezračevanje novogradnje z napravo s toplotnim izkoristkom najmanj 80% in zmanjšano rabo električne energije za pogon.
- Računska potrebna toplota za ogrevanje prostorov ter hladu za hlajenje prostorov je ločeno za obe fazi ovrednotena v višini manj kot 6,0 $kWh/(m^3a)$, kolikor je meja iz javnega poziva.

# PHPP-Energy balance calculation




| | | | |
|---|---|---|---|
| **Building:** | Prizidava OŠ Polzela - 1. faza | | |
| Street: | parc.št. *714, 779/4,..., k.o. 992 Polzela | | |
| Postcode/City: | | | |
| Province/Country: | | SI-Slovenia | |
| Building type: | CC-SI 12630 | | |
| Climate data set: | ud---01-Ljubljana, Eko sklad 2018 | | |
| Climate zone: | 3: Cool-temperate | Altitude of location: | 309 m |
| **Home owner / Client:** | Občina Polzela | | |
| Street: | Malteška cesta 28 | | |
| Postcode/City: | 3313 | Polzela | |
| Province/Country: | | SI-Slovenia | |

| | | | |
|---|---|---|---|
| **Architecture:** | Uniprojekt d.o.o. | | |
| Street: | Savinjska cesta 117 | | |
| Postcode/City: | 3313 | Polzela | |
| Province/Country: | | SI-Slovenia | |
| **Energy consultancy:** | | | |
| Street: | | | |
| Postcode/City: | | | |
| Province/Country: | | | |

| | | | |
|---|---|---|---|
| **Mechanical engineer:** | Projekt Forma d.o.o. | | |
| Street: | Začret 46b | | |
| Postcode/City: | 3202 | Začret | |
| Province/Country: | | SI-Slovenia | |
| **Certification:** | | | |
| Street: | | | |
| Postcode/City: | | | |
| Province/Country: | | | |

| | | | | | |
|---|---|---|---|---|---|
| Year of construction: | 2025 | Interior temperature winter [°C]: | 20,0 | Interior temp. summer [°C]: | 25,0 |
| No. of dwelling units: | 1 | Internal heat gains (IHG) heating case [W/m²]: | 4,2 | IHG cooling case [W/m²]: | 4,2 |
| No. of occupants: | 150,0 | Specific capacity [Wh/K per m² TFA]: | 204 | Mechanical cooling: | x |

**Specific building characteristics with reference to the treated floor area**

| | | | | | Criteria | Alternative criteria | Fullfilled?[2] |
|---|---|---|---|---|---|---|---|
| | Treated floor area | m² | 629,9 | | | | |
| **Space heating** | Heating demand | kWh/(m²a) | 12,8 | ≤ | - | - | - |
| | | kWh/(m³a) | 4,1 | | | | |
| | Heating load | W/m² | 11 | ≤ | - | - | |
| **Space cooling** | Cooling & dehum. demand | kWh/(m²a) | 2,8 | ≤ | - | - | - |
| | | kWh/(m³a) | 0,9 | | | | |
| | Cooling load | W/m² | 5 | ≤ | - | - | |
| | Frequency of overheating (> 25 °C) | % | - | ≤ | - | | - |
| | Frequency of excessively high humidity (> 12 g/kg) | % | 0 | ≤ | - | | - |
| **Airtightness** | Pressurization test result $n_{50}$ | 1/h | 0,6 | ≤ | - | | - |
| **Non-renewable Primary Energy (PE)** | PE demand | kWh/(m²a) | 93 | ≤ | - | | - |
| **Primary Energy Renewable (PER)** | PER demand | kWh/(m²a) | 48 | ≤ | - | - | - |
| | Generation of renewable energy (in relation to projected building footprint area) | kWh/(m²a) | 33 | ≥ | - | - | |

[2] Empty field: Data missing; '-': No requirement

# Specific energy for heating (monthly method)

Prizidava OŠ Polzela - 1. faza / Climate: Ljubljana, Eko sklad 2018 / TFA: 630 m² / Heating: 12,8 kWh/(m²a) / Cooling: 2,8 kWh/(m²a) / PER: 48,1 kWh/(m²a)

The sum of the heating periods calculated through the monthly method will be presented on this side.

| | | |
|---|---|---|
| Interior temperature: | 20 | °C |
| Building type: | CC-SI 12630 | |
| Treated floor area $A_{TFA}$: | 629,9 | m² |
| Spec. Capacity: | 204 | Wh/(m²K) |

| Building assembly | Temperature zone | Area m² | | U-Value W/(m²K) | | Month. red. fac. | | $G_t$ kKh/a | | kWh/a | Per m² of treated floor area |
|---|---|---|---|---|---|---|---|---|---|---|---|
| External wall - Ambient | A | 239,3 | * | 0,146 | * | 1,00 | * | 76 | = | 2662 | 4,23 |
| External wall - Ground | B | 31,3 | * | 0,157 | * | 1,00 | * | 28 | = | 138 | 0,22 |
| Roof/Ceiling - Ambient | A | 378,7 | * | 0,099 | * | 1,00 | * | 76 | = | 2849 | 4,52 |
| Floor slab / Basement ceiling | B | 459,6 | * | 0,164 | * | 1,00 | * | 28 | = | 2132 | 3,38 |
| | A | | * | | * | 1,00 | * | | = | | |
| | A | | * | | * | 1,00 | * | | = | | |
| Unheated | X | | * | | * | 0,35 | * | | = | | |
| Windows | A | 139,4 | * | 0,814 | * | 1,00 | * | 76 | = | 8637 | 13,71 |
| Exterior door | A | 4,6 | * | 0,900 | * | 1,00 | * | 76 | = | 315 | 0,50 |
| Exterior TB (length/m) | A | 100,5 | * | 0,031 | * | 1,00 | * | 76 | = | 233 | 0,37 |
| Perimeter TB (length/m) | P | 36,9 | * | 0,020 | * | 1,00 | * | 28 | = | 21 | 0,03 |
| Ground TB (length/m) | B | | * | | * | 1,00 | * | | = | | 0,00 |
| | | | | | | | | | | | kWh/(m²a) |
| **Transmission heat losses $Q_T$** | | | | | | | | | Total | 16988 | 27,0 |

| | $A_{TFA}$ m² | | Clear room height m | | m³ |
|---|---|---|---|---|---|
| Effective air volume $V_V$ | 630 | * | 3,15 | = | 1985 |

| | $n_{V,system}$ 1/h | | $\eta^*_{SHX}$ | | $\eta_{HR}$ | | $n_{V,Res}$ 1/h | | $n_{V,equi,fraction}$ 1/h |
|---|---|---|---|---|---|---|---|---|---|
| Effective air change rate Ambient nV,e | 0,554 | *(1- | 0% | )*(1- | 0,79 | )+ | 0,052 | = | 0,169 |
| Effective air change rate Ground nV,g | 0,554 | * | 0% | *(1- | 0,79 | ) | | = | 0,000 |

| | $V_V$ m³ | | $n_{V,equi,fraction}$ 1/h | | $c_{Air}$ Wh/(m³K) | | $G_t$ kKh/a | | kWh/a | kWh/(m²a) |
|---|---|---|---|---|---|---|---|---|---|---|
| **Ventilation losses ambient $Q_V$** | 1985 | * | 0,169 | * | 0,33 | * | 76 | = | 8408 | 13,3 |
| **Ventilation losses ground $Q_{V,e}$** | 1985 | * | 0,000 | * | 0,33 | * | 42 | = | 0 | 0,0 |
| **Ventilation heat losses $Q_V$** | | | | | | | | Total | 8408 | 13,3 |

| | $Q_T$ kWh/a | | $Q_V$ kWh/a | | Reduction factor night/weekend saving | kWh/a | kWh/(m²a) |
|---|---|---|---|---|---|---|---|
| **Total heat losses $Q_L$** | ( 16988 | + | 8408 | ) | 1,0 | = 25397 | **40,3** |

| Orientation of the area | Reduction factor see 'Windows' worksheet | | g-Value (perp. radiation) | | Area m² | | Global radiation kWh/(m²a) | | kWh/a |
|---|---|---|---|---|---|---|---|---|---|
| North | 0,47 | * | 0,50 | * | 122,9 | * | 119 | = | 3428 |
| East | 0,00 | * | 0,00 | * | 0,0 | * | 250 | = | 0 |
| South | 0,00 | * | 0,00 | * | 0,0 | * | 458 | = | 0 |
| West | 0,00 | * | 0,00 | * | 0,0 | * | 272 | = | 0 |
| Horizontal | 0,56 | * | 0,51 | * | 16,5 | * | 328 | = | 1554 |
| Sum opaque areas | | | | | | | | | 538 |
| | | | | | | | | | kWh/(m²a) |
| **Available solar heat gains $Q_S$** | | | | | | | | Total | 5520 | 8,8 |

| | kh/d | | Length Heat. Period d/a | | Spec. Power $q_I$ W/m² | | $A_{TFA}$ m² | | kWh/a | kWh/(m²a) |
|---|---|---|---|---|---|---|---|---|---|---|
| **Internal heat gains $Q_I$** | 0,024 | * | 212 | * | 4,2 | * | 629,9 | = | 13365 | 21,2 |

| | | | kWh/a | kWh/(m²a) |
|---|---|---|---|---|
| Free heat $Q_F$ | $Q_S$ + $Q_I$ | = | 18885 | 30,0 |
| Ratio free heat to losses | $Q_F$ / $Q_L$ | = | 0,74 | |
| Utilisation factor heat gains $h_G$ | | = | 92% | |
| | | | kWh/a | kWh/(m²a) |
| **Heat gains $Q_G$** | $\eta_G$ * $Q_F$ | = | 17314 | **27,5** |

| | | | kWh/a | kWh/(m²a) |
|---|---|---|---|---|
| **Annual heating demand $Q_H$** | $Q_L$ - $Q_G$ | = | 8082 | **12,8** |

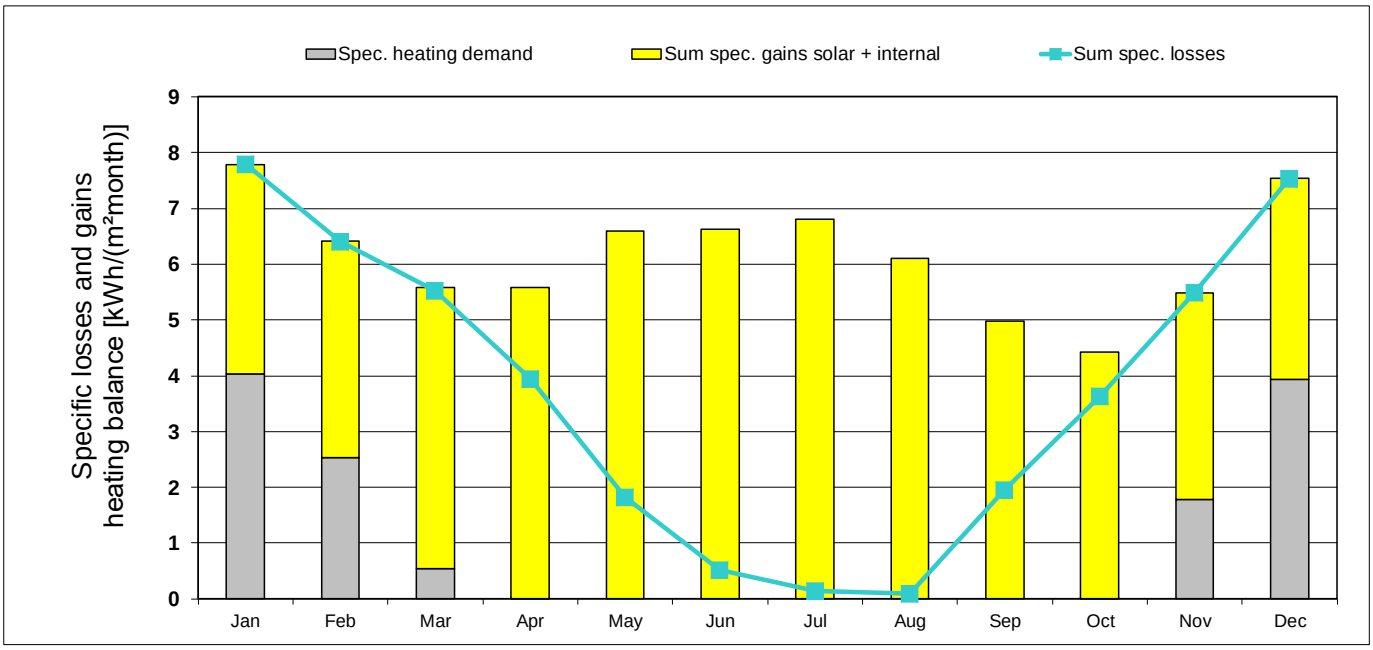
| | kWh/(m²a) | | (Yes/No) |
|---|---|---|---|
| **Limiting value** | - | **Requirement met?** | - |

# Specific energy for heating (monthly method)

Prizidava OŠ Polzela - 1. faza / Climate: Ljubljana, Eko sklad 2018 / TFA: 630 m² / Heating: 12,8 kWh/(m²a) / Cooling: 2,8 kWh/(m²a) / PER: 48,1 kWh/(m²a)

Interior temperature: 20 °C
Building type: CC-SI 12630
Treated floor area $A_{TFA}$: 630 m²

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | Year | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Heating degree hours - Externa | 15,0 | 12,2 | 10,3 | 7,1 | 3,1 | 0,4 | -0,3 | -0,4 | 3,5 | 6,6 | 10,4 | 14,6 | 82 | kKh |
| Heating degree hours - Ground | 4,3 | 4,0 | 4,4 | 4,1 | 2,7 | 2,4 | 2,3 | 2,1 | 2,1 | 3,6 | 3,7 | 4,1 | 40 | kKh |
| Losses - Exterior | 4558 | 3716 | 3123 | 2146 | 931 | 132 | -89 | -115 | 1063 | 1993 | 3153 | 4415 | 25027 | kWh |
| Losses - Ground | 349 | 324 | 357 | 335 | 221 | 194 | 183 | 174 | 169 | 293 | 301 | 332 | 3231 | kWh |
| Sum spec. losses | 7,8 | 6,4 | 5,5 | 3,9 | 1,8 | 0,5 | 0,1 | 0,1 | 2,0 | 3,6 | 5,5 | 7,5 | 44,9 | kWh/m² |
| Solar gains - North | 259 | 432 | 749 | 979 | 1325 | 1354 | 1354 | 1095 | 720 | 519 | 288 | 202 | 9276 | kWh |
| Solar gains - East | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | kWh |
| Solar gains - South | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | kWh |
| Solar gains - West | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | kWh |
| Solar gains - Horiz. | 111 | 185 | 347 | 482 | 656 | 701 | 740 | 601 | 392 | 233 | 115 | 81 | 4644 | kWh |
| Solar gains - Opaque | 41 | 65 | 119 | 161 | 216 | 227 | 239 | 196 | 131 | 81 | 42 | 30 | 1547 | kWh |
| Internal heat gains | 1954 | 1765 | 1954 | 1891 | 1954 | 1891 | 1954 | 1954 | 1891 | 1954 | 1891 | 1954 | 23010 | kWh |
| Sum spec. gains solar + interna | 3,8 | 3,9 | 5,0 | 5,6 | 6,6 | 6,6 | 6,8 | 6,1 | 5,0 | 4,4 | 3,7 | 3,6 | 61,1 | kWh/m² |
| Utilisation factor | 100% | 100% | 99% | 71% | 28% | 8% | 2% | 2% | 39% | 82% | 100% | 100% | 52% | |
| Annual heating demand | 2541 | 1592 | 346 | 0 | 0 | 0 | 0 | 0 | 0 | 4 | 1119 | 2480 | 8082 | kWh |
| Spec. heating demand | **4,0** | **2,5** | **0,5** | **0,0** | **0,0** | **0,0** | **0,0** | **0,0** | **0,0** | **0,0** | **1,8** | **3,9** | **12,8** | kWh/m² |




**Annual heating demand: Comparison**

| | | | | | |
|---|---|---|---|---|---|
| Monthly method | *('Heating')* | **8082** | **kWh/a** | **12,8** | **kWh/(m²a)** reference to treated floor area according to PHPP |
| Annual method | *('Annual heatin* | **8704** | **kWh/a** | **13,8** | **kWh/(m²a)** reference to treated floor area according to PHPP |
| | | **-** | **kWh/a** | **-** | |

| Month | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | Annual total | Heating period method |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Days | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 | 365 | 188 |
| Ambient Temp. | 0,10 | 2,10 | 6,50 | 10,50 | 16,20 | 19,70 | 20,70 | 20,80 | 15,40 | 11,40 | 5,80 | 0,70 | 10,9 | 4,1 |
| North Radiation | 9,0 | 15,0 | 26,0 | 34,0 | 46,0 | 47,0 | 47,0 | 38,0 | 25,0 | 18,0 | 10,0 | 7,0 | 322 | 94 |
| East Radiation | 23,0 | 32,0 | 57,0 | 69,0 | 92,0 | 93,0 | 103,0 | 86,0 | 62,0 | 35,0 | 19,0 | 15,0 | 686 | 201 |
| South Radiation | 61,0 | 65,0 | 86,0 | 83,0 | 87,0 | 80,0 | 89,0 | 92,0 | 88,0 | 71,0 | 51,0 | 41,0 | 894 | 383 |
| West Radiation | 24,0 | 34,0 | 54,0 | 75,0 | 88,0 | 91,0 | 96,0 | 90,0 | 65,0 | 44,0 | 24,0 | 17,0 | 702 | 215 |
| Horiz Radiation | 32,0 | 50,0 | 90,0 | 119,0 | 155,0 | 162,0 | 173,0 | 146,0 | 101,0 | 62,0 | 32,0 | 23,0 | 1145 | 254 |
| Tsky | -11,20 | -10,40 | -6,40 | -1,90 | 4,00 | 8,20 | 9,20 | 9,90 | 5,40 | 2,60 | -3,30 | -9,40 | -0,2 | |
| Ground Temp | 14,22 | 14,07 | 14,09 | 14,28 | 16,35 | 16,69 | 16,97 | 17,13 | 17,11 | 15,15 | 14,85 | 14,51 | 15,5 | 14,4 |

# Cooling: energy value for useful cooling energy

Prizidava OŠ Polzela - 1. faza / Climate: Ljubljana, Eko sklad 2018 / TFA: 630 m² / Heating: 12,8 kWh/(m²a) / Cooling: 2,8 kWh/(m²a) / PER: 48,1 kWh/(m²a)

The sum of the cooling periods calculated through the monthly method will be presented on this side.

| | | | | | |
|---|---|---|---|---|---|
| Building type: | CC-SI 12630 | | Treated floor area $A_{TFA}$: | 629,9 | m² |
| Interior temperature summer: | 25 | °C | Building volume: | 1985 | m³ |
| Nominal humidity: | 12 | g/kg | Internal humidity sources: | 2,4 | g/(m²h) |
| Spec. capacity: | 204 | Wh/(m²K) | | | |

| Building assembly | Temperature zone | Area m² | | U-Value W/(m²K) | | Mon. red. fac. | | $G_t$ kKh/a | | kWh/a | per m² treated floor area |
|---|---|---|---|---|---|---|---|---|---|---|---|
| External wall - Ambient | A | 239,3 | * | 0,146 | * | 1,00 | * | 25 | = | 885 | 1,40 |
| External wall - Ground | B | 31,3 | * | 0,157 | * | 1,00 | * | 30 | = | 147 | 0,23 |
| Roof/Ceiling - Ambient | A | 378,7 | * | 0,099 | * | 1,00 | * | 25 | = | 946 | 1,50 |
| Floor slab / Basement ceiling | B | 459,6 | * | 0,164 | * | 1,00 | * | 30 | = | 2263 | 3,59 |
| | A | | * | | * | 1,00 | * | | = | | |
| | A | | * | | * | 1,00 | * | | = | | |
| Unheated | X | | * | | * | 0,35 | * | | = | | |
| Windows | A | 139,4 | * | 0,814 | * | 1,00 | * | 25 | = | 2869 | 4,56 |
| Exterior door | A | 4,6 | * | 0,900 | * | 1,00 | * | 25 | = | 105 | 0,17 |
| Exterior TB (length/m) | A | 100,5 | * | 0,031 | * | 1,00 | * | 25 | = | 78 | 0,12 |
| Perimeter TB (length/m) | P | 36,9 | * | 0,020 | * | 1,00 | * | 25 | = | 19 | 0,03 |
| Ground TB (length/m) | B | | * | | * | 1,00 | * | | = | | 0,00 |
| | | | | | | | | | | | kWh/(m²a) |
| **Transmission losses $Q_T$ (negative: heat loads)** | | | | | | | | | Total | 7311 | 11,6 |

## Summer ventilation

from 'SummVent' worksheet

| Ventilation conductance, vent. unit | | |
|---|---|---|
| exterior $H_{V,e}$ | 76,6 | W/K |
| without HR | 363,0 | W/K |
| ground $H_{V,g}$ | 0,0 | W/K |
| without HR | 0,0 | W/K |
| **Ventilation conductance, others** | | |
| exterior | 33,8 | W/K |

| Ventilation parameter | | |
|---|---|---|
| Temperature amplitude summer | 9,9 | K |
| Minimum acceptable indoor temperature | 20,0 | °C |
| Heat capacity air | 0,33 | Wh/(m³K) |
| Supply air changes | 0,55 | 1/h |
| Outdoor air changes | 0,05 | 1/h |
| Window night vent. air change rate, manual @ 1K | 0,00 | 1/h |
| Air changes rate due to mech., autom. controlled vent. | 0,00 | 1/h |
| Specific power consumption for | 0,30 | Wh/m³ |
| $\eta_{HR}$ | 79% | |
| $\eta_{ERV}$ | 0% | |
| $\eta^*_{SHX}$ | 0% | |

| Summer ventilation regulation | HRV/ERV in summer |
|---|---|
| None | |
| Controlled by temp. | x |
| Controlled by enthalpy | |
| Always | |
| | Additional ventilation |
| Controlled by temp. | x |
| Controlled by humidity | |

| Hygienic air change | $n_{V,system}$ 1/h | | $\eta_{SHX}$ | | $\eta_{HR}$ (considers bypass) | | $n_{V,Rest}$ 1/h | | $n_{V,equi,fraction}$ 1/h |
|---|---|---|---|---|---|---|---|---|---|
| Effective air change rate Ambient $n_{V,e}$ | 0,554 | *(1- | 0% | )*(1- | 0,01 | )+ | 0,052 | = | 0,603 |
| Effective air change rate Ground $n_{V,g}$ | 0,554 | * | 0% | *(1- | 0,01 | ) | | = | 0,000 |

| | $V_V$ m³ | | $n_{V,equi,fraction}$ 1/h | | $c_{Air}$ Wh/(m³K) | | $G_t$ kKh/a | | kWh/a | kWh/(m²a) |
|---|---|---|---|---|---|---|---|---|---|---|
| **Ventilation losses ambient $Q_V$** | 1985 | * | 0,603 | * | 0,33 | * | 24 | = | 9370 | 14,9 |
| **Ventilation losses ground $Q_{V,e}$** | 1985 | * | 0,000 | * | 0,33 | * | 0 | = | 0 | 0,0 |
| **Heat losses summer ventilation** | 1985 | * | 0,000 | * | 0,33 | * | 0 | = | 0 | 0,0 |
| **Ventilation heat losses $Q_V$** | | | | | | | | Total | 9370 | 14,9 |

| | $Q_T$ kWh/a | | $Q_V$ kWh/a | | kWh/a | kWh/(m²a) |
|---|---|---|---|---|---|---|
| **Total heat losses $Q_L$** | 7311 | + | 9370 | = | 16681 | **26,5** |

| Orientation of the area | Reduction factor | | g-Value (perp. radiation) | | Area m² | | Global radiation kWh/(m²a) | | kWh/a |
|---|---|---|---|---|---|---|---|---|---|
| North | 0,21 | * | 0,50 | * | 122,9 | * | 203 | = | 2599 |
| East | 0,40 | * | 0,00 | * | 0,0 | * | 436 | = | 0 |
| South | 0,40 | * | 0,00 | * | 0,0 | * | 436 | = | 0 |
| West | 0,40 | * | 0,00 | * | 0,0 | * | 430 | = | 0 |
| Horizontal | 0,25 | * | 0,51 | * | 16,5 | * | 652 | = | 1353 |
| Sum opaque areas | | | | | | | | | 1009 |
| | | | | | | | | | kWh/(m²a) |
| **Available solar heat gains $Q_S$** | | | | | | | | Total | 4961 | 7,9 |

| | kh/d | | Length heat. period d/a | | Spec. power $q_i$ W/m² | | $A_{TFA}$ m² | | kWh/a | kWh/(m²a) |
|---|---|---|---|---|---|---|---|---|---|---|
| **Internal heat gains $Q_I$** | 0,024 | * | 153 | * | 4,2 | * | 629,9 | = | 9645 | 15,3 |

| | | | kWh/a | kWh/(m²a) |
|---|---|---|---|---|
| **Sum heat loads $Q_F$** | $Q_S$ + $Q_I$ | = | 14607 | **23,2** |

| | | | |
|---|---|---|---|
| Ratio of losses to free heat gains | $Q_L$ / $Q_F$ | = | 1,14 |
| Utilisation factor heat losses $\eta_G$ | | = | 77% |
| | | kWh/a | kWh/(m²a) |
| **Useful heat losses $Q_{V,n}$** | $\eta_G$ * $Q_L$ | = | 12883 | **20,5** |
| | | kWh/a | kWh/(m²a) |
| **Useful cooling demand $Q_K$** | $Q_F$ - $Q_{V,n}$ | = | 1724 | **2,7** |

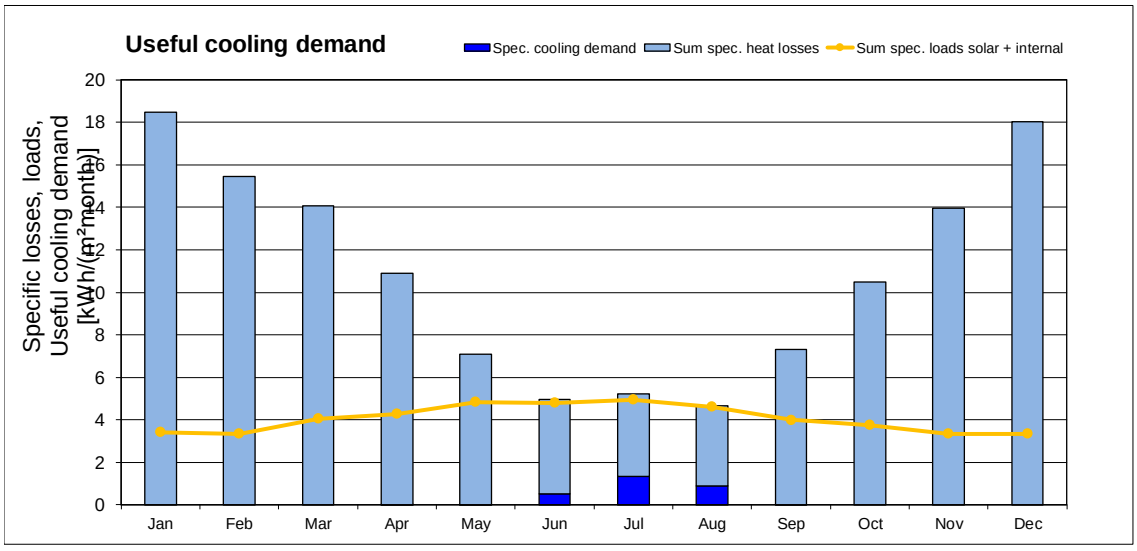
| | kWh/(m²a) | | (Yes/No) |
|---|---|---|---|
| **Recommended maximum value** | 15 | **Requirement met?** | Yes |

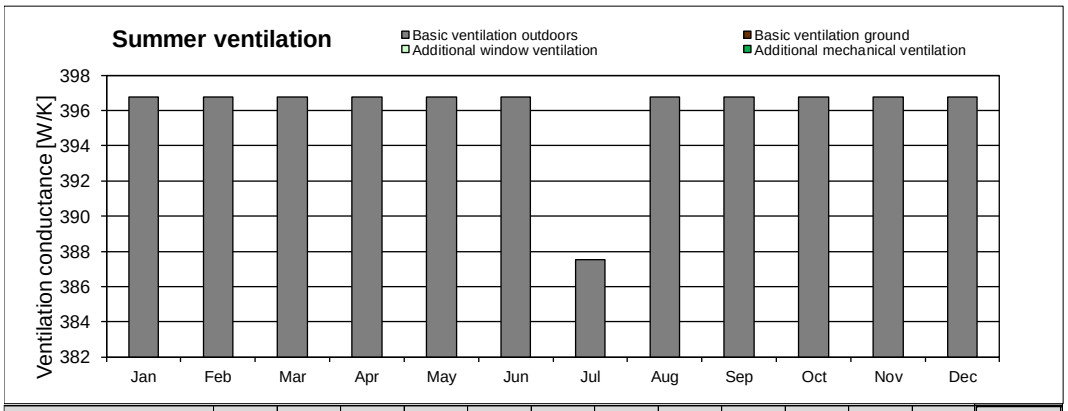
# Cooling: energy value for useful cooling energy

Prizidava OŠ Polzela - 1. faza / Climate: Ljubljana, Eko sklad 2018 / TFA: 630 m² / Heating: 12,8 kWh/(m²a) / Cooling: 2,8 kWh/(m²a) / PER: 48,1 kWh/(m²a)

Interior Temperature: 25 °C
Building type: CC-SI 12630
Treated Floor Area $A_{TFA}$: 630 m²

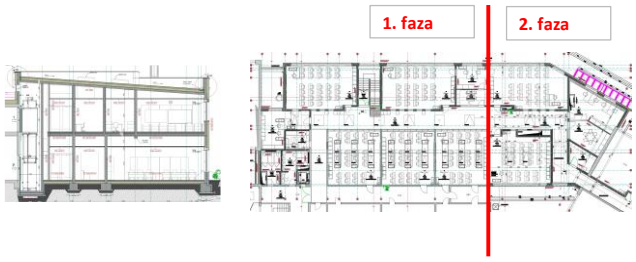
| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | Year | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Heating degree hours - Exterior | 18,9 | 15,7 | 14,2 | 10,8 | 6,9 | 4,2 | 3,6 | 3,5 | 7,2 | 10,4 | 14,1 | 18,4 | 128 | kKh |
| Heating degree hours - Ground | 8,0 | 7,3 | 8,1 | 7,7 | 6,4 | 6,0 | 6,0 | 5,9 | 5,7 | 7,3 | 7,3 | 7,8 | 84 | kKh |
| Losses - Exterior | 11005 | 9153 | 8203 | 6235 | 3939 | 2320 | 1964 | 1910 | 4139 | 6026 | 8214 | 10734 | 73841 | kWh |
| Losses - Ground | 646 | 591 | 653 | 621 | 518 | 482 | 481 | 472 | 458 | 590 | 589 | 629 | 6728 | kWh |
| Losses summer ventilation | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | kWh |
| Sum spec. heat losses | 18,5 | 15,5 | 14,1 | 10,9 | 7,1 | 4,4 | 3,9 | 3,8 | 7,3 | 10,5 | 14,0 | 18,0 | 127,9 | kWh/m² |
| Solar load North | 115 | 192 | 333 | 435 | 589 | 602 | 602 | 486 | 320 | 230 | 128 | 90 | 4122 | kWh |
| Solar load East | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | kWh |
| Solar load South | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | kWh |
| Solar load West | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | kWh |
| Solar load Horiz. | 49 | 81 | 152 | 211 | 287 | 307 | 324 | 263 | 172 | 102 | 50 | 36 | 2034 | kWh |
| Solar load Opaque | 41 | 65 | 119 | 161 | 216 | 227 | 239 | 196 | 131 | 81 | 42 | 30 | 1547 | kWh |
| Internal heat gains | 1954 | 1765 | 1954 | 1891 | 1954 | 1891 | 1954 | 1954 | 1891 | 1954 | 1891 | 1954 | 23010 | kWh |
| Sum spec. loads solar + internal | 3,4 | 3,3 | 4,1 | 4,3 | 4,8 | 4,8 | 5,0 | 4,6 | 4,0 | 3,8 | 3,4 | 3,3 | 48,8 | kWh/m² |
| Utilisation factor losses | 19% | 22% | 29% | 39% | 68% | 96% | 93% | 99% | 55% | 36% | 24% | 19% | 36% | |
| Useful cooling energy demand | 0 | 0 | 0 | 0 | 6 | 334 | 835 | 550 | 0 | 0 | 0 | 0 | 1724 | kWh |
| Spec. cooling demand | **0,0** | **0,0** | **0,0** | **0,0** | **0,0** | **0,5** | **1,3** | **0,9** | **0,0** | **0,0** | **0,0** | **0,0** | **2,7** | kWh/m² |
| Specif. dehumidification demand | **0,0** | **0,0** | **0,0** | **0,0** | **0,0** | **0,0** | **0,1** | **0,0** | **0,0** | **0,0** | **0,0** | **0,0** | **0,1** | kWh/m² |
| Sensible fraction | 100% | 100% | 100% | 100% | 100% | 100% | 95% | 100% | 100% | 100% | 100% | 100% | 98% | |




| Month | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | Year |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Days | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 | 365 |
| Ambient Temp. | 0,10 | 2,10 | 6,50 | 10,50 | 16,20 | 19,70 | 20,70 | 20,80 | 15,40 | 11,40 | 5,80 | 0,70 | 10,87 |
| North Radiation | 9,0 | 15,0 | 26,0 | 34,0 | 46,0 | 47,0 | 47,0 | 38,0 | 25,0 | 18,0 | 10,0 | 7,0 | 322,0 |
| East Radiation | 23,0 | 32,0 | 57,0 | 69,0 | 92,0 | 93,0 | 103,0 | 86,0 | 62,0 | 35,0 | 19,0 | 15,0 | 686,0 |
| South Radiation | 61,0 | 65,0 | 86,0 | 83,0 | 87,0 | 80,0 | 89,0 | 92,0 | 88,0 | 71,0 | 51,0 | 41,0 | 894,0 |
| West Radiation | 24,0 | 34,0 | 54,0 | 75,0 | 88,0 | 91,0 | 96,0 | 90,0 | 65,0 | 44,0 | 24,0 | 17,0 | 702,0 |
| Hori. Radiation | 32,0 | 50,0 | 90,0 | 119,0 | 155,0 | 162,0 | 173,0 | 146,0 | 101,0 | 62,0 | 32,0 | 23,0 | 1145,0 |
| Dew Point | -2,8 | -2,5 | 0,6 | 4,3 | 9,4 | 12,5 | 13,8 | 14,6 | 10,8 | 8,1 | 3,1 | -1,7 | 5,9 |
| Tsky | -11,20 | -10,40 | -6,40 | -1,90 | 4,00 | 8,20 | 9,20 | 9,90 | 5,40 | 2,60 | -3,30 | -9,40 | -0,22 |
| Ground Temp | 14,22 | 14,07 | 14,09 | 14,28 | 16,35 | 16,69 | 16,97 | 17,13 | 17,11 | 15,15 | 14,85 | 14,51 | 15,46 |

# PHPP-Energy balance calculation




| | | | |
|---|---|---|---|
| **Building:** | Prizidava OŠ Polzela - 2. faza | | |
| Street: | parc.št. *714, 779/4,..., k.o. 992 Polzela | | |
| Postcode/City: | | | |
| Province/Country: | | SI-Slovenia | |
| Building type: | CC-SI 12630 | | |
| Climate data set: | ud---01-Ljubljana, Eko sklad 2018 | | |
| Climate zone: | 3: Cool-temperate | Altitude of location: | 309 m |
| **Home owner / Client:** | Občina Polzela | | |
| Street: | Malteška cesta 28 | | |
| Postcode/City: | 3313 | Polzela | |
| Province/Country: | | SI-Slovenia | |
| **Architecture:** | Uniprojekt d.o.o. | | |
| Street: | Savinjska cesta 117 | | |
| Postcode/City: | 3313 | Polzela | |
| Province/Country: | | SI-Slovenia | |
| **Mechanical engineer:** | Projekt Forma d.o.o. | | |
| Street: | Začret 46b | | |
| Postcode/City: | 3202 | Začret | |
| Province/Country: | | SI-Slovenia | |
| **Energy consultancy:** | | | |
| Street: | | | |
| Postcode/City: | | | |
| Province/Country: | | | |
| **Certification:** | | | |
| Street: | | | |
| Postcode/City: | | | |
| Province/Country: | | | |

| | | | | | |
|---|---|---|---|---|---|
| Year of construction: | 2025 | Interior temperature winter [°C]: | 20,0 | Interior temp. summer [°C]: | 25,0 |
| No. of dwelling units: | 1 | Internal heat gains (IHG) heating case [W/m²]: | 4,6 | IHG cooling case [W/m²]: | 4,6 |
| No. of occupants: | 50,0 | Specific capacity [Wh/K per m² TFA]: | 204 | Mechanical cooling: | x |

**Specific building characteristics with reference to the treated floor area**

| | | | | | Criteria | Alternative criteria | Fullfilled?[2] |
|---|---|---|---|---|---|---|---|
| | Treated floor area | m² | 407,6 | | | | |
| **Space heating** | Heating demand | kWh/(m²a) | 9,5 | ≤ | - | - | - |
| | | kWh/(m³a) | 3,0 | | | | |
| | Heating load | W/m² | 10 | ≤ | - | - | |
| **Space cooling** | Cooling & dehum. demand | kWh/(m²a) | 3,9 | ≤ | - | - | - |
| | | kWh/(m³a) | 1,2 | | | | |
| | Cooling load | W/m² | 6 | ≤ | - | - | |
| | Frequency of overheating (> 25 °C) | % | - | ≤ | - | | - |
| | Frequency of excessively high humidity (> 12 g/kg) | % | 0 | ≤ | - | | - |
| **Airtightness** | Pressurization test result $n_{50}$ | 1/h | 0,6 | ≤ | - | | - |
| **Non-renewable Primary Energy (PE)** | PE demand | kWh/(m²a) | 167 | ≤ | - | | - |
| **Primary Energy Renewable (PER)** | PER demand | kWh/(m²a) | 85 | ≤ | - | - | - |
| | Generation of renewable energy (in relation to projected building footprint area) | kWh/(m²a) | 34 | ≥ | - | - | |

[2] Empty field: Data missing; '-': No requirement

# Specific energy for heating (monthly method)

Prizidava OŠ Polzela - 2. faza / Climate: Ljubljana, Eko sklad 2018 / TFA: 408 m² / Heating: 9,5 kWh/(m²a) / Cooling: 3,9 kWh/(m²a) / PER: 84,6 kWh/(m²a)

The sum of the heating periods calculated through the monthly method will be presented on this side.

| | | |
|---|---|---|
| Interior temperature: | 20 | °C |
| Building type: | CC-SI 12630 | |
| Treated floor area $A_{TFA}$: | 407,6 | m² |
| Spec. Capacity: | 204 | Wh/(m²K) |

| Building assembly | Temperature zone | Area m² | | U-Value W/(m²K) | | Month. red. fac. | | $G_t$ kKh/a | | kWh/a | Per m² of treated floor area |
|---|---|---|---|---|---|---|---|---|---|---|---|
| External wall - Ambient | A | 216,6 | * | 0,146 | * | 1,00 | * | 63 | = | 1987 | 4,87 |
| External wall - Ground | B | 12,6 | * | 0,157 | * | 1,00 | * | 22 | = | 44 | 0,11 |
| Roof/Ceiling - Ambient | A | 293,5 | * | 0,085 | * | 1,00 | * | 63 | = | 1566 | 3,84 |
| Floor slab / Basement ceiling | B | 281,9 | * | 0,155 | * | 1,00 | * | 22 | = | 980 | 2,40 |
| | A | | * | | * | 1,00 | * | | = | | |
| | A | | * | | * | 1,00 | * | | = | | |
| Unheated | X | | * | | * | 0,35 | * | | = | | |
| Windows | A | 60,6 | * | 0,806 | * | 1,00 | * | 63 | = | 3065 | 7,52 |
| Exterior door | A | 7,5 | * | 0,900 | * | 1,00 | * | 63 | = | 423 | 1,04 |
| Exterior TB (length/m) | A | 31,2 | * | 0,025 | * | 1,00 | * | 63 | = | 49 | 0,12 |
| Perimeter TB (length/m) | P | 77,0 | * | 0,060 | * | 1,00 | * | 22 | = | 104 | 0,25 |
| Ground TB (length/m) | B | | * | | * | 1,00 | * | | = | | 0,00 |
| **Transmission heat losses $Q_T$** | | | | | | | | | Total | 8218 | kWh/(m²a) 20,2 |

| | $A_{TFA}$ m² | | Clear room height m | | m³ |
|---|---|---|---|---|---|
| Effective air volume $V_V$ | 408 | * | 3,15 | = | 1284 |

| | $n_{V,system}$ 1/h | | $\eta^*_{SHX}$ | | $\eta_{HR}$ | | $n_{V,Res}$ 1/h | | $n_{V,equi,fraction}$ 1/h |
|---|---|---|---|---|---|---|---|---|---|
| Effective air change rate Ambient nV,e | 0,521 | *(1- | 0% | )*(1- | 0,73 | )+ | 0,049 | = | 0,191 |
| Effective air change rate Ground nV,g | 0,521 | * | 0% | *(1- | 0,73 | ) | | = | 0,000 |

| | $V_V$ m³ | | $n_{V,equi,fraction}$ 1/h | | $c_{Air}$ Wh/(m³K) | | $G_t$ kKh/a | | kWh/a | kWh/(m²a) |
|---|---|---|---|---|---|---|---|---|---|---|
| **Ventilation losses ambient $Q_V$** | 1284 | * | 0,191 | * | 0,33 | * | 63 | = | 5088 | 12,5 |
| **Ventilation losses ground $Q_{V,e}$** | 1284 | * | 0,000 | * | 0,33 | * | 30 | = | 0 | 0,0 |
| **Ventilation heat losses $Q_V$** | | | | | | | | Total | 5088 | 12,5 |

| | $Q_T$ kWh/a | | $Q_V$ kWh/a | | Reduction factor night/weekend saving | kWh/a | kWh/(m²a) |
|---|---|---|---|---|---|---|---|
| **Total heat losses $Q_L$** | ( 8218 | + | 5088 | ) | 1,0 | = 13306 | **32,6** |

| Orientation of the area | Reduction factor see 'Windows' worksheet | | g-Value (perp. radiation) | | Area m² | | Global radiation kWh/(m²a) | | kWh/a |
|---|---|---|---|---|---|---|---|---|---|
| North | 0,45 | * | 0,50 | * | 32,0 | * | 70 | = | 506 |
| East | 0,00 | * | 0,00 | * | 0,0 | * | 146 | = | 0 |
| South | 0,49 | * | 0,50 | * | 21,9 | * | 304 | = | 1641 |
| West | 0,00 | * | 0,00 | * | 0,0 | * | 153 | = | 0 |
| Horizontal | 0,57 | * | 0,51 | * | 6,8 | * | 183 | = | 360 |
| Sum opaque areas | | | | | | | | | 269 |
| **Available solar heat gains $Q_S$** | | | | | | | | Total | 2775 |

| | kh/d | | Length Heat. Period d/a | | Spec. Power $q_i$ W/m² | | $A_{TFA}$ m² | | kWh/a | kWh/(m²a) |
|---|---|---|---|---|---|---|---|---|---|---|
| **Internal heat gains $Q_I$** | 0,024 | * | 151 | * | 4,6 | * | 407,6 | = | 6795 | 16,7 |

| | | | kWh/a | kWh/(m²a) |
|---|---|---|---|---|
| Free heat $Q_F$ | $Q_S$ + $Q_I$ | = | 9570 | 23,5 |
| Ratio free heat to losses | $Q_F$ / $Q_L$ | = | 0,72 | |
| Utilisation factor heat gains $h_G$ | | = | 99% | |
| **Heat gains $Q_G$** | $\eta_G$ * $Q_F$ | = | 9445 | **23,2** |

| | | kWh/a | kWh/(m²a) |
|---|---|---|---|
| **Annual heating demand $Q_H$** | $Q_L$ - $Q_G$ = | 3860 | **9,5** |

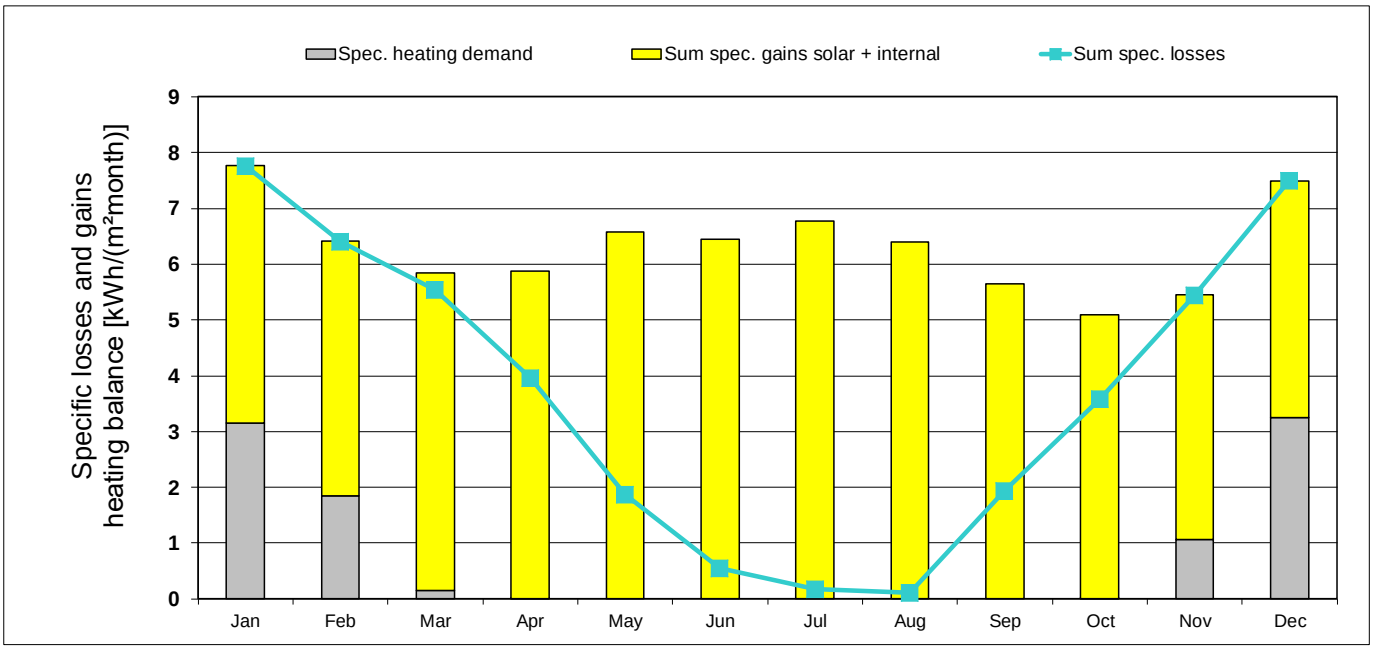
| | kWh/(m²a) | | (Yes/No) |
|---|---|---|---|
| **Limiting value** | - | **Requirement met?** | - |

# Specific energy for heating (monthly method)

Prizidava OŠ Polzela - 2. faza / Climate: Ljubljana, Eko sklad 2018 / TFA: 408 m² / Heating: 9,5 kWh/(m²a) / Cooling: 3,9 kWh/(m²a) / PER: 84,6 kWh/(m²a)

Interior temperature: 20 °C
Building type: CC-SI 12630
Treated floor area $A_{TFA}$: 408 m²

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | Year | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Heating degree hours - Externa | 15,1 | 12,3 | 10,3 | 7,1 | 3,1 | 0,5 | -0,2 | -0,3 | 3,5 | 6,6 | 10,4 | 14,6 | 83 | kKh |
| Heating degree hours - Ground | 4,8 | 4,5 | 4,9 | 4,5 | 3,1 | 2,6 | 2,3 | 2,1 | 2,1 | 3,6 | 3,8 | 4,4 | 43 | kKh |
| Losses - Exterior | 2925 | 2387 | 2009 | 1383 | 605 | 94 | -47 | -65 | 688 | 1282 | 2025 | 2833 | 16119 | kWh |
| Losses - Ground | 240 | 225 | 248 | 229 | 157 | 130 | 116 | 106 | 104 | 180 | 193 | 221 | 2149 | kWh |
| Sum spec. losses | 7,8 | 6,4 | 5,5 | 4,0 | 1,9 | 0,5 | 0,2 | 0,1 | 1,9 | 3,6 | 5,4 | 7,5 | 44,8 | kWh/m² |
| Solar gains - North | 67 | 113 | 206 | 266 | 369 | 377 | 387 | 306 | 201 | 131 | 70 | 50 | 2542 | kWh |
| Solar gains - East | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | kWh |
| Solar gains - South | 329 | 351 | 464 | 448 | 469 | 432 | 480 | 496 | 475 | 383 | 275 | 221 | 4824 | kWh |
| Solar gains - West | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | kWh |
| Solar gains - Horiz. | 48 | 79 | 149 | 204 | 278 | 295 | 313 | 254 | 167 | 99 | 49 | 35 | 1972 | kWh |
| Solar gains - Opaque | 41 | 59 | 102 | 128 | 170 | 175 | 186 | 155 | 109 | 69 | 39 | 29 | 1261 | kWh |
| Internal heat gains | 1395 | 1260 | 1395 | 1350 | 1395 | 1350 | 1395 | 1395 | 1350 | 1395 | 1350 | 1395 | 16425 | kWh |
| Sum spec. gains solar + interna | 4,6 | 4,6 | 5,7 | 5,9 | 6,6 | 6,5 | 6,8 | 6,4 | 5,6 | 5,1 | 4,4 | 4,2 | 66,3 | kWh/m² |
| Utilisation factor | 100% | 100% | 95% | 67% | 28% | 9% | 2% | 2% | 34% | 70% | 100% | 100% | 53% | |
| Annual heating demand | 1285 | 750 | 65 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 436 | 1324 | 3860 | kWh |
| Spec. heating demand | **3,2** | **1,8** | **0,2** | **0,0** | **0,0** | **0,0** | **0,0** | **0,0** | **0,0** | **0,0** | **1,1** | **3,2** | **9,5** | kWh/m² |




**Annual heating demand: Comparison**

| | | | | | |
|---|---|---|---|---|---|
| Monthly method | *('Heating')* | **3860** | **kWh/a** | **9,5** | **kWh/(m²a)** reference to treated floor area according to PHPP |
| Annual method | *('Annual heatin* | **4423** | **kWh/a** | **10,9** | **kWh/(m²a)** reference to treated floor area according to PHPP |
| | | **-** | **kWh/a** | **-** | |

| Month | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | Annual total | Heating period method |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Days | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 | 365 | 188 |
| Ambient Temp. | 0,10 | 2,10 | 6,50 | 10,50 | 16,20 | 19,70 | 20,70 | 20,80 | 15,40 | 11,40 | 5,80 | 0,70 | 10,9 | 4,1 |
| North Radiation | 9,0 | 15,0 | 26,0 | 34,0 | 46,0 | 47,0 | 47,0 | 38,0 | 25,0 | 18,0 | 10,0 | 7,0 | 322 | 98 |
| East Radiation | 23,0 | 32,0 | 57,0 | 69,0 | 92,0 | 93,0 | 103,0 | 86,0 | 62,0 | 35,0 | 19,0 | 15,0 | 686 | 201 |
| South Radiation | 61,0 | 65,0 | 86,0 | 83,0 | 87,0 | 80,0 | 89,0 | 92,0 | 88,0 | 71,0 | 51,0 | 41,0 | 894 | 383 |
| West Radiation | 24,0 | 34,0 | 54,0 | 75,0 | 88,0 | 91,0 | 96,0 | 90,0 | 65,0 | 44,0 | 24,0 | 17,0 | 702 | 215 |
| Horiz Radiation | 32,0 | 50,0 | 90,0 | 119,0 | 155,0 | 162,0 | 173,0 | 146,0 | 101,0 | 62,0 | 32,0 | 23,0 | 1145 | 261 |
| Tsky | -11,20 | -10,40 | -6,40 | -1,90 | 4,00 | 8,20 | 9,20 | 9,90 | 5,40 | 2,60 | -3,30 | -9,40 | -0,2 | |
| Ground Temp | 13,60 | 13,33 | 13,37 | 13,69 | 15,82 | 16,40 | 16,89 | 17,16 | 17,12 | 15,20 | 14,67 | 14,09 | 15,1 | 13,9 |

# Cooling: energy value for useful cooling energy

Prizidava OŠ Polzela - 2. faza / Climate: Ljubljana, Eko sklad 2018 / TFA: 408 m² / Heating: 9,5 kWh/(m²a) / Cooling: 3,9 kWh/(m²a) / PER: 84,6 kWh/(m²a)

The sum of the cooling periods calculated through the monthly method will be presented on this side.

| | | | | | |
|---|---|---|---|---|---|
| Building type: | CC-SI 12630 | | Treated floor area $A_{TFA}$: | 407,6 | m² |
| Interior temperature summer: | 25 | °C | Building volume: | 1284 | m³ |
| Nominal humidity: | 12 | g/kg | Internal humidity sources: | 1,2 | g/(m²h) |
| Spec. capacity: | 204 | Wh/(m²K) | | | |

| Building assembly | Temperature zone | Area m² | | U-Value W/(m²K) | | Mon. red. fac. | | $G_t$ kKh/a | | kWh/a | per m² treated floor area |
|---|---|---|---|---|---|---|---|---|---|---|---|
| External wall - Ambient | A | 216,6 | * | 0,146 | * | 1,00 | * | 26 | = | 816 | 2,00 |
| External wall - Ground | B | 12,6 | * | 0,157 | * | 1,00 | * | 31 | = | 60 | 0,15 |
| Roof/Ceiling - Ambient | A | 293,5 | * | 0,085 | * | 1,00 | * | 26 | = | 643 | 1,58 |
| Floor slab / Basement ceiling | B | 281,9 | * | 0,155 | * | 1,00 | * | 31 | = | 1336 | 3,28 |
| | A | | * | | * | 1,00 | * | | = | | |
| | A | | * | | * | 1,00 | * | | = | | |
| Unheated | X | | * | | * | 0,35 | * | | = | | |
| Windows | A | 60,6 | * | 0,806 | * | 1,00 | * | 26 | = | 1259 | 3,09 |
| Exterior door | A | 7,5 | * | 0,900 | * | 1,00 | * | 26 | = | 174 | 0,43 |
| Exterior TB (length/m) | A | 31,2 | * | 0,025 | * | 1,00 | * | 26 | = | 20 | 0,05 |
| Perimeter TB (length/m) | P | 77,0 | * | 0,060 | * | 1,00 | * | 26 | = | 119 | 0,29 |
| Ground TB (length/m) | B | | * | | * | 1,00 | * | | = | | 0,00 |

| | Total kWh/a | kWh/(m²a) |
|---|---|---|
| **Transmission losses $Q_T$ (negative: heat loads)** | 4428 | 10,9 |

## Summer ventilation

from 'SummVent' worksheet

**Ventilation conductance, vent. unit**

| | | |
|---|---|---|
| exterior $H_{V,e}$ | 60,5 | W/K |
| without HR | 220,7 | W/K |
| ground $H_{V,g}$ | 0,0 | W/K |
| without HR | 0,0 | W/K |

**Ventilation conductance, others**

| | | |
|---|---|---|
| exterior | 20,6 | W/K |

**Ventilation parameter**

| | | |
|---|---|---|
| Temperature amplitude summer | 9,9 | K |
| Minimum acceptable indoor temperature | 20,0 | °C |
| Heat capacity air | 0,33 | Wh/(m³K) |
| Supply air changes | 0,52 | 1/h |
| Outdoor air changes | 0,05 | 1/h |
| Window night vent. air change rate, manual @ 1K | 0,00 | 1/h |
| Air changes rate due to mech., autom. controlled vent. | 0,00 | 1/h |
| Specific power consumption for | 0,30 | Wh/m³ |
| $\eta_{HR}$ | 73% | |
| $\eta_{ERV}$ | 0% | |
| $\eta^*_{SHX}$ | 0% | |

**Summer ventilation regulation**

| | HRV/ERV in summer |
|---|---|
| None | |
| Controlled by temp. | x |
| Controlled by enthalpy | |
| Always | |
| | Additional ventilation |
| Controlled by temp. | x |
| Controlled by humidity | |

| | $n_{V,system}$ 1/h | | $\eta_{SHX}$ | | $\eta_{HR}$ (considers bypass) | | $n_{V,Rest}$ 1/h | | $n_{V,equi,fraction}$ 1/h |
|---|---|---|---|---|---|---|---|---|---|
| **Hygienic air change** | | | | | | | | | |
| Effective air change rate Ambient $n_{V,e}$ | 0,521 | *(1- | 0% | )*(1- | 0,00 | )+ | 0,049 | = | 0,567 |
| Effective air change rate Ground $n_{V,g}$ | 0,521 | * | 0% | *(1- | 0,00 | ) | | = | 0,000 |

| | $V_V$ m³ | | $n_{V,equi,fraction}$ 1/h | | $c_{Air}$ Wh/(m³K) | | $G_t$ kKh/a | | kWh/a | kWh/(m²a) |
|---|---|---|---|---|---|---|---|---|---|---|
| **Ventilation losses ambient $Q_V$** | 1284 | * | 0,567 | * | 0,33 | * | 24 | = | 5697 | 14,0 |
| **Ventilation losses ground $Q_{V,e}$** | 1284 | * | 0,000 | * | 0,33 | * | 0 | = | 0 | 0,0 |
| **Heat losses summer ventilation** | 1284 | * | 0,000 | * | 0,33 | * | 0 | = | 0 | 0,0 |

| | Total kWh/a | kWh/(m²a) |
|---|---|---|
| **Ventilation heat losses $Q_V$** | 5697 | 14,0 |

| | $Q_T$ kWh/a | | $Q_V$ kWh/a | kWh/a | kWh/(m²a) |
|---|---|---|---|---|---|
| **Total heat losses $Q_L$** | 4428 | + | 5697 | = 10125 | **24,8** |

| Orientation of the area | Reduction factor | | g-Value (perp. radiation) | | Area m² | | Global radiation kWh/(m²a) | | kWh/a |
|---|---|---|---|---|---|---|---|---|---|
| North | 0,21 | * | 0,50 | * | 32,0 | * | 226 | = | 744 |
| East | 0,40 | * | 0,00 | * | 0,0 | * | 436 | = | 0 |
| South | 0,20 | * | 0,50 | * | 21,9 | * | 436 | = | 943 |
| West | 0,40 | * | 0,00 | * | 0,0 | * | 430 | = | 0 |
| Horizontal | 0,25 | * | 0,51 | * | 6,8 | * | 664 | = | 573 |
| Sum opaque areas | | | | | | | | | 794 |

| | Total kWh/a | kWh/(m²a) |
|---|---|---|
| **Available solar heat gains $Q_S$** | 3053 | 7,5 |

| | kh/d | | Length heat. period d/a | | Spec. power $q_I$ W/m² | | $A_{TFA}$ m² | kWh/a | kWh/(m²a) |
|---|---|---|---|---|---|---|---|---|---|
| **Internal heat gains $Q_I$** | 0,024 | * | 153 | * | 4,6 | * | 407,6 | = 6885 | 16,9 |

| | kWh/a | kWh/(m²a) |
|---|---|---|
| **Sum heat loads $Q_F$** | $Q_S$ + $Q_I$ = 9938 | **24,4** |

| | | kWh/a | kWh/(m²a) |
|---|---|---|---|
| Ratio of losses to free heat gains | $Q_L$ / $Q_F$ = | 1,02 | |
| Utilisation factor heat losses $\eta_G$ | = | 83% | |
| **Useful heat losses $Q_{V,n}$** | $\eta_G$ * $Q_L$ = | 8386 | **20,6** |
| **Useful cooling demand $Q_K$** | $Q_F$ - $Q_{V,n}$ = | 1552 | **3,8** |

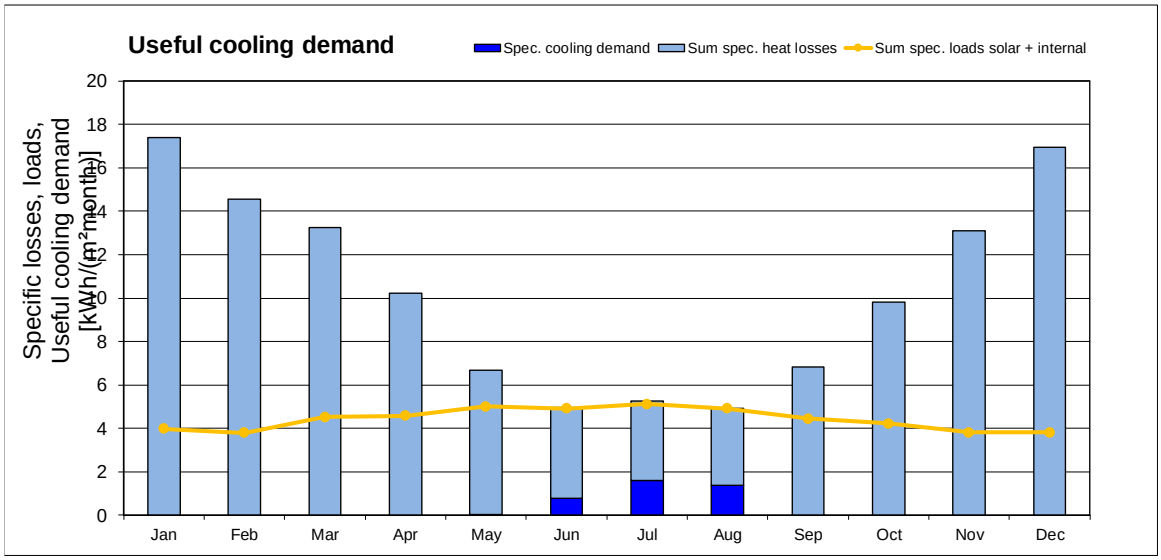
| | kWh/(m²a) | (Yes/No) |
|---|---|---|
| **Recommended maximum value** | 15 | **Requirement met?** Yes |

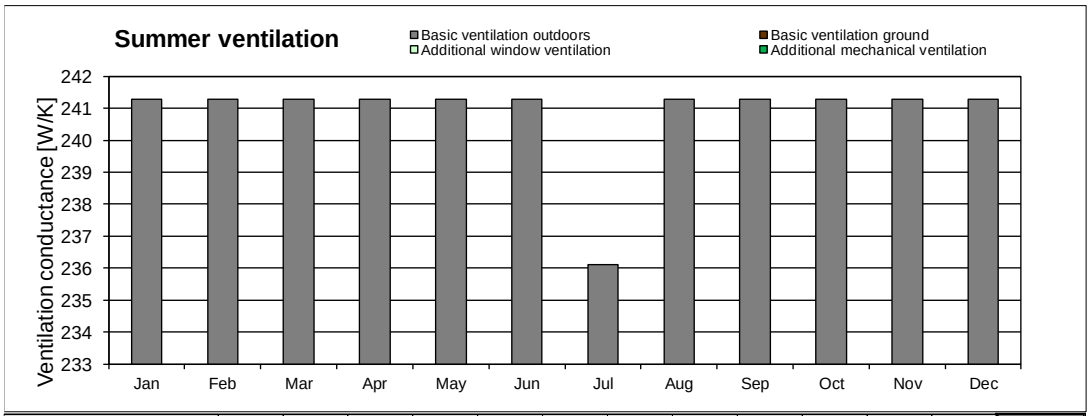
# Cooling: energy value for useful cooling energy

Prizidava OŠ Polzela - 2. faza / Climate: Ljubljana, Eko sklad 2018 / TFA: 408 m² / Heating: 9,5 kWh/(m²a) / Cooling: 3,9 kWh/(m²a) / PER: 84,6 kWh/(m²a)

Interior Temperature: 25 °C
Building type: CC-SI 12630
Treated Floor Area $A_{TFA}$: 408 m²

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | Year | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Heating degree hours - Exterior | 18,9 | 15,8 | 14,3 | 10,9 | 7,0 | 4,3 | 3,7 | 3,6 | 7,3 | 10,5 | 14,2 | 18,5 | 129 | kKh |
| Heating degree hours - Ground | 8,5 | 7,8 | 8,7 | 8,1 | 6,8 | 6,2 | 6,0 | 5,8 | 5,7 | 7,3 | 7,4 | 8,1 | 87 | kKh |
| Losses - Exterior | 6699 | 5574 | 4999 | 3802 | 2406 | 1421 | 1205 | 1172 | 2525 | 3671 | 5001 | 6534 | 45009 | kWh |
| Losses - Ground | 388 | 358 | 395 | 372 | 312 | 283 | 275 | 267 | 259 | 333 | 340 | 371 | 3952 | kWh |
| Losses summer ventilation | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | kWh |
| Sum spec. heat losses | 17,4 | 14,6 | 13,2 | 10,2 | 6,7 | 4,2 | 3,6 | 3,5 | 6,8 | 9,8 | 13,1 | 16,9 | 120,1 | kWh/m² |
| Solar load North | 30 | 51 | 93 | 121 | 167 | 171 | 175 | 139 | 91 | 59 | 32 | 23 | 1153 | kWh |
| Solar load East | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | kWh |
| Solar load South | 132 | 141 | 186 | 180 | 188 | 173 | 193 | 199 | 190 | 154 | 110 | 89 | 1934 | kWh |
| Solar load West | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | kWh |
| Solar load Horiz. | 21 | 35 | 65 | 89 | 122 | 129 | 137 | 111 | 73 | 43 | 21 | 15 | 863 | kWh |
| Solar load Opaque | 41 | 59 | 102 | 128 | 170 | 175 | 186 | 155 | 109 | 69 | 39 | 29 | 1261 | kWh |
| Internal heat gains | 1395 | 1260 | 1395 | 1350 | 1395 | 1350 | 1395 | 1395 | 1350 | 1395 | 1350 | 1395 | 16425 | kWh |
| Sum spec. loads solar + internal | 4,0 | 3,8 | 4,5 | 4,6 | 5,0 | 4,9 | 5,1 | 4,9 | 4,4 | 4,2 | 3,8 | 3,8 | 53,1 | kWh/m² |
| Utilisation factor losses | 23% | 26% | 34% | 45% | 75% | 98% | 97% | 100% | 65% | 43% | 29% | 22% | 41% | |
| Useful cooling energy demand | 0 | 0 | 0 | 0 | 8 | 323 | 656 | 564 | 1 | 0 | 0 | 0 | 1552 | kWh |
| Spec. cooling demand | **0,0** | **0,0** | **0,0** | **0,0** | **0,0** | **0,8** | **1,6** | **1,4** | **0,0** | **0,0** | **0,0** | **0,0** | **3,8** | kWh/m² |
| Specif. dehumidification demand | **0,0** | **0,0** | **0,0** | **0,0** | **0,0** | **0,0** | **0,0** | **0,0** | **0,0** | **0,0** | **0,0** | **0,0** | **0,0** | kWh/m² |
| Sensible fraction | 100% | 100% | 100% | 100% | 100% | 100% | 97% | 100% | 100% | 100% | 100% | 100% | 99% | |




| Month | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | Year |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Days | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 | 365 |
| Ambient Temp. | 0,10 | 2,10 | 6,50 | 10,50 | 16,20 | 19,70 | 20,70 | 20,80 | 15,40 | 11,40 | 5,80 | 0,70 | 10,87 |
| North Radiation | 9,0 | 15,0 | 26,0 | 34,0 | 46,0 | 47,0 | 47,0 | 38,0 | 25,0 | 18,0 | 10,0 | 7,0 | 322,0 |
| East Radiation | 23,0 | 32,0 | 57,0 | 69,0 | 92,0 | 93,0 | 103,0 | 86,0 | 62,0 | 35,0 | 19,0 | 15,0 | 686,0 |
| South Radiation | 61,0 | 65,0 | 86,0 | 83,0 | 87,0 | 80,0 | 89,0 | 92,0 | 88,0 | 71,0 | 51,0 | 41,0 | 894,0 |
| West Radiation | 24,0 | 34,0 | 54,0 | 75,0 | 88,0 | 91,0 | 96,0 | 90,0 | 65,0 | 44,0 | 24,0 | 17,0 | 702,0 |
| Hori. Radiation | 32,0 | 50,0 | 90,0 | 119,0 | 155,0 | 162,0 | 173,0 | 146,0 | 101,0 | 62,0 | 32,0 | 23,0 | 1145,0 |
| Dew Point | -2,8 | -2,5 | 0,6 | 4,3 | 9,4 | 12,5 | 13,8 | 14,6 | 10,8 | 8,1 | 3,1 | -1,7 | 5,9 |
| Tsky | -11,20 | -10,40 | -6,40 | -1,90 | 4,00 | 8,20 | 9,20 | 9,90 | 5,40 | 2,60 | -3,30 | -9,40 | -0,22 |
| Ground Temp | 13,60 | 13,33 | 13,37 | 13,69 | 15,82 | 16,40 | 16,89 | 17,16 | 17,12 | 15,20 | 14,67 | 14,09 | 15,12 |

# 7 RAZMERNIKI POTREBNE TOPLOTE IN RAZMERNIKI OVE

Iz izračuna energijske učinkovitosti novogradnje so pridobljene tudi vrednosti rabe energije za ključne segmente rabe energije. Razmernika potrebne toplote za ogrevanje znašata ločeno pri obeh fazah 0,4 ter potrebna toplota za hlajenje stavbe znaša manj kot 5 kWh/m²a. Razmernik ROVE za obe fazi presega vrednosti 80%.

Projekt: Prizidava OŠ Polzela, 1 faza

**Analiza stavbe**

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Uporabna površina | **629,9** m² | Neto ogrevana prostornina | **2030,8** m³ | Površina ovoja | **1233,9** m² | z | **0,090** | fo | **0,49** | m⁻¹ |
| Namembnost | 1263001 Stavbe za izobraževanje in znanstvenoraziskovalno delo | | | | | | | | | |

| Ovoj stavbe | po projektu | dovoljeno | status |
|---|---|---|---|
| Gradbene konstrukcije ustrezajo zahtevam | | | DA |
| Spec. koef. transm. topl. izgub z dod. topl. mostov (H'tr) | 0,208 W/m²K | 0,339 W/m²K | |

| Toplotna in hladilna obremenitev | po projektu | na enoto površine |
|---|---|---|
| Potrebna toplota za ogrevanje stavbe QH,nd,an | 6696 kWh/a | 10,6 kWh/m²a |
| Potrebna toplota za hlajenje stavbe QC,nd,an | 2423 kWh/a | 3,8 kWh/m²a |
| Potrebna energija za vlaženje zraka QHU,nd | 0 kWh/a | |
| Potrebna energija za razvlaževanje zraka QDHU,nd | 0 kWh/a | |

| Ustreznost | po projektu | dovoljeno | status |
|---|---|---|---|
| Specifična potrebna toplota za ogrevanje Q'H,nd,an | 10,6 kWh/m²a | | |
| Razmernik potrebne toplote za ogrevanje Hnd | 0,37 | 0,80 | DA |
| Spec. potr. odvedena toplota za hlajenje Q'C,nd,an | 3,8 kWh/m²a | | |
| Razmernik potrebne toplote za hlajenje Cnd | 1,54 | 0,80 | Se ne preverja |

Projekt: Prizidava OŠ Polzela, 1 faza

**Analiza SNES**

| Kazalniki energijske učinkovitosti stavbe | |
|---|---|
| | Vrednost (%) |
| Razmernik obnovljivih virov energije ROVE | 86 |
| Minimalni zahtevani razmernik ROVEmin | 55 |
| Ustreza minimalni zahtevi | Ustreza |
| | |
| | Vrednost (-) |
| Korekcijski faktor razmernika ROVE XOVE | 1,1 |
| Kompenzacijski faktor razmernika ROVE YROVE | 0,8 |
| Korekcijski faktor dovoljene skupne primarne energije glede na vrsto stavbe Xs | 0,9 |
| Korekcijski faktor dovoljene skupne primarne energije glede na leto uveljavitve Xp | 0,9 |
| | |
| | Količina (kWh/(m²an)) |
| Specifična potrebna skupna primarna energija E'Ptot,an | 107,2 |
| Korigirana specifična potrebna primarna energija E'Ptot,kor,an | 85,8 |
| Specifična potrebna skupna primarna energija referenčne stavbe E'Ptot,ref,an | 230,8 |
| Korigirana spec. potrebna skupna primarna energija referenčne stavbe E'Ptot,ref,kor,an | 187,0 |
| Ustreza minimalni zahtevi | Ustreza |

Projekt: Prizidava OŠ Polzela, 2 faza

## Analiza stavbe

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Uporabna površina | **407,6** | $m^2$ | Neto ogrevana prostornina | **1237,9** | $m^3$ | Površina ovoja | **860,3** | $m^2$ | z | **0,056** | fo | **0,58** | $m^{-1}$ |
| Namembnost | 1263001 Stavbe za izobraževanje in znanstvenoraziskovalno delo | | | | | | | | | | | | |

| Ovoj stavbe | po projektu | dovoljeno | status |
|---|---|---|---|
| Gradbene konstrukcije ustrezajo zahtevam | | | DA |
| Spec. koef. transm. topl. izgub z dod. topl. mostov (H'tr) | 0,191 W/$m^2$K | 0,323 W/$m^2$K | |

| Toplotna in hladilna obremenitev | po projektu | na enoto površine |
|---|---|---|
| Potrebna toplota za ogrevanje stavbe QH,nd,an | 2977 kWh/a | 7,3 kWh/$m^2$a |
| Potrebna toplota za hlajenje stavbe QC,nd,an | 1883 kWh/a | 4,6 kWh/$m^2$a |
| Potrebna energija za vlaženje zraka QHU,nd | 0 kWh/a | |
| Potrebna energija za razvlaževanje zraka QDHU,nd | 0 kWh/a | |

| Ustreznost | po projektu | dovoljeno | status |
|---|---|---|---|
| Specifična potrebna toplota za ogrevanje Q'H,nd,an | 7,3 kWh/$m^2$a | | |
| Razmernik potrebne toplote za ogrevanje Hnd | 0,41 | 0,80 | DA |
| Spec. potr. odvedena toplota za hlajenje Q'C,nd,an | 4,6 kWh/$m^2$a | | |
| Razmernik potrebne toplote za hlajenje Cnd | 1,40 | 0,80 | Se ne preverja |

Projekt: Prizidava OŠ Polzela, 2 faza

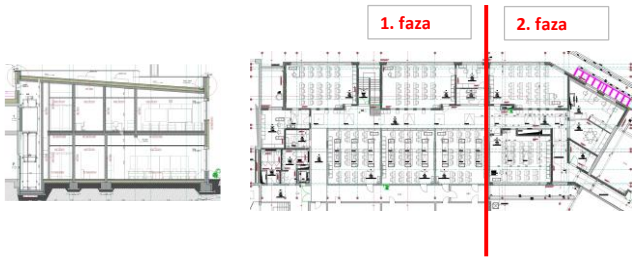
## Analiza SNES

| Kazalniki energijske učinkovitosti stavbe | |
|---|---|
| | Vrednost (%) |
| Razmernik obnovljivih virov energije ROVE | 88 |
| Minimalni zahtevani razmernik ROVEmin | 55 |
| Ustreza minimalni zahtevi | Ustreza |

| | Vrednost (-) |
|---|---|
| Korekcijski faktor razmernika ROVE XOVE | 1,1 |
| Kompenzacijski faktor razmernika ROVE YROVE | 0,8 |
| Korekcijski faktor dovoljene skupne primarne energije glede na vrsto stavbe Xs | 0,9 |
| Korekcijski faktor dovoljene skupne primarne energije glede na leto uveljavitve Xp | 0,9 |

| | Količina (kWh/($m^2$an)) |
|---|---|
| Specifična potrebna skupna primarna energija E'Ptot,an | 107,2 |
| Korigirana specifična potrebna primarna energija E'Ptot,kor,an | 85,8 |
| Specifična potrebna skupna primarna energija referenčne stavbe E'Ptot,ref,an | 222,6 |
| Korigirana spec. potrebna skupna primarna energija referenčne stavbe E'Ptot,ref,kor,an | 180,3 |
| Ustreza minimalni zahtevi | Ustreza |

# PHPP-Energy balance calculation




| | |
|---|---|
| **Building:** | Prizidava OŠ Polzela - 1. faza |
| Street: | parc.št. *714, 779/4,..., k.o. 992 Polzela |
| Postcode/City: | |
| Province/Country: | SI-Slovenia |
| Building type: | CC-SI 12630 |
| Climate data set: | ud---01-Ljubljana, Eko sklad 2018 |
| Climate zone: | 3: Cool-temperate — Altitude of location: 309 m |
| **Home owner / Client:** | Občina Polzela |
| Street: | Malteška cesta 28 |
| Postcode/City: | 3313 Polzela |
| Province/Country: | SI-Slovenia |

| | |
|---|---|
| **Architecture:** | Uniprojekt d.o.o. |
| Street: | Savinjska cesta 117 |
| Postcode/City: | 3313 Polzela |
| Province/Country: | SI-Slovenia |
| **Energy consultancy:** | |
| Street: | |
| Postcode/City: | |
| Province/Country: | |

| | |
|---|---|
| **Mechanical engineer:** | Projekt Forma d.o.o. |
| Street: | Začret 46b |
| Postcode/City: | 3202 Začret |
| Province/Country: | SI-Slovenia |
| **Certification:** | |
| Street: | |
| Postcode/City: | |
| Province/Country: | |

| | | | | | |
|---|---|---|---|---|---|
| Year of construction: | 2025 | Interior temperature winter [°C]: | 20,0 | Interior temp. summer [°C]: | 25,0 |
| No. of dwelling units: | 1 | Internal heat gains (IHG) heating case [W/m²]: | 4,2 | IHG cooling case [W/m²]: | 4,2 |
| No. of occupants: | 150,0 | Specific capacity [Wh/K per m² TFA]: | 204 | Mechanical cooling: | x |

**Specific building characteristics with reference to the treated floor area**

| | | | | | Criteria | Alternative criteria | Fullfilled?[2] |
|---|---|---|---|---|---|---|---|
| | Treated floor area | m² | 629,9 | | | | |
| **Space heating** | Heating demand | kWh/(m²a) | 12,8 | ≤ | - | - | - |
| | | kWh/(m³a) | 4,1 | | | | |
| | Heating load | W/m² | 11 | ≤ | - | - | |
| **Space cooling** | Cooling & dehum. demand | kWh/(m²a) | 2,8 | ≤ | - | - | - |
| | | kWh/(m³a) | 0,9 | | | | |
| | Cooling load | W/m² | 5 | ≤ | - | - | |
| | Frequency of overheating (> 25 °C) | % | - | ≤ | - | | - |
| | Frequency of excessively high humidity (> 12 g/kg) | % | 0 | ≤ | - | | - |
| **Airtightness** | Pressurization test result $n_{50}$ | 1/h | 0,6 | ≤ | - | | - |
| **Non-renewable Primary Energy (PE)** | PE demand | kWh/(m²a) | 93 | ≤ | - | | - |
| **Primary Energy Renewable (PER)** | PER demand | kWh/(m²a) | 48 | ≤ | - | - | - |
| | Generation of renewable energy (in relation to projected building footprint area) | kWh/(m²a) | 33 | ≥ | - | - | |

[2] Empty field: Data missing; '-': No requirement

# Climate data

Prizidava OŠ Polzela - 1. faza / Climate: Ljubljana, Eko sklad 2018 / TFA: 630 m² / Heating: 12,8 kWh/(m²a) / Cooling: 2,8 kWh/(m²a) / PER: 48,1 kWh/(m²a)

**Selection of climate data**

| | |
|---|---|
| Country: | ud-User Data |
| Region: | All |
| | 1-Sortierung: Alphabetisch |
| Climate data set: | ud---01-Ljubljana, Eko sklad 2018 |
| Climate zone: | 3: Cool-temperate |

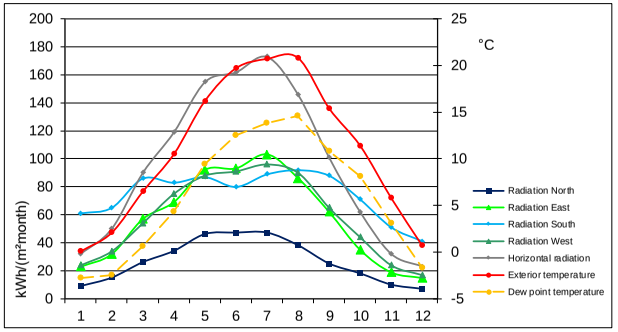
**Altitude**

| | | |
|---|---|---|
| Weather station: | 309,0 | m |
| Building location: | 309 | m |

**Result overview**

| | | |
|---|---|---|
| Annual heating demand | 12,8 | kWh/(m²a) |
| Heating load | 11,4 | W/m² |
| Frequency of overheating | - | % |
| Sensible cooling | 2,7 | kWh/(m²a) |
| Latent cooling | 0,1 | kWh/(m²a) |
| Cooling load | 5,1 | W/m² |
| PER demand | 48,1 | kWh/(m²a) |

| | Data for heating Annual method | Data from monthly balance Heating | Cooling | |
|---|---|---|---|---|
| Heating / cooling period | 188 | 212 | 153 | d/a |
| Heating / cooling degree hours | 71 | 76 | -25 | kKh/a |
| Radiation North | 94 | 119 | 203 | kWh/(m²a) |
| Radiation East | 201 | 250 | 436 | kWh/(m²a) |
| Radiation South | 383 | 458 | 436 | kWh/(m²a) |
| Radiation West | 215 | 272 | 430 | kWh/(m²a) |
| Horizontal radiation | 322 | 328 | 652 | kWh/(m²a) |




| | Month | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | Heating load Weather 1 | Heating load Weather 2 | Cooling load Weather 1 | Cooling load Weather 2 | PER factors | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Days | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 | | | | | | |
| | ud---01-Ljubljana, Eko sklad 2018 | Latitude ° | 46,1 | Longitude ° | 14,5 | Altitude [m] | 309 | Daily temperature swing Summer [K] | | | 9,9 | | | Radiation: [W/m²] | | Radiation: [W/m²] | | | |
| ° C | Exterior temperature | 0,1 | 2,1 | 6,5 | 10,5 | 16,2 | 19,7 | 20,7 | 20,8 | 15,4 | 11,4 | 5,8 | 0,7 | -6,8 | -5,9 | 25,9 | 25,9 | 1,30 | Household electri |
| kWh/(m²month) | Radiation North | 9 | 15 | 26 | 34 | 46 | 47 | 47 | 38 | 25 | 18 | 10 | 7 | 11 | 8 | 47 | 47 | 1,30 | Domestic hot wat |
| kWh/(m²month) | Radiation East | 23 | 32 | 57 | 69 | 92 | 93 | 103 | 86 | 62 | 35 | 19 | 15 | 29 | 9 | 114 | 114 | 1,80 | Heating |
| kWh/(m²month) | Radiation South | 61 | 65 | 86 | 83 | 87 | 80 | 89 | 92 | 88 | 71 | 51 | 41 | 88 | 39 | 131 | 131 | 1,10 | Cooling |
| kWh/(m²month) | Radiation West | 24 | 34 | 54 | 75 | 88 | 91 | 96 | 90 | 65 | 44 | 24 | 17 | 32 | 29 | 124 | 124 | 1,15 | Dehumidification |
| kWh/(m²month) | Horizontal radiation | 32 | 50 | 90 | 119 | 155 | 162 | 173 | 146 | 101 | 62 | 32 | 23 | 41 | 23 | 203 | 203 | | |
| ° C | Dew point temperature | -2,8 | -2,5 | 0,6 | 4,3 | 9,4 | 12,5 | 13,8 | 14,6 | 10,8 | 8,1 | 3,1 | -1,7 | | | 17,6 | 17,6 | | |
| ° C | Sky temperature | -11,2 | -10,4 | -6,4 | -1,9 | 4,0 | 8,2 | 9,2 | 9,9 | 5,4 | 2,6 | -3,3 | -9,4 | | | 15,2 | 17,6 | | |
| ° C | Ground temperature | 14,2 | 14,1 | 14,1 | 14,3 | 16,4 | 16,7 | 17,0 | 17,1 | 17,1 | 15,2 | 14,8 | 14,5 | 14,1 | 14,1 | 17,1 | 17,1 | | |
| | Comment | Eko sklad, referenca | | | | | | | | | | | | | | | | | |

# Heat losses through the ground

Prizidava OŠ Polzela - 1. faza / Climate: Ljubljana, Eko sklad 2018 / TFA: 630 m² / Heating: 12,8 kWh/(m²a) / Cooling: 2,8 kWh/(m²a) / PER: 48,1 kWh/(m²a)

## Building section 1

| Ground characteristics | | | |
|---|---|---|---|
| Thermal conductivity | λ | 2,0 | W/(mK) |
| Heat capacity | ρc | 2,0 | MJ/(m³K) |
| Periodic penetration depth | δ | 3,17 | m |

| Climate data | | | |
|---|---|---|---|
| Avg indoor temp. winter | $T_i$ | 20,0 | °C |
| Avg indoor temp. summer | $T_i$ | 25,0 | °C |
| Avg ground surface temperature | $T_{g,ave}$ | 11,8 | °C |
| Amplitude of $T_{g,ave}$ | $T_{g,\wedge}$ | 10,4 | °C |
| Phase shifting of $T_{e,m}$ | τ | 1,0 | Months |
| Length of the heating period | n | 6,2 | Months |
| Heating degree hours - exterior | $G_t$ | 71,4 | kKh/a |

| Building data | | | | | | | |
|---|---|---|---|---|---|---|---|
| Area of ground floor slab / basement | A | 459,6 | m² | U-value floor slab/basement ceiling | $U_f$ | 0,164 | W/(m²K) |
| Perimeter length | P | 36,9 | m | TBs floor slab / basement ceiling | $\Psi_B$*l | 0,74 | W/K |
| Charact. dimension of floor slab | B' | 24,94 | m | U-value floor slab / basement ceiling i | $U_f$' | 0,166 | W/(m²K) |
| | | | | Equivalent thickness floor | $d_t$ | 12,05 | m |

**Floor slab type (select only one)**

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| x | **Slab on grade** | | | | | | | |
| | Perimeter insulation width/depth | D | 1,10 | m | Orientation of perimeter insulation | horizontal | | |
| | Perimeter insulation thickness | $d_n$ | 0,22 | m | (check only one field) | vertical | x | |
| | Conductivity perimeter insulation | $\lambda_n$ | 0,035 | W/(mK) | | | | |
| | **Heated basement or floor slab completely / partially below ground level** | | | | | | | |
| | Basement wall height below ground le | z | | m | U-Value wall below ground | $U_{wB}$ | | W/(m²K) |
| | **Unheated basement** | | | | | | | |
| | Height aboveground wall | h | | m | U-Value wall above ground | $U_W$ | | W/(m²K) |
| | Basement wall height below ground le | z | | m | U-Value wall below ground | $U_{WB}$ | | W/(m²K) |
| | Air change unheated basement | n | | $h^{-1}$ | U-Value basement floor slab | $U_{fB}$ | | W/(m²K) |
| | Air volume basement | V | | m³ | | | | |
| | **Suspended floor above a ventilated crawl space (at max. 0.5 m below ground)** | | | | | | | |
| | U-Value crawl space | $U_{Crawl}$ | | W/(m²K) | Area of ventilation openings | εP | | m² |
| | Height of crawl space wall | h | | m | Wind velocity at 10 m height | v | 4,0 | m/s |
| | U-Value crawl space wall | $U_W$ | | W/(m²K) | Wind shield factor | $f_W$ | 0,05 | - |

| Additional thermal bridge heat losses at perimeter | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | | | Steady-state fraction | $\Psi_{P,stat}$*l | | W/K |
| Phase shift | β | | Months | Harmonic fraction | $\Psi_{P,harm}$*l | 0,000 | W/K |

| Groundwater correction | | | | | | | |
|---|---|---|---|---|---|---|---|
| Depth of the groundwater table | $z_w$ | 3,0 | m | Groundwater correction factor | $G_w$ | 1,26129553 | - |
| Groundwater flow rate | $q_w$ | 0,05 | m/d | | | | |

**Interim results**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Phase shift | β | 1,40 | Months | Steady-state heat flow | $\Phi_{stat}$ | 403,3 | W |
| Steady-state transmittance | $L_S$ | 49,33 | W/K | Periodic heat flow | $\Phi_{harm}$ | 23,0 | W |
| Exterior periodic transmittance | $L_{pe}$ | 4,85 | W/K | Heat losses during heating period | $Q_{tot}$ | 1920 | kWh |
| Transmittance building | $L_0$ | 76,30 | W/K | | | | |

**Monthly average temperatures in the ground for monthly method (building assembly 1)**

| Month | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | Avg. value |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Winter | 14,2 | 14,1 | 14,1 | 14,3 | 14,6 | 14,9 | 15,2 | 15,4 | 15,3 | 15,2 | 14,8 | 14,5 | 14,7 |
| Summer | 16,0 | 15,8 | 15,9 | 16,0 | 16,4 | 16,7 | 17,0 | 17,1 | 17,1 | 16,9 | 16,6 | 16,3 | 16,5 |

**Design ground temperature for 'Heating load' worksheet** 14,1 — **For 'Cooling load' worksheet** 17,1

**Reduction factor for 'Annual heating' worksheet** 0,35

## Total result (all building parts)

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Phase shift | β | 1,40 | Months | Steady-state heat flow | $\Phi_{stat}$ | 403,3 | W |
| Steady-state transmittance | $L_S$ | 49,33 | W/K | Periodic heat flow | $\Phi_{harm}$ | 23,0 | W |
| Exterior periodic transmittance | $L_{pe}$ | 4,85 | W/K | Heat losses during heating period | $Q_{tot}$ | 1920 | kWh |
| Transmittance building | $L_0$ | 76,30 | W/K | Charact. dimension of floor slab | B' | 12,20 | m |

**Monthly Average temperatures in the ground for monthly method (all building assemblies)**

| Month | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | Avg. value |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Winter | **14,2** | **14,1** | **14,1** | **14,3** | **14,6** | **14,9** | **15,2** | **15,4** | **15,3** | **15,2** | **14,8** | **14,5** | **14,7** |
| Summer | **16,0** | **15,8** | **15,9** | **16,0** | **16,4** | **16,7** | **17,0** | **17,1** | **17,1** | **16,9** | **16,6** | **16,3** | **16,5** |

**Design ground temperature for 'Heating load' worksheet** 14,1 — **For 'Cooling load' worksheet** 17,1

**Reduction factor for 'Annual heating' worksheet** **0,35**

# Areas determination

Prizidava OŠ Polzela - 1. faza / Climate: Ljubljana, Eko sklad 2018 / TFA: 630 m² / Heating: 12,8 kWh/(m²a) / Cooling: 2,8 kWh/(m²a) / PER: 48,1 kWh/(m²a)

## Summary

| Temp.-zone | Area group | Group no. | Area / Length | Unit | Comment | Building assembly overview | Average U-value [W/(m²K)] | Radiation-gains heating season [kWh/a] 7 Months | Radiation-load cooling period [kWh/a] 5 Months |
|---|---|---|---|---|---|---|---|---|---|
| | **Treated floor area** | 1 | **629,92** | m² | *Treated floor area according to PHPP manual* | | | | |
| A | **North windows** | 2 | **122,90** | m² | | **North windows** | **0,795** | **3428** | **2599** |
| A | **East windows** | 3 | **0,00** | m² | Results come from the 'Windows' worksheet. | **East windows** | | | |
| A | **South windows** | 4 | **0,00** | m² | Window areas are subtracted from individual opaque areas. | **South windows** | | | |
| A | **West windows** | 5 | **0,00** | m² | which is displayed in the 'Windows' worksheet. | **West windows** | | | |
| A | **Horizontal windows** | 6 | **16,50** | m² | | **Horizontal windows** | **0,952** | **1554** | **1353** |
| A | **Exterior door** | 7 | **4,60** | m² | *Please subtract area of door from respective building assembly* | **Exterior door** | **0,900** | | |
| A | **External wall - Ambient** | 8 | **239,26** | m² | *Temperature zone "A" is ambient air* | **External wall - Ambient** | **0,146** | **33** | **186** |
| B | **External wall - Ground** | 9 | **31,26** | m² | *Temperature zone "B" is the ground* | **External wall - Ground** | **0,157** | | |
| A | **Roof/Ceiling - Ambient** | 10 | **378,66** | m² | | **Roof/Ceiling - Ambient** | **0,099** | **63** | **481** |
| B | **Floor slab / Basement ceiling** | 11 | **459,60** | m² | | **Floor slab / Basement ceiling** | **0,164** | | |
| | | 12 | **0,00** | m² | *Temperature zones "A", "B","P" and "X" may be used. NOT "I"* | | | | |
| | | 13 | **0,00** | m² | *Temperature zones "A", "B","P" and "X" may be used. NOT "I"* Factor for X | | | | |
| X | **Unheated** | 14 | **0,00** | m² | *Temperature zone "X": Please provide user-defined reduction factor ( 0 < fr < 1):* **35%** | **Unheated** | | | |
| | | | | | | **Thermal bridges - Overview** | **Ψ [W/(mK)]** | | |
| A | **Thermal bridges Ambient** | 15 | **100,46** | m | *Units in m* | **Thermal bridges Ambient** | **0,031** | | |
| P | **Perimeter thermal bridges** | 16 | **36,85** | m | *Units in m; temperature zone "P" is perimeter (see 'Ground' worksheet)* | **Perimeter thermal bridges** | **0,020** | | |
| B | **Thermal bridges FS/BC** | 17 | **0,00** | m | *Units in m* | **Thermal bridges FS/BC** | | | |
| I | **Building element towards neigh** | 18 | **0,00** | m² | *No heat losses, only considered for the heating load calculation* | **Building element towards neighbour** | | | |
| **Total thermal envelope** | | | **1252,78** | **m²** | | **Average therm. envelope** | **0,219** | | |

Go to building components list

## Area input

2-Sorting: BY ID

| Area no. | Building assembly description | To group No. | Assigned to group | Quantity | x ( | a [m] | x | b [m] | + | User determined [m²] | - | User subtraction [m²] | - | Subtraction window areas [m²] | ) = | Area [m²] | Selection building assembly / Building system | U-Value [W/(m²K)] | Deviation from North | Angle of inclination from the horizontal | Orientation | Reduction factor shading | Exterior absorptivity | Exterior emissivity |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Projected building footprint | **0** | Projected building footprint | **1** | x ( | | x | | + | **459,60** | - | | ) | | = | 459,6 | | | | | | | | |
| | Treated floor area | **1** | Treated floor area | | x ( | | x | | + | | - | | ) | | = | 0,0 | | | | | | | | |
| | Exterior door | **7** | Exterior door | | x ( | | x | | + | | - | | ) - | | = | | Exterior door | | | | | | | |
| 1 | **tla na terenu 1 F novogradnja** | **11** | Floor slab / Basement ceiling | **1** | x ( | | x | | + | **459,60** | - | **6,76** | ) - | 0,0 | = | 452,8 | **03ud-Tlak na terenu, prostori** | **0,164** | **0** | **180** | Hor | | | |
| 2 | **tla na terenu 2 F novogradnja** | **11** | Floor slab / Basement ceiling | **0** | x ( | | x | | + | **281,90** | - | | ) - | 0,0 | = | 0,0 | **04ud-Tlak na terenu, kuhinja** | **0,155** | **0** | **180** | Hor | | | |
| 3 | **tla ješka dvigala** | **11** | Floor slab / Basement ceiling | **1** | x ( | **2,60** | x | **2,60** | + | | - | | ) - | 0,0 | = | 6,8 | **06ud-Tla na terenu, ješek** | **0,169** | **180** | **180** | Hor | | | |
| 4 | **vkopane stene jaška** | **9** | External wall - Ground | **1** | x ( | **10,40** | x | **1,20** | + | | - | | ) - | 0,0 | = | 12,5 | **05ud-Vkopana AB stena** | **0,157** | | **90** | | | | |
| 5 | **previs S 1F** | **10** | Roof/Ceiling - Ambient | **1** | x ( | | x | | + | **12,90** | - | | ) - | 0,0 | = | 12,9 | **10ud-Previsni del** | **0,114** | **0** | **180** | Hor | **0,00** | **0,80** | **0,80** |
| 6 | **previs SV 2F** | **10** | Roof/Ceiling - Ambient | **0** | x ( | **22,30** | x | **0,45** | + | | - | | ) - | 0,0 | = | 0,0 | **10ud-Previsni del** | **0,114** | **30** | **180** | Hor | **0,00** | **0,80** | **0,80** |
| 7 | **ravna streha SZ 1F** | **10** | Roof/Ceiling - Ambient | **1** | x ( | **5,80** | x | **3,20** | + | | - | | ) - | 0,0 | = | 18,6 | **09ud-Ravna streha** | **0,085** | **0** | **0** | Hor | **0,70** | **0,80** | **0,80** |
| 8 | **poševna streha S 1F** | **10** | Roof/Ceiling - Ambient | **1** | x ( | | x | | + | **363,70** | - | | ) - | **16,5** | = | 347,2 | **08ud-Poševna streha** | **0,099** | **0** | **15** | Hor | **0,70** | **0,80** | **0,80** |
| 9 | **poševna streha S 2F** | **10** | Roof/Ceiling - Ambient | **0** | x ( | | x | | + | **290,20** | - | | ) - | 0,0 | = | 0,0 | **08ud-Poševna streha** | **0,099** | **30** | **15** | Hor | **0,70** | **0,80** | **0,80** |
| 10 | **fasada S 1F** | **8** | External wall - Ambient | **1** | x ( | **33,90** | x | **8,35** | + | **1,16** | - | **28,33** | ) - | **122,9** | = | 133,0 | **01ud-Zunanja AB stena, fasada** | **0,148** | **0** | **90** | North | **0,70** | **0,80** | **0,80** |
| 11 | **fasada Z 1F** | **8** | External wall - Ambient | **1** | x ( | **1,35** | x | **2,65** | + | **31,73** | - | **7,74** | ) - | 0,0 | = | 27,6 | **01ud-Zunanja AB stena, fasada** | **0,148** | **270** | **90** | West | **0,70** | **0,80** | **0,80** |
| 12 | **fasada V 1F** | **8** | External wall - Ambient | **1** | x ( | **1,60** | x | **2,65** | + | | - | **1,12** | ) - | 0,0 | = | 3,1 | **01ud-Zunanja AB stena, fasada** | **0,148** | **90** | **90** | East | **0,70** | **0,80** | **0,80** |
| 13 | **cokl S 1F** | **8** | External wall - Ambient | **1** | x ( | **33,90** | x | **0,70** | + | | - | | ) - | 0,0 | = | 23,7 | **02ud-Zunanja AB stena, cokl** | **0,135** | **0** | **90** | North | **0,70** | **0,80** | **0,80** |
| 14 | **cokl Z 1F** | **8** | External wall - Ambient | **1** | x ( | **11,05** | x | **0,70** | + | | - | | ) - | 0,0 | = | 7,7 | **02ud-Zunanja AB stena, cokl** | **0,135** | **270** | **90** | West | **0,70** | **0,80** | **0,80** |
| 15 | **cokl V 1F** | **8** | External wall - Ambient | **1** | x ( | **1,60** | x | **0,70** | + | | - | | ) - | 0,0 | = | 1,1 | **02ud-Zunanja AB stena, cokl** | **0,135** | **90** | **90** | East | **0,70** | **0,80** | **0,80** |
| 16 | **podzidek SVZ 1F** | **9** | External wall - Ground | **1** | x ( | **37,55** | x | **0,50** | + | | - | | ) - | 0,0 | = | 18,8 | **05ud-Vkopana AB stena** | **0,157** | | **90** | | **0,70** | **0,80** | **0,80** |
| 17 | **fasada S 2F** | **8** | External wall - Ambient | **0** | x ( | **8,80** | x | **8,35** | + | | - | **0,00** | ) - | 0,0 | = | 0,0 | **01ud-Zunanja AB stena, fasada** | **0,148** | **0** | **90** | North | **0,70** | **0,80** | **0,80** |
| 18 | **fasada SV 2F** | **8** | External wall - Ambient | **0** | x ( | **13,50** | x | **8,35** | + | | - | **0,00** | ) - | 0,0 | = | 0,0 | **01ud-Zunanja AB stena, fasada** | **0,148** | **30** | **90** | North | **0,70** | **0,80** | **0,80** |
| 19 | **fasada JV 2F** | **8** | External wall - Ambient | **0** | x ( | **2,80** | x | **8,35** | + | | - | **0,00** | ) - | 0,0 | = | 0,0 | **01ud-Zunanja AB stena, fasada** | **0,148** | **120** | **90** | East | **0,70** | **0,80** | **0,80** |
| 20 | **cokl S 2F** | **8** | External wall - Ambient | **0** | x ( | **8,80** | x | **0,70** | + | | - | | ) - | 0,0 | = | 0,0 | **02ud-Zunanja AB stena, cokl** | **0,135** | **0** | **90** | North | **0,70** | **0,80** | **0,80** |
| 21 | **cokl SV 2F** | **8** | External wall - Ambient | **0** | x ( | **13,50** | x | **0,70** | + | | - | | ) - | 0,0 | = | 0,0 | **02ud-Zunanja AB stena, cokl** | **0,135** | **30** | **90** | North | **0,70** | **0,80** | **0,80** |
| 22 | **cokl JV 2F** | **8** | External wall - Ambient | **0** | x ( | **2,80** | x | **0,70** | + | | - | | ) - | 0,0 | = | 0,0 | **02ud-Zunanja AB stena, cokl** | **0,135** | **120** | **90** | East | **0,70** | **0,80** | **0,80** |
| 23 | **podzidek S SV JV 2F** | **9** | External wall - Ground | **0** | x ( | **25,10** | x | **0,50** | + | | - | | ) - | 0,0 | = | 0,0 | **05ud-Vkopana AB stena** | **0,157** | | **90** | | **0,70** | **0,80** | **0,80** |
| 24 | **fasada J 2F** | **8** | External wall - Ambient | **0** | x ( | **13,40** | x | **5,10** | + | | - | **0,00** | ) - | 0,0 | = | 0,0 | **01ud-Zunanja AB stena, fasada** | **0,148** | **180** | **90** | South | **0,70** | **0,80** | **0,80** |
| 25 | **cokl J 2F** | **8** | External wall - Ambient | **0** | x ( | **13,40** | x | **0,70** | + | | - | | ) - | 0,0 | = | 0,0 | **02ud-Zunanja AB stena, cokl** | **0,135** | **180** | **90** | South | **0,70** | **0,80** | **0,80** |
| 26 | **vrata ZV2 1F** | **7** | Exterior door | **1** | x ( | **2,00** | x | **2,30** | + | | - | | ) - | 0,0 | = | 4,6 | **03ud-Door external** | **0,900** | **0** | **90** | North | **0,70** | **0,80** | **0,80** |
| 27 | **vrata ZV3 2F** | **7** | Exterior door | **0** | x ( | **1,90** | x | **2,50** | + | | - | | ) - | 0,0 | = | 0,0 | **03ud-Door external** | **0,900** | **30** | **90** | North | **0,70** | **0,80** | **0,80** |
| 28 | **vrata ZV4 2F** | **7** | Exterior door | **0** | x ( | **1,10** | x | **2,50** | + | | - | | ) - | 0,0 | = | 0,0 | **03ud-Door external** | **0,900** | **30** | **90** | North | **0,70** | **0,80** | **0,80** |
| 29 | **fasada Z 1F proti 2F začasno** | **8** | External wall - Ambient | **1** | x ( | | x | | + | **43,00** | - | | ) - | 0,0 | = | 43,0 | **01ud-Zunanja AB stena, fasada** | **0,148** | **90** | **90** | East | **0,70** | **0,80** | **0,80** |
| 30 | | | | | x ( | | x | | + | | - | | ) - | 0,0 | = | | | | | | | | | |
| 31 | | | | | x ( | | x | | + | | - | | ) - | 0,0 | = | | | | | | | | | |
| 32 | | | | | x ( | | x | | + | | - | | ) - | 0,0 | = | | | | | | | | | |
| 33 | | | | | x ( | | x | | + | | - | | ) - | 0,0 | = | | | | | | | | | |
| 34 | | | | | x ( | | x | | + | | - | | ) - | 0,0 | = | | | | | | | | | |
| 35 | | | | | x ( | | x | | + | | - | | ) - | 0,0 | = | | | | | | | | | |
| 36 | | | | | x ( | | x | | + | | - | | ) - | 0,0 | = | | | | | | | | | |
| 37 | | | | | x ( | | x | | + | | - | | ) - | 0,0 | = | | | | | | | | | |
| 38 | | | | | x ( | | x | | + | | - | | ) - | 0,0 | = | | | | | | | | | |
| 39 | **1F** | | | | x ( | | x | **2030,84** | + | **629,92** | - | | ) - | 0,0 | = | | | | | | | | | |
| 40 | **P** | **1** | Treated floor area | **1** | x ( | | x | **1140,77** | + | **329,29** | - | | ) - | 0,0 | = | 329,3 | | | | | | | | |
| 41 | **N** | **1** | Treated floor area | **1** | x ( | | x | **890,07** | + | **300,63** | - | | ) - | 0,0 | = | 300,6 | | | | | | | | |
| 42 | | | | | x ( | | x | | + | | - | | ) - | 0,0 | = | | | | | | | | | |
| 43 | | | | | x ( | | x | | + | | - | | ) - | 0,0 | = | | | | | | | | | |
| 44 | **2F** | | | | x ( | | x | **1237,86** | + | **407,61** | - | | ) - | 0,0 | = | | | | | | | | | |
| 45 | **P** | **1** | Treated floor area | **0** | x ( | | x | **474,00** | + | **152,99** | - | | ) - | 0,0 | = | 0,0 | | | | | | | | |
| 46 | **N** | **1** | Treated floor area | **0** | x ( | | x | **763,86** | + | **254,62** | - | | ) - | 0,0 | = | 0,0 | | | | | | | | |
| 47 | | | | | x ( | | x | | + | | - | | ) - | 0,0 | = | | | | | | | | | |
| 48 | **neto površina** | | | | x ( | | x | | + | **1037,53** | - | | ) - | 0,0 | = | | | | | | | | | |
| 49 | **neto prostornina** | | | | x ( | | x | | + | **3268,70** | - | | ) - | 0,0 | = | | | | | | | | | |
| 50 | **višina** | | | | x ( | | x | | + | **3,15** | - | | ) - | 0,0 | = | | | | | | | | | |
| 51 | | | | | x ( | | x | | + | | - | | ) - | 0,0 | = | | | | | | | | | |
| 52 | | | | | x ( | | x | | + | | - | | ) - | 0,0 | = | | | | | | | | | |
| 53 | **1F** | | | | x ( | **506338,00** | x | **126216,00** | + | **290,00** | - | | ) - | 0,0 | = | | | | | | | | | |
| 54 | **2F** | | | | x ( | **506360,00** | x | **126204,00** | + | **290,00** | - | | ) - | 0,0 | = | | | | | | | | | |
| 55 | | | | | x ( | | x | | + | | - | | ) - | 0,0 | = | | | | | | | | | |
| 56 | | | | | x ( | | x | | + | | - | | ) - | 0,0 | = | | | | | | | | | |
| 57 | | | | | x ( | | x | | + | | - | | ) - | 0,0 | = | | | | | | | | | |
| 58 | | | | | x ( | | x | | + | | - | | ) - | 0,0 | = | | | | | | | | | |
| 59 | | | | | x ( | | x | | + | | - | | ) - | 0,0 | = | | | | | | | | | |
| 60 | | | | | x ( | | x | | + | | - | | ) - | 0,0 | = | | | | | | | | | |
| 61 | | | | | x ( | | x | | + | | - | | ) - | 0,0 | = | | | | | | | | | |
| 62 | | | | | x ( | | x | | + | | - | | ) - | 0,0 | = | | | | | | | | | |
| 63 | | | | | x ( | | x | | + | | - | | ) - | 0,0 | = | | | | | | | | | |
| 64 | | | | | x ( | | x | | + | | - | | ) - | 0,0 | = | | | | | | | | | |
| 65 | | | | | x ( | | x | | + | | - | | ) - | 0,0 | = | | | | | | | | | |
| 66 | | | | | x ( | | x | | + | | - | | ) - | 0,0 | = | | | | | | | | | |
| 67 | | | | | x ( | | x | | + | | - | | ) - | 0,0 | = | | | | | | | | | |
| 68 | | | | | x ( | | x | | + | | - | | ) - | 0,0 | = | | | | | | | | | |
| 69 | | | | | x ( | | x | | + | | - | | ) - | 0,0 | = | | | | | | | | | |
| 70 | | | | | x ( | | x | | + | | - | | ) - | 0,0 | = | | | | | | | | | |
| 71 | | | | | x ( | | x | | + | | - | | ) - | 0,0 | = | | | | | | | | | |
| 72 | | | | | x ( | | x | | + | | - | | ) - | 0,0 | = | | | | | | | | | |
| 73 | | | | | x ( | | x | | + | | - | | ) - | 0,0 | = | | | | | | | | | |
| 74 | | | | | x ( | | x | | + | | - | | ) - | 0,0 | = | | | | | | | | | |
| 75 | | | | | x ( | | x | | + | | - | | ) - | 0,0 | = | | | | | | | | | |
| 76 | | | | | x ( | | x | | + | | - | | ) - | 0,0 | = | | | | | | | | | |
| 77 | | | | | x ( | | x | | + | | - | | ) - | 0,0 | = | | | | | | | | | |
| 78 | | | | | x ( | | x | | + | | - | | ) - | 0,0 | = | | | | | | | | | |
| 79 | | | | | x ( | | x | | + | | - | | ) - | 0,0 | = | | | | | | | | | |
| 80 | | | | | x ( | | x | | + | | - | | ) - | 0,0 | = | | | | | | | | | |
| 81 | | | | | x ( | | x | | + | | - | | ) - | 0,0 | = | | | | | | | | | |
| 82 | | | | | x ( | | x | | + | | - | | ) - | 0,0 | = | | | | | | | | | |
| 83 | | | | | x ( | | x | | + | | - | | ) - | 0,0 | = | | | | | | | | | |
| 84 | | | | | x ( | | x | | + | | - | | ) - | 0,0 | = | | | | | | | | | |
| 85 | | | | | x ( | | x | | + | | - | | ) - | 0,0 | = | | | | | | | | | |
| 86 | | | | | x ( | | x | | + | | - | | ) - | 0,0 | = | | | | | | | | | |
| 87 | | | | | x ( | | x | | + | | - | | ) - | 0,0 | = | | | | | | | | | |
| 88 | | | | | x ( | | x | | + | | - | | ) - | 0,0 | = | | | | | | | | | |
| 89 | | | | | x ( | | x | | + | | - | | ) - | 0,0 | = | | | | | | | | | |
| 90 | | | | | x ( | | x | | + | | - | | ) - | 0,0 | = | | | | | | | | | |
| 91 | | | | | x ( | | x | | + | | - | | ) - | 0,0 | = | | | | | | | | | |
| 92 | | | | | x ( | | x | | + | | - | | ) - | 0,0 | = | | | | | | | | | |
| 93 | | | | | x ( | | x | | + | | - | | ) - | 0,0 | = | | | | | | | | | |
| 94 | | | | | x ( | | x | | + | | - | | ) - | 0,0 | = | | | | | | | | | |
| 95 | | | | | x ( | | x | | + | | - | | ) - | 0,0 | = | | | | | | | | | |
| 96 | | | | | x ( | | x | | + | | - | | ) - | 0,0 | = | | | | | | | | | |
| 97 | | | | | x ( | | x | | + | | - | | ) - | 0,0 | = | | | | | | | | | |
| 98 | | | | | x ( | | x | | + | | - | | ) - | 0,0 | = | | | | | | | | | |
| 99 | | | | | x ( | | x | | + | | - | | ) - | 0,0 | = | | | | | | | | | |
| 100 | | | | | x ( | | x | | + | | - | | ) - | 0,0 | = | | | | | | | | | |

Aend

To thermal bridge list

Sortierung ändern

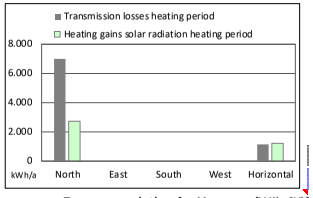
## Thermal bridge inputs

| No. | Thermal bridge - denomination | Group No. | Assigned to group | Quantity | x ( | Length [m] | - | Subtraction length [m] | ) = | Length ℓ [m] | User determined psi value [W/(mK)] | User determined $f_{Rsi=0,25}$ (optional) | | or | Selection building system | Ψ-Value [W/(mK)] | $f_{Rsi}$-Requirement met? |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | **vgradnja senčil** | **15** | Thermal bridges Ambient | **1** | x ( | **63,61** | - | | ) = | 63,61 | **0,025** | | | or | | **0,025** | |
| 2 | **temeljna plošča 1F** | **16** | Perimeter thermal bridges | **1** | x ( | **36,85** | - | | ) = | 36,85 | **0,020** | | | or | | **0,020** | |
| 3 | **atika** | **15** | Thermal bridges Ambient | **1** | x ( | **36,85** | - | | ) = | 36,85 | **0,040** | | | or | | **0,040** | |
| 4 | **atika** | **16** | Perimeter thermal bridges | **0** | x ( | **38,50** | - | | ) = | 0,00 | **0,100** | | | or | | **0,100** | |
| 5 | **temeljna plošča 2F** | **16** | Perimeter thermal bridges | **0** | x ( | **38,50** | - | | ) = | 0,00 | **0,020** | | | or | | **0,020** | |
| 6 | | | | | x ( | | - | | ) = | | | | | or | | | |

# Windows

Prizidava OŠ Polzela - 1. faza / Climate: Ljubljana, Eko sklad 2018 / TFA: 630 m² / Heating: 12,8 kWh/(m²a) / Cooling: 2,8 kWh/(m²a) / PER: 48,1 kWh/(m²a)

| Window area orientation | Global radiation (main orientations) | Shading | Dirt | Non-vertical radiation incidence | Glazing fraction | g-Value | Solar irradiation reduction factor | Window area | Window U-Value | Glazing area | Average global radiation | | Transmission losses heating period | Heating gains solar radiation heating period |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Standard values → | kWh/(m²a) | 0,75 | 0,95 | 0,85 | | | | m² | W/(m²K) | m² | kWh/(m²a) | | kWh/a | kWh/a |
| North | 94 | 0,82 | 0,95 | 0,85 | 0,71 | 0,50 | 0,47 | 122,90 | 0,80 | 86,72 | 94 | North | 6974 | 2714 |
| East | 201 | 1,00 | 0,95 | 0,85 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 201 | East | 0 | 0 |
| South | 383 | 1,00 | 0,95 | 0,85 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 383 | South | 0 | 0 |
| West | 215 | 1,00 | 0,95 | 0,85 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 215 | West | 0 | 0 |
| Horizontal | 322 | 0,94 | 0,95 | 0,85 | 0,74 | 0,51 | 0,56 | 16,50 | 0,95 | 12,26 | 254 | Horizontal | 1121 | 1201 |
| Total or average value for all windows. | | | | | | 0,50 | 0,48 | 139,40 | 0,81 | 98,98 | | | 8095 | 3915 |




Heating degree hours [kKh/a]: 71,4

Go to glazing list | Go to window frames list

Recommendation for $U_{W,installed}$ [W/(m²K)]: 0,85 | 1,00 | 1,10 | 0,52

| Quantity | Description | Deviation from north | Angle of inclination from the horizontal | Orientation | Window rough openings: Width | Window rough openings: Height | Installed in: Selection from 'Areas' worksheet | Glazing: Selection from 'Components' worksheet | Frame: Selection from 'Components' worksheet | g-Value: Perpendicular radiation | U-Value: Glazing | U-Value: Frames (avg.) | Ψ Glazing edge (Avg.) | Installation situation: left | right | bottom | top | Ψ Installation (Avg.) | Results: Window Area | Glazing area | $U_w$ installed | Glazed fraction per window |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | ° | ° | | m | m | | 1-Sorting: LIKE LIST | 1-Sorting: LIKE LIST | - | W/(m²K) | W/(m²K) | W/(mK) | W/(mK) or 1/0 | | | | W/(mK) | m² | m² | W/(m²K) | % |
| 6 | str 1F | 0 | 15 | Horizontal | 1,500 | 1,500 | 8-poševna streha S 1F | 06ud-Velux GGU | 06ud-Velux GGL GGU | 0,51 | 0,50 | 1,20 | 0,090 | 1 | 1 | 1 | 1 | 0,020 | 13,5 | 10,16 | 0,93 | 75% |
| 2 | | 0 | 15 | Horizontal | 1,000 | 1,500 | 8-poševna streha S 1F | 06ud-Velux GGU | 06ud-Velux GGL GGU | 0,51 | 0,50 | 1,20 | 0,090 | 1 | 1 | 1 | 1 | 0,020 | 3,0 | 2,10 | 1,03 | 70% |
| 0 | str 2F | 30 | 15 | Horizontal | 1,500 | 1,500 | 9-poševna streha S 2F | 06ud-Velux GGU | 06ud-Velux GGL GGU | 0,51 | 0,50 | 1,20 | 0,090 | 1 | 1 | 1 | 1 | 0,020 | | | | |
| 1 | 1F o1 | 0 | 90 | North | 1,009 | 2,260 | 10-fasada S 1F | 02ud-PVC stekla | 02ud-PVC elementi | 0,50 | 0,50 | 1,10 | 0,038 | 0 | 1 | 1 | 1 | 0,010 | 2,3 | 1,61 | 0,79 | 71% |
| 5 | | 0 | 90 | North | 1,009 | 2,260 | 10-fasada S 1F | 02ud-PVC stekla | 02ud-PVC elementi | 0,50 | 0,50 | 1,10 | 0,038 | 0 | 0 | 1 | 1 | 0,010 | 11,4 | 8,04 | 0,78 | 71% |
| 1 | | 0 | 90 | North | 1,009 | 2,260 | 10-fasada S 1F | 02ud-PVC stekla | 02ud-PVC elementi | 0,50 | 0,50 | 1,10 | 0,038 | 1 | 0 | 1 | 1 | 0,010 | 2,3 | 1,61 | 0,79 | 71% |
| 1 | 1F o2 | 0 | 90 | North | 0,865 | 2,260 | 10-fasada S 1F | 02ud-PVC stekla | 02ud-PVC elementi | 0,50 | 0,50 | 1,10 | 0,038 | 0 | 1 | 1 | 1 | 0,010 | 2,0 | 1,32 | 0,82 | 67% |
| 1 | | 0 | 90 | North | 0,865 | 2,260 | 10-fasada S 1F | 02ud-PVC stekla | 02ud-PVC elementi | 0,50 | 0,50 | 1,10 | 0,038 | 1 | 0 | 1 | 1 | 0,010 | 2,0 | 1,32 | 0,82 | 67% |
| 1 | 1F zv1 | 0 | 90 | North | 1,200 | 2,300 | 10-fasada S 1F | 01ud-Alu stekla | 01ud-Alu elementi | 0,50 | 0,50 | 1,40 | 0,040 | 0 | 1 | 1 | 1 | 0,010 | 2,8 | 1,98 | 0,86 | 72% |
| 1 | | 0 | 90 | North | 1,200 | 2,300 | 10-fasada S 1F | 01ud-Alu stekla | 01ud-Alu elementi | 0,50 | 0,50 | 1,40 | 0,040 | 1 | 0 | 1 | 1 | 0,010 | 2,8 | 1,98 | 0,86 | 72% |
| 1 | 1F zpv1 | 0 | 90 | North | 1,030 | 2,950 | 10-fasada S 1F | 02ud-PVC stekla | 02ud-PVC elementi | 0,50 | 0,50 | 1,10 | 0,038 | 0 | 1 | 1 | 1 | 0,010 | 3,0 | 2,21 | 0,77 | 73% |
| 4 | | 0 | 90 | North | 1,000 | 2,950 | 10-fasada S 1F | 02ud-PVC stekla | 02ud-PVC elementi | 0,50 | 0,50 | 1,10 | 0,038 | 0 | 0 | 1 | 1 | 0,010 | 11,8 | 8,52 | 0,76 | 72% |
| 1 | | 0 | 90 | North | 1,015 | 2,950 | 10-fasada S 1F | 01ud-Alu stekla | 01ud-Alu elementi | 0,50 | 0,50 | 1,40 | 0,040 | 0 | 0 | 1 | 1 | 0,010 | 3,0 | 2,10 | 0,87 | 70% |
| 1 | | 0 | 90 | North | 1,015 | 2,950 | 10-fasada S 1F | 01ud-Alu stekla | 01ud-Alu elementi | 0,50 | 0,50 | 1,40 | 0,040 | 0 | 0 | 1 | 1 | 0,010 | 3,0 | 2,10 | 0,87 | 70% |
| 1 | | 0 | 90 | North | 1,015 | 2,950 | 10-fasada S 1F | 01ud-Alu stekla | 01ud-Alu elementi | 0,50 | 0,50 | 1,40 | 0,040 | 0 | 0 | 1 | 1 | 0,010 | 3,0 | 2,10 | 0,87 | 70% |
| 1 | | 0 | 90 | North | 1,015 | 2,950 | 10-fasada S 1F | 01ud-Alu stekla | 01ud-Alu elementi | 0,50 | 0,50 | 1,40 | 0,040 | 0 | 0 | 1 | 1 | 0,010 | 3,0 | 2,10 | 0,87 | 70% |
| 4 | | 0 | 90 | North | 1,000 | 2,950 | 10-fasada S 1F | 02ud-PVC stekla | 02ud-PVC elementi | 0,50 | 0,50 | 1,10 | 0,038 | 0 | 0 | 1 | 1 | 0,010 | 11,8 | 8,52 | 0,76 | 72% |
| 1 | | 0 | 90 | North | 1,030 | 2,950 | 10-fasada S 1F | 02ud-PVC stekla | 02ud-PVC elementi | 0,50 | 0,50 | 1,10 | 0,038 | 1 | 0 | 1 | 1 | 0,010 | 3,0 | 2,21 | 0,77 | 73% |
| 0 | 2F o3 | 30 | 90 | North | 1,030 | 1,700 | 18-fasada SV 2F | 02ud-PVC stekla | 02ud-PVC elementi | 0,50 | 0,50 | 1,10 | 0,038 | 0 | 1 | 1 | 1 | 0,010 | | | | |
| 0 | | 30 | 90 | North | 1,030 | 1,700 | 18-fasada SV 2F | 02ud-PVC stekla | 02ud-PVC elementi | 0,50 | 0,50 | 1,10 | 0,038 | 1 | 0 | 1 | 1 | 0,010 | | | | |
| 1 | 1F o4 | 0 | 90 | North | 1,030 | 2,614 | 10-fasada S 1F | 02ud-PVC stekla | 02ud-PVC elementi | 0,50 | 0,50 | 1,10 | 0,038 | 0 | 1 | 1 | 1 | 0,010 | 2,7 | 1,94 | 0,78 | 72% |
| 1 | | 0 | 90 | North | 1,030 | 2,614 | 10-fasada S 1F | 02ud-PVC stekla | 02ud-PVC elementi | 0,50 | 0,50 | 1,10 | 0,038 | 1 | 0 | 1 | 1 | 0,010 | 2,7 | 1,94 | 0,78 | 72% |
| 1 | 1F o5 | 0 | 90 | North | 1,007 | 2,000 | 10-fasada S 1F | 02ud-PVC stekla | 02ud-PVC elementi | 0,50 | 0,50 | 1,10 | 0,038 | 0 | 1 | 1 | 1 | 0,010 | 2,0 | 1,40 | 0,80 | 70% |
| 7 | | 0 | 90 | North | 1,007 | 2,000 | 10-fasada S 1F | 02ud-PVC stekla | 02ud-PVC elementi | 0,50 | 0,50 | 1,10 | 0,038 | 0 | 0 | 1 | 1 | 0,010 | 14,1 | 9,80 | 0,79 | 70% |
| 1 | | 0 | 90 | North | 1,007 | 2,000 | 10-fasada S 1F | 02ud-PVC stekla | 02ud-PVC elementi | 0,50 | 0,50 | 1,10 | 0,038 | 1 | 0 | 1 | 1 | 0,010 | 2,0 | 1,40 | 0,80 | 70% |
| 2 | 1F o6 | 0 | 90 | North | 1,020 | 2,000 | 10-fasada S 1F | 02ud-PVC stekla | 02ud-PVC elementi | 0,50 | 0,50 | 1,10 | 0,038 | 0 | 1 | 1 | 1 | 0,010 | 4,1 | 2,85 | 0,80 | 70% |
| 2 | | 0 | 90 | North | 1,020 | 2,000 | 10-fasada S 1F | 02ud-PVC stekla | 02ud-PVC elementi | 0,50 | 0,50 | 1,10 | 0,038 | 0 | 0 | 1 | 1 | 0,010 | 4,1 | 2,85 | 0,79 | 70% |
| 2 | | 0 | 90 | North | 1,020 | 2,000 | 10-fasada S 1F | 02ud-PVC stekla | 02ud-PVC elementi | 0,50 | 0,50 | 1,10 | 0,038 | 1 | 0 | 1 | 1 | 0,010 | 4,1 | 2,85 | 0,80 | 70% |
| 1 | 1F o7 | 0 | 90 | North | 1,006 | 2,000 | 10-fasada S 1F | 02ud-PVC stekla | 02ud-PVC elementi | 0,50 | 0,50 | 1,10 | 0,038 | 0 | 1 | 1 | 1 | 0,010 | 2,0 | 1,40 | 0,80 | 70% |
| 8 | | 0 | 90 | North | 1,006 | 2,000 | 10-fasada S 1F | 02ud-PVC stekla | 02ud-PVC elementi | 0,50 | 0,50 | 1,10 | 0,038 | 0 | 0 | 1 | 1 | 0,010 | 16,1 | 11,19 | 0,79 | 70% |
| 1 | | 0 | 90 | North | 1,006 | 2,000 | 10-fasada S 1F | 02ud-PVC stekla | 02ud-PVC elementi | 0,50 | 0,50 | 1,10 | 0,038 | 1 | 0 | 1 | 1 | 0,010 | 2,0 | 1,40 | 0,80 | 70% |
| 0 | 2F o9 | 0 | 90 | North | 1,008 | 2,000 | 17-fasada S 2F | 02ud-PVC stekla | 02ud-PVC elementi | 0,50 | 0,50 | 1,10 | 0,038 | 0 | 1 | 1 | 1 | 0,010 | | | | |
| 0 | | 0 | 90 | North | 1,008 | 2,000 | 17-fasada S 2F | 02ud-PVC stekla | 02ud-PVC elementi | 0,50 | 0,50 | 1,10 | 0,038 | 0 | 0 | 1 | 1 | 0,010 | | | | |
| 0 | | 0 | 90 | North | 1,008 | 2,000 | 17-fasada S 2F | 02ud-PVC stekla | 02ud-PVC elementi | 0,50 | 0,50 | 1,10 | 0,038 | 1 | 0 | 1 | 1 | 0,010 | | | | |
| 0 | 2F o10 | 30 | 90 | North | 1,030 | 2,000 | 18-fasada SV 2F | 02ud-PVC stekla | 02ud-PVC elementi | 0,50 | 0,50 | 1,10 | 0,038 | 0 | 1 | 1 | 1 | 0,010 | | | | |
| 0 | | 30 | 90 | North | 1,030 | 2,000 | 18-fasada SV 2F | 02ud-PVC stekla | 02ud-PVC elementi | 0,50 | 0,50 | 1,10 | 0,038 | 1 | 0 | 1 | 1 | 0,010 | | | | |
| 0 | 2F o11 | 180 | 90 | South | 1,300 | 2,500 | 24-fasada J 2F | 02ud-PVC stekla | 02ud-PVC elementi | 0,50 | 0,50 | 1,10 | 0,038 | 0 | 1 | 1 | 1 | 0,010 | | | | |
| 0 | | 180 | 90 | South | 1,000 | 2,500 | 24-fasada J 2F | 02ud-PVC stekla | 02ud-PVC elementi | 0,50 | 0,50 | 1,10 | 0,038 | 1 | 0 | 1 | 1 | 0,010 | | | | |
| 0 | 2F o11 | 180 | 90 | South | 1,008 | 2,000 | 24-fasada J 2F | 02ud-PVC stekla | 02ud-PVC elementi | 0,50 | 0,50 | 1,10 | 0,038 | 0 | 1 | 1 | 1 | 0,010 | | | | |
| 0 | | 180 | 90 | South | 1,008 | 2,000 | 24-fasada J 2F | 02ud-PVC stekla | 02ud-PVC elementi | 0,50 | 0,50 | 1,10 | 0,038 | 0 | 0 | 1 | 1 | 0,010 | | | | |
| 0 | | 180 | 90 | South | 1,008 | 2,000 | 24-fasada J 2F | 02ud-PVC stekla | 02ud-PVC elementi | 0,50 | 0,50 | 1,10 | 0,038 | 1 | 0 | 1 | 1 | 0,010 | | | | |

# Calculation of shading coefficients

Prizidava OŠ Polzela - 1. faza / Climate: Ljubljana, Eko sklad 2018 / TFA: 630 m² / Heating: 12,8 kWh/(m²a) / Cooling: 2,8 kWh/(m²a) / PER: 48,1 kWh/(m²a)

Latitude: 46,07 °

| Orientation | Glazing area [m²] | Reduction factor winter $r_v$ | Reduction factor cooling $r_{v,1}$ | Reduction factor cooling load $r_{v,2}$ | Solar load [kWh/(m²$_{glazing}$a)] |
|---|---|---|---|---|---|
| North | 86,72 | 82% | 35% | 28% | 30 |
| East | 0,00 | 100% | 100% | 100% | 0 |
| South | 0,00 | 100% | 100% | 100% | 0 |
| West | 0,00 | 100% | 100% | 100% | 0 |
| Horizontal | 12,26 | 94% | 39% | 32% | 110 |

| | | | | | | | | Horizon | | Lateral reveal | | Reveal / Overhang | | | | | | Reduction factors for shading in winter | | | | Reduction factors for shading in summer | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Quantity | Description | Deviation from North | Angle of inclination from the horizontal | Orientation | Glazing width | Glazing height | Glazing area | Height of the shading object | Horizontal distance | Window reveal depth | Distance from glazing edge to reveal | Overhang depth | Distance from upper glazing edge to overhang | Additional reduction factor winter shading | Additional reduction factor summer shading | Reduction factor z for temporary sun protection | Regulated / transparent | Horizon | Reveal | Overhang | Total for heating case | Horizon | Reveal | Overhang | Total for cooling case | Total for cooling load |
| | | [Degree] | [Degree] | | $w_G$ [m] | $h_G$ [m] | $A_G$ [m²] | $h_{Hori}$ [m] | $d_{Hori}$ [m] | $o_{Reveal}$ [m] | $d_{Reveal}$ [m] | $o_{Over}$ [m] | $d_{Over}$ [m] | $r_{other,w}$ [%] | $r_{other,s}$ [%] | z [%] | | $r_H$ [%] | $r_R$ [%] | $r_O$ [%] | $r_S$ [%] | $r_H$ [%] | $r_R$ [%] | $r_O$ [%] | $r_{S,1}$ [%] | $r_{S,2}$ [%] |
| 6 | str 1F | 0 | 15 | Horizontal | 1,31 | 1,29 | 10,2 | | | 0,05 | 0,05 | 0,05 | 0,05 | | | 25% | x | | 98% | 96% | 94% | | 98% | 99% | 39% | 32% |
| 2 | | 0 | 15 | Horizontal | 0,81 | 1,29 | 2,1 | | | 0,05 | 0,05 | 0,05 | 0,05 | | | 25% | x | | 96% | 96% | 93% | | 97% | 99% | 39% | 31% |
| 0 | str 2F | 30 | 15 | Horizontal | 1,31 | 1,29 | | | | 0,05 | 0,05 | 0,05 | 0,05 | | | 25% | x | | | | | | | | | |
| 1 | 1F o1 | 0 | 90 | North | 0,79 | 2,04 | 1,6 | | | 0,25 | 0,14 | 0,25 | 0,14 | | | 25% | x | | 87% | 94% | 82% | | 88% | 98% | 34% | 28% |
| 5 | | 0 | 90 | North | 0,79 | 2,04 | 8,0 | | | 0,25 | 0,14 | 0,25 | 0,14 | | | 25% | x | | 87% | 94% | 82% | | 88% | 98% | 34% | 28% |
| 1 | | 0 | 90 | North | 0,79 | 2,04 | 1,6 | | | 0,25 | 0,14 | 0,25 | 0,14 | | | 25% | x | | 87% | 94% | 82% | | 88% | 98% | 34% | 28% |
| 1 | 1F o2 | 0 | 90 | North | 0,65 | 2,04 | 1,3 | | | 0,25 | 0,14 | 0,25 | 0,14 | | | 25% | x | | 86% | 94% | 80% | | 86% | 98% | 34% | 28% |
| 1 | | 0 | 90 | North | 0,65 | 2,04 | 1,3 | | | 0,25 | 0,14 | 0,25 | 0,14 | | | 25% | x | | 86% | 94% | 80% | | 86% | 98% | 34% | 28% |
| 1 | 1F zv1 | 0 | 90 | North | 0,96 | 2,06 | 2,0 | | | 0,25 | 0,14 | 0,25 | 0,14 | | | 25% | x | | 89% | 94% | 84% | | 89% | 98% | 35% | 29% |
| 1 | | 0 | 90 | North | 0,96 | 2,06 | 2,0 | | | 0,25 | 0,14 | 0,25 | 0,14 | | | 25% | x | | 89% | 94% | 84% | | 89% | 98% | 35% | 29% |
| 1 | 1F zpv1 | 0 | 90 | North | 0,81 | 2,73 | 2,2 | | | 0,25 | 0,14 | 0,25 | 0,14 | | | 25% | x | | 87% | 95% | 83% | | 88% | 99% | 35% | 28% |
| 4 | | 0 | 90 | North | 0,78 | 2,73 | 8,5 | | | 0,25 | 0,14 | 0,25 | 0,14 | | | 25% | x | | 87% | 95% | 83% | | 88% | 99% | 35% | 28% |
| 1 | | 0 | 90 | North | 0,78 | 2,71 | 2,1 | | | 0,25 | 0,14 | 0,25 | 0,14 | | | 25% | x | | 87% | 95% | 83% | | 88% | 99% | 35% | 28% |
| 1 | | 0 | 90 | North | 0,78 | 2,71 | 2,1 | | | 0,25 | 0,14 | 0,25 | 0,14 | | | 25% | x | | 87% | 95% | 83% | | 88% | 99% | 35% | 28% |
| 1 | | 0 | 90 | North | 0,78 | 2,71 | 2,1 | | | 0,25 | 0,14 | 0,25 | 0,14 | | | 25% | x | | 87% | 95% | 83% | | 88% | 99% | 35% | 28% |
| 1 | | 0 | 90 | North | 0,78 | 2,71 | 2,1 | | | 0,25 | 0,14 | 0,25 | 0,14 | | | 25% | x | | 87% | 95% | 83% | | 88% | 99% | 35% | 28% |
| 4 | | 0 | 90 | North | 0,78 | 2,73 | 8,5 | | | 0,25 | 0,14 | 0,25 | 0,14 | | | 25% | x | | 87% | 95% | 83% | | 88% | 99% | 35% | 28% |
| 1 | | 0 | 90 | North | 0,81 | 2,73 | 2,2 | | | 0,25 | 0,14 | 0,25 | 0,14 | | | 25% | x | | 87% | 95% | 83% | | 88% | 99% | 35% | 28% |
| 0 | 2F o3 | 30 | 90 | North | 0,81 | 1,48 | | | | 0,25 | 0,14 | 0,25 | 0,14 | | | 25% | x | | | | | | | | | |
| 0 | | 30 | 90 | North | 0,81 | 1,48 | | | | 0,25 | 0,14 | 0,25 | 0,14 | | | 25% | x | | | | | | | | | |
| 1 | 1F o4 | 0 | 90 | North | 0,81 | 2,39 | 1,9 | | | 0,25 | 0,14 | 0,25 | 0,14 | | | 25% | x | | 87% | 95% | 83% | | 88% | 99% | 35% | 28% |
| 1 | | 0 | 90 | North | 0,81 | 2,39 | 1,9 | | | 0,25 | 0,14 | 0,25 | 0,14 | | | 25% | x | | 87% | 95% | 83% | | 88% | 99% | 35% | 28% |
| 1 | 1F o5 | 0 | 90 | North | 0,79 | 1,78 | 1,4 | | | 0,25 | 0,14 | 0,25 | 0,14 | | | 25% | x | | 87% | 93% | 81% | | 88% | 98% | 34% | 28% |
| 7 | | 0 | 90 | North | 0,79 | 1,78 | 9,8 | | | 0,25 | 0,14 | 0,25 | 0,14 | | | 25% | x | | 87% | 93% | 81% | | 88% | 98% | 34% | 28% |
| 1 | | 0 | 90 | North | 0,79 | 1,78 | 1,4 | | | 0,25 | 0,14 | 0,25 | 0,14 | | | 25% | x | | 87% | 93% | 81% | | 88% | 98% | 34% | 28% |
| 2 | 1F o6 | 0 | 90 | North | 0,80 | 1,78 | 2,8 | | | 0,25 | 0,14 | 0,25 | 0,14 | | | 25% | x | | 87% | 93% | 82% | | 88% | 98% | 34% | 28% |
| 2 | | 0 | 90 | North | 0,80 | 1,78 | 2,8 | | | 0,25 | 0,14 | 0,25 | 0,14 | | | 25% | x | | 87% | 93% | 82% | | 88% | 98% | 34% | 28% |
| 2 | | 0 | 90 | North | 0,80 | 1,78 | 2,8 | | | 0,25 | 0,14 | 0,25 | 0,14 | | | 25% | x | | 87% | 93% | 82% | | 88% | 98% | 34% | 28% |
| 1 | 1F o7 | 0 | 90 | North | 0,79 | 1,78 | 1,4 | | | 0,25 | 0,14 | 0,25 | 0,14 | | | 25% | x | | 87% | 93% | 81% | | 88% | 98% | 34% | 28% |
| 8 | | 0 | 90 | North | 0,79 | 1,78 | 11,2 | | | 0,25 | 0,14 | 0,25 | 0,14 | | | 25% | x | | 87% | 93% | 81% | | 88% | 98% | 34% | 28% |
| 1 | | 0 | 90 | North | 0,79 | 1,78 | 1,4 | | | 0,25 | 0,14 | 0,25 | 0,14 | | | 25% | x | | 87% | 93% | 81% | | 88% | 98% | 34% | 28% |
| 0 | 2F o9 | 0 | 90 | North | 0,79 | 1,78 | | | | 0,25 | 0,14 | 0,25 | 0,14 | | | 25% | x | | | | | | | | | |
| 0 | | 0 | 90 | North | 0,79 | 1,78 | | | | 0,25 | 0,14 | 0,25 | 0,14 | | | 25% | x | | | | | | | | | |
| 0 | | 0 | 90 | North | 0,79 | 1,78 | | | | 0,25 | 0,14 | 0,25 | 0,14 | | | 25% | x | | | | | | | | | |
| 0 | 2F o10 | 30 | 90 | North | 0,81 | 1,78 | | | | 0,25 | 0,14 | 0,25 | 0,14 | | | 25% | x | | | | | | | | | |
| 0 | | 30 | 90 | North | 0,81 | 1,78 | | | | 0,25 | 0,14 | 0,25 | 0,14 | | | 25% | x | | | | | | | | | |
| 0 | 2F o11 | 180 | 90 | South | 1,08 | 2,28 | | | | 0,25 | 0,14 | 0,25 | 0,14 | | | 25% | x | | | | | | | | | |
| 0 | | 180 | 90 | South | 0,78 | 2,28 | | | | 0,25 | 0,14 | 0,25 | 0,14 | | | 25% | x | | | | | | | | | |
| 0 | 2F o11 | 180 | 90 | South | 0,79 | 1,78 | | | | 0,25 | 0,14 | 0,25 | 0,14 | | | 25% | x | | | | | | | | | |
| 0 | | 180 | 90 | South | 0,79 | 1,78 | | | | 0,25 | 0,14 | 0,25 | 0,14 | | | 25% | x | | | | | | | | | |
| 0 | | 180 | 90 | South | 0,79 | 1,78 | | | | 0,25 | 0,14 | 0,25 | 0,14 | | | 25% | x | | | | | | | | | |

# Ventilation data



| | | | | |
|---|---|---|---|---|
| Treated floor area $A_{TFA}$ | m² | 630 | | *('Areas' worksheet)* |
| Room height h | m | 3,15 | 3,15 | |
| Volume of ventilated space ($A_{TFA}$*h) : $V_V$ | m³ | 1985 | | *(Worksheet 'Annual heating')* |

## Ventilation type

Please select: **1-Balanced PH ventilation with HR**

## Infiltration air change rate

| Wind protection coefficients e and f | | |
|---|---|---|
| Coefficient e for wind protection class | Several side exposed | One side exposed |
| No protection | 0,10 | 0,03 |
| Moderate protection | 0,07 | 0,02 |
| High protection | 0,04 | 0,01 |
| Coefficient f | 15 | 20 |

| | | | For annual demand: | For heating load: | | | | |
|---|---|---|---|---|---|---|---|---|
| Wind protection coefficient, e | | | 0,07 | 0,18 | | | | |
| Wind protection coefficient, f | | | 15 | 15 | Net air volume for press. test | $V_{n50}$ | Air permeability | $q_{50}$ |
| Air change rate at press. test | $n_{50}$ | 1/h | 0,60 | 0,60 | 2437 | m³ | 1,17 | m³/(hm²) |

| | | | For annual demand: | For heating load: |
|---|---|---|---|---|
| Excess extract air | | 1/h | 0,00 | 0,00 |
| Infiltration air change rate | $n_{V,Rest}$ | 1/h | **0,052** | **0,129** |

## Selection of ventilation input - Results

PHPP offers two methods for dimensioning air quantities and choosing the ventilation unit. With "Standard data input for balanced ventilation", supply or extract air quantities for residential buildings and parameters for ventilation systems with a maximum of 1 ventilation unit can be planned. Projects with up to 10 different ventilation units and air quantities determined according to rooms or zones can be entered in the 'Addl vent' worksheet. Please select your design method here:

| | Ventilation unit / Heat recovery efficiency design | | Average air flow rate m³/h | Average air change rate 1/h | Extract air excess (extract air system) 1/h | Effective heat recovery efficiency unit [-] | Humidity recovery efficiency [-] | Specific power input Wh/m³ | Heat recovery efficiency SHX [-] |
|---|---|---|---|---|---|---|---|---|---|
| x | Standard design | *('Ventilation' worksheet, see below)* | **1100** | **0,55** | **0,00** | **78,9%** | **N/A** | **0,21** | **0,0%** |
| | Multiple ventilation units, non-res | *('Addl vent' worksheet)* | | | | | | | |

| Cooling recovery | Efficiency SHX $\eta^*_{SHX}$ |
|---|---|
| | 0% |

**Average interior humidity during winter operation**

| Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 29% | 29% | 35% | 43% | - | - | - | - | - | 53% | 40% | 30% |

# Standard data input for balanced ventilation

Dimensioning of ventilation system with only one ventilation unit

| | | | | | | |
|---|---|---|---|---|---|---|
| Occupancy | m²/P | 4 | | | | |
| Number of occupants | P | 150,0 | | | | |
| Supply air per person | m³/(P*h) | 20 | | | | |
| Supply air requirement | m³/h | 3000 | | Bathroom | | |
| Extract air rooms | | Kitchen | Bathroom | (shower only) | WC | Sum |
| Quantity | | | | | | 1 |
| Extract air requirement per room | m³/h | 60 | 40 | 20 | 20 | 3000 |
| Total extract air requirement | m³/h | 3000 | | | | |

Design air flow rate (maximum) m³/h **3000** Recommended: 3000 m³/h

**Average air change rate calculation**

| Type of operation | Daily operation times h/d | Factors referenced to maximum | Air flow rate m³/h | Air change rate 1/h |
|---|---|---|---|---|
| maximum | 8,0 | 1,00 | 3000 | 1,51 |
| Standard | | 0,77 | 2308 | 1,16 |
| Basic ventilation | | 0,50 | 1500 | 0,76 |
| Minimum | 16,0 | 0,05 | 150 | 0,08 |
| | | | Average air flow rate (m³/h) | Average air change rate (1/h) |
| | Average value | 0,37 | 1100 | 0,55 |

**Selection of ventilation unit with heat recovery**

Location of ventilation unit: **2-Outside of thermal envelope**

| | Go to ventilation units list<br>1-Sorting: LIKE LIST | Heat recovery efficiency | Humidity recovery efficiency | Specific efficiency [Wh/m³] | Application [m³/h] | Frost power input |
|---|---|---|---|---|---|---|
| Ventilation unit selection | 11ud-uteženo povprečje naprav | 0,80 | N/A | 0,21 | N/A | N/A |

| | | | | | |
|---|---|---|---|---|---|
| Conductivity supply air duct | Ψ | W/(mK) | 0,689 | Implementation of frost protection | 2-Elec. |
| Length of supply air duct | | m | 5 | Limit temperature [°C] | -8 |
| Conductivity extract air duct | Ψ | W/(mK) | 0,689 | Useful energy [kWh/a] | 49 |
| Length of extract air duct | | m | 5 | | |
| Temperature of mechanical services room | | °C | 4,9 | Room temperature (°C) | 20 |
| (Enter only if the central unit is outside of the thermal envelope) | | | | Avg. ambient temp. heat. period (°C | 4,9 |
| | | | | Avg. ground temp (°C) | 11,8 |

Effective heat recovery efficiency $\eta_{HR,eff}$ **78,9%**

**Effective heat recovery efficiency subsoil heat exchanger**

| | | |
|---|---|---|
| SHX efficiency | $\eta^*_{SHX}$ | 0% |
| Heat recovery efficiency SHX | $\eta_{SHX}$ | 0% |

# Summer ventilation

Prizidava OŠ Polzela - 1. faza / Climate: Ljubljana, Eko sklad 2018 / TFA: 630 m² / Heating: 12,8 kWh/(m²a) / Cooling: 2,8 kWh/(m²a) / PER: 48,1 kWh/(m²a)

| | | | | | |
|---|---|---|---|---|---|
| Building volume: | 1985 | m³ | Building type: | CC-SI 12630 | |
| Max. indoor absolute humidity: | 12 | g/kg | Heat recovery efficiency: | 79% | |
| Internal humidity sources: | 10 | g/(P*h) | Humidity recovery efficiency: | 0% | |
| | | | Subsoil heat exchanger efficiency: | 0% | |

| Results passive cooling | | | Results active cooling | | |
|---|---|---|---|---|---|
| Frequency of overheating: | 14,3% | at the overheating limit $\vartheta_{max}$ = 25 °C | Useful cooling demand: | 2,7 | kWh/(m²a) |
| max. humidity: | 13,7 | g/kg | Dehumidification demand: | 0,1 | kWh/(m²a) |
| Frequency of exceeded humidity: | 0,3% | | Frequency of exceeded humidity: | 0,0% | |

## Summer basic ventilation to ensure adequate air quality

| | | | | |
|---|---|---|---|---|
| Air change rate via vent. system with supply ai | 0,55 | 1/h | HRV/ERV in summer (check only one field) | |
| | | | None | |
| | | | Automatic bypass, controlled by temperature difference | x |
| | | | Automatic bypass, controlled by enthalpy difference | |
| | | | Always | |
| Air change rate via extract air system: | | 1/h | | |
| | | | Specific power consumption (for extract air system) | 0,20 Wh/m³ |
| Window ventilation air change rate: | | 1/h | | |

**Effective air change rate**

| | $n_{V,system}$ 1/h | | $\eta^*_{SHX}$ | | $\eta_{HP}$ | | $n_{V,equi,fraction}$ 1/h |
|---|---|---|---|---|---|---|---|
| Exterior $n_{V,e}$ | 0,554 | *(1- | 0% | )*(1- | 0,79 | ) = | 0,117 |
| without HR | 0,554 | *(1- | 0% | ) | | = | 0,554 |
| Ground $n_{L,g}$ | 0,554 | * | 0% | *(1- | 0,79 | ) = | 0,000 |
| without HR | 0,554 | * | 0% | | | = | 0,000 |

**Ventilation conductance**

| | $V_V$ m³ | | $n_{V,equi,fraction}$ 1/h | | $c_{Air}$ Wh/(m³K) | | | |
|---|---|---|---|---|---|---|---|---|
| exterior $H_{V,e}$ | 1985 | * | 0,117 | * | 0,33 | = | 76,6 | W/K |
| without HR | 1985 | * | 0,554 | * | 0,33 | = | 363,0 | W/K |
| ground $H_{V,g}$ | 1985 | * | 0,000 | * | 0,33 | = | 0,0 | W/K |
| without HR | 1985 | * | 0,000 | * | 0,33 | = | 0,0 | W/K |
| Infiltration, window, extract air system | 1985 | * | 0,052 | * | 0,33 | = | 33,8 | W/K |

## Additional summer ventilation for cooling

**Additional ventilation regulation**

Minimum acceptable indoor temp. 20,0 °C

**Type of additional ventilation**

| | | | | | |
|---|---|---|---|---|---|
| Window night ventilation, manual | | Night ventilation value | | 1/h | |
| Mechanical, automatically Controlled ventilation | | Corresponding air change rate during operation, in addition to basic air change | | 1/h | Controlled by (please check) |
| | | Specific power consumption | 0,30 | Wh/m³ | Temperature diff. x |
| | | | | | Humidity diff. |

# Summer: Passive cooling

Prizidava OŠ Polzela - 1. faza / Climate: Ljubljana, Eko sklad 2018 / TFA: 630 m² / Heating: 12,8 kWh/(m²a) / Cooling: 2,8 kWh/(m²a) / PER: 48,1 kWh/(m²a)

| | | | | | |
|---|---|---|---|---|---|
| Building type: | CC-SI 12630 | | Treated floor area $A_{TFA}$: | 629,9 | m² |
| Upper temperature limit: | 25 | °C | Building volume: | 1985 | m³ |
| Nominal humidity: | 12 | g/kg | Internal humidity sources: | 2,4 | g/(m²h) |
| Spec. capacity: | 204 | Wh/(m²K) | | | |

| Building assembly | Temperature zone | Area m² | | U-Value W/(m²K) | | Red. factor $f_{T,Summer}$ | | $H_{Summer}$ heat conductance |
|---|---|---|---|---|---|---|---|---|
| External wall - Ambient | A | 239,3 | * | 0,146 | * | 1,00 | = | 35,0 |
| External wall - Ground | B | 31,3 | * | 0,157 | * | 1,00 | = | 4,9 |
| Roof/Ceiling - Ambient | A | 378,7 | * | 0,099 | * | 1,00 | = | 37,4 |
| Floor slab / Basement ceiling | B | 459,6 | * | 0,164 | * | 1,00 | = | 75,6 |
| | A | | * | | * | 1,00 | = | |
| | A | | * | | * | 1,00 | = | |
| Unheated | X | | * | | * | 0,35 | = | |
| Windows | A | 139,4 | * | 0,814 | * | 1,00 | = | 113,4 |
| Exterior door | A | 4,6 | * | 0,900 | * | 1,00 | = | 4,1 |
| Exterior TB (length/m) | A | 100,5 | * | 0,031 | * | 1,00 | = | 3,1 |
| Perimeter TB (length/m) | P | 36,9 | * | 0,020 | * | 1,00 | = | 0,7 |
| Ground TB (length/m) | B | | * | | * | 1,00 | = | |

| | | |
|---|---|---|
| **Exterior thermal transmittance, $H_{T,e}$** | 193,0 | W/K |
| **Ground thermal transmittance, $H_{T,g}$** | 81,2 | W/K |

## Summer ventilation

from 'SummVent' worksheet

**Ventilation unit conductance**

| | | |
|---|---|---|
| exterior $H_{V,e}$ | 76,6 | W/K |
| without HR | 363,0 | W/K |
| ground $H_{V,g}$ | 0,0 | W/K |
| without HR | 0,0 | W/K |

**Ventilation conductance, others**

| | | |
|---|---|---|
| exterior | 33,8 | W/K |

**Ventilation parameter**

| | | |
|---|---|---|
| Temperature amplitude summer | 9,9 | K |
| Minimum acceptable indoor temperature | 20,0 | °C |
| Heat capacity air | 0,33 | Wh/(m³K) |
| Supply air changes | 0,55 | 1/h |
| Outdoor air changes | 0,05 | 1/h |
| Window night ventilation air change rate, manual @ 1K | 0,00 | 1/h |
| Air change rate due to mech. automatically controlled vent. | 0,00 | 1/h |
| Specific power consumption for | 0,30 | Wh/m³ |
| $\eta_{HR}$ | 79% | |
| $\eta_{ERV}$ | 0% | |
| $\eta^*_{SHX}$ | 0% | |

**Summer ventilation regulation**

| | HRV/ERV |
|---|---|
| None | |
| Controlled by temperature | x |
| Controlled by enthalpy | |
| Always | |
| | Additional ventilation |
| Controlled by temperature | x |
| Controlled by humidity | |

| Orientation of the area | Angle factor Summer | | Shading factor Summer | | Shading dirt | | g-Value (perp. radiation) | | Area m² | | Portion of glazing | | Aperture m² |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| North | 0,9 | * | 0,28 | * | 0,95 | * | 0,50 | * | 122,9 | * | 71% | = | 10,4 |
| East | 0,9 | * | 1,00 | * | 0,95 | * | 0,00 | * | 0,0 | * | 0% | = | 0,0 |
| South | 0,9 | * | 1,00 | * | 0,95 | * | 0,00 | * | 0,0 | * | 0% | = | 0,0 |
| West | 0,9 | * | 1,00 | * | 0,95 | * | 0,00 | * | 0,0 | * | 0% | = | 0,0 |
| Horizontal | 0,9 | * | 0,32 | * | 0,95 | * | 0,51 | * | 16,5 | * | 74% | = | 1,7 |
| Sum opaque areas | | | | | | | | | | | | | 2,2 |

**Solar aperture** — Total 14,3 m²/m² 0,02

**Internal heat gains $Q_I$**

| Specif. power $q_I$ W/m² | | $A_{TFA}$ m² | | W | W/m² |
|---|---|---|---|---|---|
| 4,2 | * | 630 | = | 2627 | 4,2 |

**Frequency of overheating $h_{\vartheta \geq Jmax}$** 14,3%

**At the overheating limit $\vartheta_{max}$ = 25 °C**

If the "frequency over 25°C" exceeds 10%, additional measures to protect against the heat during the summer are necessary.

**Daily internal temperature fluctuation**

| Transmission kWh/d | | Ventilation kWh/d | | Solar load kWh/d | | 1/k | | Spec. capacity Wh/(m²K) | | $A_{TFA}$: m² | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ( 22,9 | + | 47,1 | + | 25,2 | ) * | 1000 | / ( | 204 | * | 630 | ) = | 0,7 K |

# Aux Electricity

Prizidava OŠ Polzela - 1. faza / Climate: Ljubljana, Eko sklad 2018 / TFA: 630 m² / Heating: 12,8 kWh/(m²a) / Cooling: 2,8 kWh/(m²a) / PER: 48,1 kWh/(m²a)

| | | |
|---|---|---|
| Treated floor area | 630 | m² |
| Heating period | 188 | d |
| Air volume | 1985 | m³ |
| Dwelling units | 1 | HH |

| | | |
|---|---|---|
| Heat recovery efficiency ventilation unit | 0,79 | |
| Operation vent. system Winter | 4,50 | kh/a |
| Operation vent. system Summer | 4,26 | kh/a |
| Air change rate | 0,55 | h⁻¹ |

| | | |
|---|---|---|
| Annual space heating demand | 13 | kWh/(m²a) |
| Boiler rated power | 15 | kW |
| DHW system heating demand | 23805 | kWh/a |
| Design forward flow temperature | 35 | °C |

| Column no. | 1 | 2 | 3 | | 4 | | 5 | | 6 | | 7 | | 8 | | 9 | | 10 | | 11 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Application | Existing [1/0] | Within the thermal envelope [1/0] | Norm demand | | Utilisation factor | | Period of operation | | Reference size | | Electricity demand [kWh/a] | | Available as interior heat | | Utilisation period [h/a] | | Internal heat gains winter [W] | | Internal heat gains summer [W] |
| **Ventilation system** | | | | | | | | | | | | | | | | | | | |
| Winter ventilation | 1 | | 0,21 | Wh/m³ * | 0,55 | h⁻¹ * | 4,5 | kh/a * | 1985 | m³ = | 1043 | | considered in heat recovery efficiency | | | | | | |
| Defroster HX | 1 | 1 | Data entries in 'Ventilation' worksheet or in 'Addl vent' | | | | | | | | 49 | * | 0,2 | / | 4,50 | = | 2 | | |
| Summer ventilation | 1 | 0,10 | 0,21 | Wh/m³ * | 0,55 | h⁻¹ * | 4,3 | kh/a * | 1985 | m³ = | 986 | * | 1,0 | / | 4,26 | = | | | 23 |
| | | | | | | | | | | | | | | | | | Internal heat sources ' Additional summer ventilation' | | 0,0 |
| Additional vent. summer | 0 | 0,10 | 0,30 | Wh/m³ * | 0,00 | h⁻¹ * | 4,3 | kh/a * | 1985 | m³ = | 0 | * | 1,0 | / | 4,26 | = | | | 0,0 |
| **Heating system** | | | Controlled / non controlled [1/0] | | | | | | | | | | | | | | | | |
| Enter the rated power of the pump | | | | W | 1 | | | | | | | | | | | | | | |
| Circulator pump heating | 1 | 1 | 203 | W * | 0,7 | * | 4,5 | kh/a * | 1 | = | 664 | * | 1,0 | / | 4,50 | = | 147 | | |
| Boiler electricity consumption at 30% load | | | | W | | | | | | | | | | | | | | | |
| Aux. energy - Heat. boiler | 0 | 0 | 55 | W * | 1,00 | * | 0,00 | kh/a * | 1 | = | 0 | * | 1,0 | / | 4,50 | = | 0 | | |
| Aux. energy - Wood fired/Pellet boiler | 0 | 0 | Data entries in 'Boiler' worksheet. Aux. energy demand including possible drinking water production. | | | | | | | | 0 | * | 1,0 | / | 4,50 | = | 0 | | |
| **DHW system** | | | | | | | | | | | | | | | | | | | |
| Enter average power consumption of pump | | | | W | | | | | | | | | | | | | | | |
| Circulation pump DHW | 1 | 1 | 34 | W * | 1,00 | * | 6,4 | kh/a * | 1 | = | 216 | * | 1,0 | / | 8,76 | = | 25 | | 25 |
| Enter the rated power of the pump | | | | W | | | | | | | | | | | | | | | |
| Storage load pump DHW | 1 | 1 | 92 | W * | 1,00 | * | 1,6 | kh/a * | 1 | = | 147 | * | 1,0 | / | 8,76 | = | 17 | | 17 |
| Boiler electricity consumption at 100% load | | | | W | | | | | | | | | | | | | | | |
| DHW boiler aux. energy | 0 | 0 | 165 | W * | 1,00 | * | 0,0 | kh/a * | 1 | = | 0 | * | 1,0 | / | 8,76 | = | 0 | | 0 |
| Enter the rated power of the solar DHW pump | | | | W | | | | | | | | | | | | | | | |
| Solar aux. electricity | 0 | 1 | 71 | W * | 1,00 | * | 1,8 | kh/a * | 1 | = | 0 | * | 1,0 | / | 8,76 | = | 0 | | 0 |
| **Aux. electricity cooling and dehumidification** | | | | | | | | | | | | | | | | | | | |
| Aux. electricity cooling | 1 | 1 | 29 | kWh/a * | 1,00 | * | 1,0 | * | 1 | = | 29 | * | 1,0 | / | 4,26 | = | | | 7 |
| Aux. electricity dehum. | 1 | 1 | 29 | kWh/a * | 1,00 | * | 1,0 | * | 1 | = | 29 | * | 1,0 | / | 4,26 | = | | | 7 |
| **Misc. aux. electricity** | | | | | | | | | | | | | | | | | | | |
| Misc. aux. electricity | | | | kWh/a * | 1,00 | * | 1,0 | * | 1 | = | 0 | * | 1,0 | / | 8,76 | = | 0 | | 0 |
| **Total** | | | | | | | | | | | 3162 | | | | | | 191 | | 78 |
| **Specific demand** | kWh/(m²a) (treated floor area) | | | | | | | | | | 5,0 | | | | | | | | |

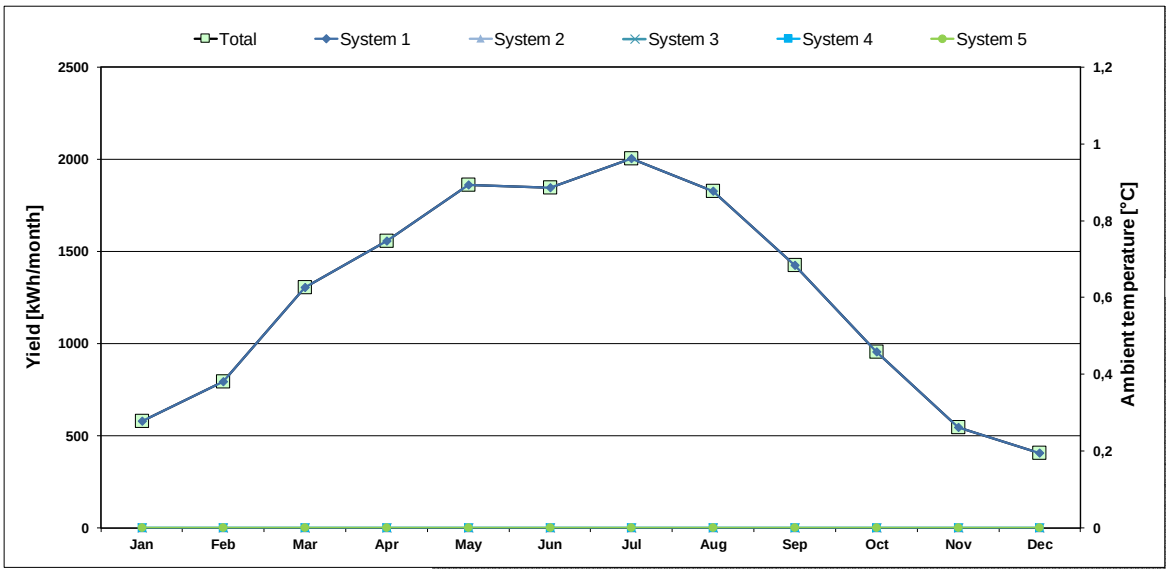
# Photovoltaic systems

Prizidava OŠ Polzela - 1. faza / Climate: Ljubljana, Eko sklad 2018 / TFA: 630 m² / Heating: 12,8 kWh/(m²a) / Cooling: 2,8 kWh/(m²a) / PER: 48,1 kWh/(m²a)

| | | |
|---|---|---|
| Climate data set: | ud---01-Ljubljana, Eko sklad 2018 | |
| Building type: | CC-SI 12630 | |
| Projected building footprint: | 459,6 | m² |

| Name of system | | System 1 | System 2 | System 3 | System 4 | System 5 | Reference PV syst. | |
|---|---|---|---|---|---|---|---|---|
| Location: Selection in 'Areas' worksheet | | 8-poševna streha S 1F | | | | | 6-poševna streha JZ | |
| Size of selected area | | 347,2 | | | | | 0,0 | m² |
| Deviation from North | | 180 | | | | | 30 | ° |
| Angle of inclination from horizontal | | 30 | | | | | 180 | ° |
| Alternative input: Deviation from North | | 180 | | | | | | ° |
| Alternative input: Angle of inclination from the horizontal | | 30 | | | | | | ° |
| **Information from the module data sheet** | | | | | | | | |
| Technology | | 5-Poly-Si | | | | | 4-Mono-Si | |
| Nominal current | $I_{MPP0}$ | 10,98 | | | | | 7,71 | A |
| Nominal voltage | $U_{MPP0}$ | 41,00 | | | | | 30,50 | V |
| Nominal power | $P_n$ | 450 | 0 | 0 | 0 | 0 | 235 | Wp |
| Temperature coefficient short-circuit current | $\alpha$ | 0,040 | | | | | 0,040 | %/K |
| Temperature coefficient open-circuit voltage | $\beta$ | -0,340 | | | | | -0,340 | %/K |
| Module dimensions: Height | | 2,100 | | | | | 1,658 | m |
| Module dimensions: Width | | 1,040 | | | | | 0,994 | m |
| | | | | | | | 1,6 | Module area [m²] |
| **Further specifications** | | | | | | | | |
| Number of modules | $n_M$ | 33 | | | | | 0,0 | |
| Height of module array | | | | | | | 1 | m |
| Height of horizon | $h_{Hori}$ | | | | | | 0 | m |
| Horizontal distance | $a_{Hori}$ | | | | | | 1000,0 | m |
| Additional reduction factor shading | $r_{other}$ | 95% | | | | | 100% | |
| Efficiency of the inverter | $\eta_{HRV}$ | 95% | | | | | 95% | |
| **Results** | | | | | | | | |
| Area of module field | | 72,1 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | m² |
| Free area on the selected building element | | 275,1 | | | | | #N/A | m² |
| Allocation to building element | | 21% | | | | | #N/A | |
| Annual losses due to shading | | 794 | | | | | | kWh |

| | | | | | | | | Total | |
|---|---|---|---|---|---|---|---|---|---|
| **Annual electricity yield after the inverter, absolute** | 15095 | | | | | | 15095 | kWh/a |
| Related to projected building footprint area | 32,8 | | | | | | 33 | $kWh/m^2A_{Proje}$ |
| CO2-equivalent emissions according to 2-CO2 factors user determined | 0,0 | | | | | | 0,0 | kg/a |
| PE-factor according to 8-PE factors user determined | 0,00 | | | | | 0,0 | 0,00 | $kWh_{prim}/kWh$ |



# Primary Energy Renewable PER

Prizidava OŠ Polzela - 1. faza / Climate: Ljubljana, Eko sklad 2018 / TFA: 630 m² / Heating: 12,8 kWh/(m²a) / Cooling: 2,8 kWh/(m²a) / PER: 48,1 kWh/(m²a)

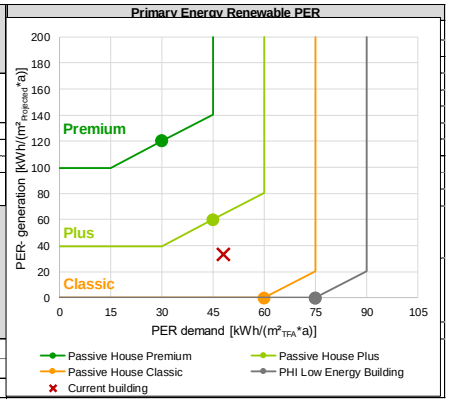
| | | | | | |
|---|---|---|---|---|---|
| | | | | Building type: | CC-SI 12630 |
| | | | | Treated floor area $A_{TFA}$: | 630 m² |
| | | | | Projected building footprint $A_{Projected}$: | 460 m² |
| **Selection of heat generation system(s)** | **Contribution margin (useful energy)** | | | Heating demand incl. distribution & hydr. frost protection | 13 kWh/(m²a) |
| **Primary heat generation type** | **Heating** | **DHW** | **Addl. input in following worksheets** | Cooling energy dem. incl. dehumidification | 3 kWh/(m²a) |
| 2-Heat pump(s) | 100% | 100% | HP, possibly HP ground | DHW demand including distribution: | 38 kWh/(m²a) |
| **Secondary heat generation type (optional & different)** | | | | | |
| - | 0% | 0% | - | | |

| **Energy demand** | **Efficiency** | | **Final energy** | | **PER** | | | **PE** | | **$CO_2$** | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Reference: Treated floor area** | Calculation | User defined value | Contribution (final energy) | **Final energy demand** | PER factor | Effective PER factor (including biomass | **PER specific value** | PE factor | PE value | $CO_2$ emissions factor ($CO_2$-eq) | $CO_2$eq emissions |
| | - | - | | kWh/(m²a) | kWh/kWh | kWh/kWh | kWh/(m²a) | kWh/kWh | kWh/(m²a) | kg/kWh | kg/(m²a) |
| | | | | | | | | 8-PE factors user determined | | 2-CO2 factors user determined | |
| | | | | | | | **48,1** | | 93,3 | | 19,8 |
| **Heating** | | | 100% | | | 1,31 | **13,6** | 2,50 | **26,0** | | **5,5** |
| Electricity (HP compact unit) | | | | | 1,80 | | | 2,50 | | 0,530 | |
| Electricity (heat pump) | 1,71 | | 100% | 7,6 | 1,80 | 1,13 | 8,6 | 2,50 | 19,0 | 0,530 | 4,0 |
| District heating: 1-None | | | | | 2,8\|4,5\|3,3 | | | | | 0,000 | |
| Pelletfeuerung indirekt: 50-Pellets | | | | | 1,10 | | | 0,10 | | 0,000 | |
| Natural gas / RE gas | | | | | 1,75 | | | 1,10 | | 0,200 | |
| Heating oil / RE methanol | | | | | 2,30 | | | 1,10 | | 0,280 | |
| Solar thermal system | | | | | | | | 0,00 | | 0,000 | |
| Electricity (direct) | | | | | 1,80 | | | 2,50 | | 0,530 | |
| | | | | | | | | | | | |
| Aux. electricity (heating, wintertime ventilation) | | | | 2,8 | 1,80 | 1,80 | 5,0 | 2,50 | 7,0 | 0,530 | 1,5 |
| **Cooling and dehumidification** | | | | | 1,10 | | **2,8** | | **6,3** | | **1,3** |
| Electricity cooling (heat pump) | 3,50 | | | 0,9 | 1,10 | | 0,9 | 2,50 | 2,1 | 0,530 | 0,5 |
| Auxiliary electricity cooling, ventilation summer | | | | 1,6 | 1,10 | | 1,8 | 2,50 | 4,0 | 0,530 | 0,9 |
| Electricity dehumidification (heat pump) | 3,50 | | | 0,0 | 1,15 | | 0,0 | 2,50 | 0,0 | 0,530 | 0,0 |
| Auxiliary electricity (dehumidification) | | | | 0,0 | 1,15 | | 0,1 | 2,50 | 0,1 | 0,530 | 0,0 |
| **DHW generation** | | | 100% | | | 1,30 | **26,4** | 2,50 | **50,8** | | **10,8** |
| Electricity (HP compact unit) | | | | | 1,30 | | | 2,50 | | 0,530 | |
| Electricity (heat pump) | 1,92 | | 100% | 19,7 | 1,30 | 1,30 | 25,6 | 2,50 | 49,3 | 0,530 | 10,5 |
| District heating: 1-None | | | | | 2,8\|4,5\|3,3 | | | | | 0,000 | |
| Pelletfeuerung indirekt: 50-Pellets | | | | | 1,10 | | | 0,10 | | 0,000 | |
| Natural gas / RE gas | | | | | 1,75 | | | 1,10 | | 0,200 | |
| Heating oil / Methanol | | | | | 2,30 | | | 1,10 | | 0,280 | |
| Solar thermal system | | | | | | | | 0,00 | | 0,000 | |
| Electricity (direct) | | | | | 1,30 | | | 2,50 | | 0,530 | |
| | | | | | | | | | | | |
| Aux. electricity (DHW + solar DHW) | | | | 0,6 | 1,30 | 1,30 | 0,7 | 2,50 | 1,4 | 0,530 | 0,3 |
| **Household electricity** | | | | **4,1** | | 1,30 | **5,3** | | **10,2** | | **2,2** |
| Electricity (household or non-residential lighting, etc.) | | | | 4,1 | 1,30 | 1,30 | 5,3 | 2,50 | 10,2 | 0,530 | 2,2 |
| Auxiliary electricity (other) | | | | | 1,30 | | | 2,50 | | 0,530 | |
| **Gas / RE gas dry/cook** | | | | **0,0** | 1,75 | | **0,0** | 2,50 | **0,0** | 0,215 | **0,0** |

| **Energy generation** | **Final energy** | | **PER** | | **PE** | | **$CO_2$** | |
|---|---|---|---|---|---|---|---|---|
| **Reference: Projected building footprint area** | Final energy generation | **Final energy generation** | PER factor | **PER specific value** | PE factor | PE Value | Emission factor ($CO_2$-eq) | $CO_2$eq emissions |
| | kWh/a | **kWh/(m²$A_{Projected}$*a)** | kWh/kWh | kWh/(m²$A_{Projected}$a) | kWh/kWh | kWh/(m²a) | kg/kWh | kg/a |
| | | | | **32,8** | | **0,0** | | **0,0** |
| PV electricity | 15095 | 32,8 | 1,00 | 32,8 | 0,00 | 0,0 | - | |
| Solar thermal system | 0 | 0,0 | - | 0,0 | 1,22 | 0,0 | 0,000 | 0,0 |
| | | 0,0 | | | | | | |

| | | | | |
|---|---|---|---|---|
| **PE demand requirement in case of verification through PE (non-renewable) [kWh/(m²a)]** | - | **Current building reaches following class** | 93 | **Requirement met?** - |

| **Achievable energy standard through the verification of renewable primary energy (assessment of individual aspects)** | **Useful energy, performance** | | | | **Airtightness** |
|---|---|---|---|---|---|
| | **Annual heat. dem.** Treated floor area | **Heating load** Treated floor area | **Useful cool. energy** Treated floor area | **Cooling load** Treated floor area | $n_{50}$ |
| | kWh/(m²a) | W/m² | kWh/(m²a) | W/m² | 1/h |
| Requirement Passive House Premium | | | | | |
| Requirement Passive House Plus | 15 | 10 | 15 | 12 | 0,60 |
| Requirement Passive House Classic | | | | | |
| Requirement PHI Low Energy Building | 30 | | 30 | | 1,00 |
| **Current building reaches following class for aspe** | 13 | 11 | 3 | 5 | 0,6 |
| | Premium | | Premium | | Premium |




| **Summary** | **Final energy** | **PER specific value** | **PE value** | **CO2eq emissions** | **$CO_2$eq substitution balance** |
|---|---|---|---|---|---|
| Though, from the scientific point of view, not entirely correct, different energy carriers will be added together here. This is done to meet the criteria of other energy standards. | MWh/a | MWh/a | 8-PE factors user determined MWh/a | 2-CO2 factors user determined kg/a | 2-CO2 factors user determined kg/a |
| **Demand** | **23,5** | **30,3** | 58,77 | 12459 | 12459 |
| **Generation** | **-15,1** | **-15,1** | 0,00 | 0 | 0 |
| **Demand, cumulative generation (annual balance)** | 8,41 | 15,22 | 58,77 | 12459 | 12459 |
| **Demand w/o household electricity** | **20,9** | **27,0** | 52,32 | 11093 | 11093 |
| **Demand w/o household electricity, cum. generation** | 5,83 | 11,86 | 52,32 | 11093 | 11093 |

# Heat pump

Prizidava OŠ Polzela - 1. faza / Climate: Ljubljana, Eko sklad 2018 / TFA: 630 m² / Heating: 12,8 kWh/(m²a) / Cooling: 2,8 kWh/(m²a) / PER: 48,1 kWh/(m²a)

| | | | | | |
|---|---|---|---|---|---|
| | | | Building type: | CC-SI 12630 | |
| | | | Treated floor area $A_{TFA}$: | 630 | m² |
| Covered fraction of space heating demand | | *('PER' worksheet)* | | 100% | |
| Space heating demand + distribution losses | $Q_H+Q_{HL}$: | *(DHW+Distribution)* | | 8209 | kWh/a |
| Solar fraction for space heat | $\eta_{Solar,\ H}$ | *('SolarDHW' worksheet)* | | 0% | |
| **Effective annual heating demand** | $Q_{H,WI}=Q_H*(1-\eta_{Solar,\ H})$ | | | **8209** | kWh/a |
| Covered fraction of DHW demand | | *('PER' worksheet)* | | 100% | |
| Total heating demand of DHW system | $Q_{gDHW}$ | *(DHW+Distribution)* | | 23805 | kWh/a |
| Solar fraction for DHW | $\eta_{Solar,\ DHW}$ | *('SolarDHW' worksheet)* | | 0% | |
| **Effective DHW demand** | $Q_{DHW,WI}=Q_{DHW}*(1-\eta_{Solar,\ DHW})$ | | | **23805** | kWh/a |
| Number of heat pumps in the system | | | | 2 | |
| Functionality | | | | Heating & DHW | |
| **Heating** | | | | | |
| Selection of HP: 1-Standard air/water heat pump | | Heat source: | | 1-Outdoor air | |
| Selection of distribution system | | | | 1-Underfloor heating | |
| Design distribution temperature | $\theta_{design}$ | *(DHW+Distribution)* | | 35,00 | °C |
| Nominal power of distribution system | $P_{nom}$ | | | 50,00 | kW |
| **Distribution system (to be completed by experienced users only)** | | | | | |
| Nominal power of distribution system | $P_{nom}$ | | | 50,00 | kW |
| Radiator exponent | n | | | 1,20 | |
| Heat storage tank (buffer storage tank 'DHW+Distribution' worksheet) | | | | 1-Yes | |
| Specific heat losses storage | U * $A_{Storage}$ | | | 1,3 | W/K |
| Storage location in thermal envelope | | | | 1-Inside | |
| Room temperature (storage location: outside of thermal envelope) | | *(DHW+Distribution)* | | 20,00 | °C |
| Sink temperature of heat pump for heating | $\theta_{snk}$ | | | 26,20 | °C |
| **Entries in relation to the domestic hot water system** | | | | | |
| Selection of HP: 1-Standard air/water heat pump | | Heat source: | | 1-Outdoor air | |
| DHW temperature | | *(DHW+Distribution)* | | 60,00 | °C |
| Orientation of DHW storage tank ('storage 1' in 'DHW+Distribution' worksheet) | | | | 1-Inside | |
| Specific heat losses storage | U * $A_{Storage}$ | | | 1,6 | W/K |
| Room temperature (storage location: outside of thermal envelope) | | *(DHW+Distribution)* | | 20,00 | °C |
| Type of backup heater | | | | 1-Elec. Immersion heater | |
| Δθ of electric continuous flow water heater | | | | | K |
| **Additional options in case of <u>one</u> heat pump for both functions: Heating & DHW** | | | | | |
| Same heat pump's sink temperature for Heating and for DHW | | | | 0-No | |
| Heat pump priority | | *(Manufacturer, tech. data)* | | 1-DHW-priority | |
| **Control strategy** | | | | | |
| Heat pump control strategy | | | | 2-Ideal | |
| **Heating** | | | | | |
| Depth ground water / Ground collector / Ground probe | z | | | | m |
| Power of pump for ground heat exchanger | $P_{pump}$ | | | | kW |

# Internal heat gains for non-residential buildings



Prizidava OŠ Polzela - 1. faza / Climate: Ljubljana, Eko sklad 2018 / TFA: 630 m² / Heating: 12,8 kWh/(m²a) / Cooling: 2,8 kWh/(m²a) / PER: 48,1 kWh/(m²a)

Utilisation: 21-School — IHG: 4,17 W/m² — Calculation results from this worksheet: 4,17 W/m²

Type of values used: 4-PHPP calculation ('IHG non-res' worksheet) — Enter here results from cell above: 4,17 W/m²

Persons: 150,0 P — Treated floor area: 629,92 m² — Heating period: 188 d/a — Room temperature: 20 °C — Internal heat gains aux. electricity: 191 W

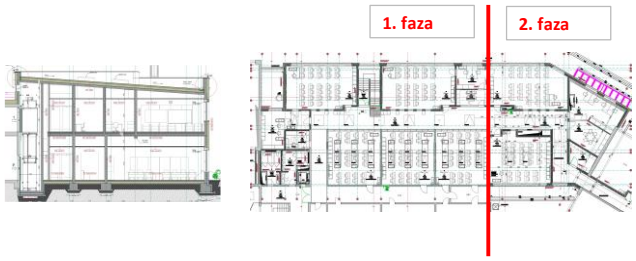
| Persons | Selection of user profile | Select | Activity of persons | Planning 0 = according to ground area or usable zone 1 = according to occupancy | | Number of occupants | | Ground area of useful zone [m²] | | Average occupancy [Pers./m²] | | Heat emitted per person [W] | | Utilisation hours per year [h/a] | | Relative presence | | Utilisation period [h/a] | | Average heat release persons [W] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | 27 | | | | 9 | | 18 | | | | |
| Persons A | 1-Prostori | 3 | >10 yr., standing or light work | 1 | Planning with occupancy | { 140 } | * | or { | * | 0,892970536 | } * | 100 | * | 2160 | * | 0,70 | / | 8760 | = | 2416 |
| Persons B | 2-Komunikacije | 3 | >10 yr., standing or light work | 1 | Planning with occupancy | { 10 } | * | or { | * | 0,892970536 | } * | 100 | * | 2160 | * | 0,70 | / | 8760 | = | 173 |
| Persons C | 1-Prostori | 3 | >10 yr., standing or light work | 1 | Planning with occupancy | { 0 } | * | or { | * | 0,892970536 | } * | 100 | * | 2160 | * | 0,70 | / | 8760 | = | 2 |
| Persons D | 2-Komunikacije | 3 | >10 yr., standing or light work | 1 | Planning with occupancy | { 0 } | * | or { | * | 0,892970536 | } * | 100 | * | 2160 | * | 0,70 | / | 8760 | = | 2 |
| Persons E | | | Invalid input | | | { } | * | or { | * | Not a standard value | } * | 0 | * | 0 | * | 1,00 | / | 8760 | = | 0 |
| Persons F | | | Invalid input | | | { } | * | or { | * | Not a standard value | } * | 0 | * | 0 | * | 1,00 | / | 8760 | = | 0 |
| Persons G | | | Invalid input | | | { } | * | or { | * | Not a standard value | } * | 0 | * | 0 | * | 1,00 | / | 8760 | = | 0 |
| Evaporation (person specific) | | | | | | 150 | * | | | | | -15 | * | 2160 | * | 0,70 | / | 8760 | = | -388 |

| Lighting / Equipment / Aux. electricity | Useful energy [kWh/a] | | Availability | | Utilisation period [h/a] | | Average heat release |
|---|---|---|---|---|---|---|---|
| **Lighting** | 1261 | * | 1 | / | 8,76 | = | 144 |
| **Office applications** (within therm. envelope) | 769 | * | 1 | / | 8,76 | = | 88 |
| **Cooking** (within therm. envelope) | 0 | * | 0,5 | / | 8,76 | = | 0 |
| **Dishwashing** (within therm. envelope) | 0 | * | 0,3 | / | 8,76 | = | 0 |
| **Cooling** (within therm. envelope) | 548 | * | 1 | / | 8,76 | = | 63 |
| **Other** (within thermal envelope) | 0 | * | 1 | / | 8,76 | = | 0 |
| **Auxiliary appliances (see 'Aux Electricity' worksheet)** | | | | | | = | 191 |

| Heat loss due to cold water (calculation from column AJ) | On/Off [1 / 0] | | Predominant utilisation pattern of building (Data transferred from 'Electricity non-res' worksheet; input 2) | Number of WCs (user data) | Amount of WCs: Utilisation of standard values for schools? | Number of WCs (calculation value) | DT: Cold water temp. - Room temp. [K] | Occupied days per year [d/a] 8 | | Loss daytime [W] | | Loss night-time [W] | | Availability | Utilisation period [d/a] | | Average power cold water |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Cold water due to flushing WC** | 1 | 1 | Prostori | | x | 13 | -8,2 | 240 | * ( | -55 | + | -41 | ) * | 1 | 365 | = | -63 |

| | | | |
|---|---|---|---|
| **Total IHG** | | W | 2627 |
| **Specific IHG** | | W/m² | 4,2 |
| **Heat available from internal sources** | 188 d/a | kWh/(m²a) | 19 |

# PHPP-Energy balance calculation




| | |
|---|---|
| **Building:** | Prizidava OŠ Polzela - 2. faza |
| Street: | parc.št. *714, 779/4,..., k.o. 992 Polzela |
| Postcode/City: | |
| Province/Country: | SI-Slovenia |
| Building type: | CC-SI 12630 |
| Climate data set: | ud---01-Ljubljana, Eko sklad 2018 |
| Climate zone: | 3: Cool-temperate — Altitude of location: 309 m |
| **Home owner / Client:** | Občina Polzela |
| Street: | Malteška cesta 28 |
| Postcode/City: | 3313 Polzela |
| Province/Country: | SI-Slovenia |

| | |
|---|---|
| **Architecture:** | Uniprojekt d.o.o. |
| Street: | Savinjska cesta 117 |
| Postcode/City: | 3313 Polzela |
| Province/Country: | SI-Slovenia |
| **Energy consultancy:** | |
| Street: | |
| Postcode/City: | |
| Province/Country: | |

| | |
|---|---|
| **Mechanical engineer:** | Projekt Forma d.o.o. |
| Street: | Začret 46b |
| Postcode/City: | 3202 Začret |
| Province/Country: | SI-Slovenia |
| **Certification:** | |
| Street: | |
| Postcode/City: | |
| Province/Country: | |

| | | | |
|---|---|---|---|
| Year of construction: | 2025 | Interior temperature winter [°C]: | 20,0 |
| No. of dwelling units: | 1 | Internal heat gains (IHG) heating case [W/m²]: | 4,6 |
| No. of occupants: | 50,0 | Specific capacity [Wh/K per m² TFA]: | 204 |
| | | Interior temp. summer [°C]: | 25,0 |
| | | IHG cooling case [W/m²]: | 4,6 |
| | | Mechanical cooling: | x |

**Specific building characteristics with reference to the treated floor area**

| | | | | | Criteria | Alternative criteria | Fullfilled?[2] |
|---|---|---|---|---|---|---|---|
| | Treated floor area | m² | 407,6 | | | | |
| **Space heating** | Heating demand | kWh/(m²a) | 9,5 | ≤ | - | - | - |
| | | kWh/(m³a) | 3,0 | | | | |
| | Heating load | W/m² | 10 | ≤ | - | - | |
| **Space cooling** | Cooling & dehum. demand | kWh/(m²a) | 3,9 | ≤ | - | - | - |
| | | kWh/(m³a) | 1,2 | | | | |
| | Cooling load | W/m² | 6 | ≤ | - | - | |
| | Frequency of overheating (> 25 °C) | % | - | ≤ | - | | - |
| | Frequency of excessively high humidity (> 12 g/kg) | % | 0 | ≤ | - | | - |
| **Airtightness** | Pressurization test result $n_{50}$ | 1/h | 0,6 | ≤ | - | | - |
| **Non-renewable Primary Energy (PE)** | PE demand | kWh/(m²a) | 167 | ≤ | - | | - |
| **Primary Energy Renewable (PER)** | PER demand | kWh/(m²a) | 85 | ≤ | - | - | - |
| | Generation of renewable energy (in relation to projected building footprint area) | kWh/(m²a) | 34 | ≥ | - | - | |

[2] Empty field: Data missing; '-': No requirement

# Climate data

Prizidava OŠ Polzela - 2. faza / Climate: Ljubljana, Eko sklad 2018 / TFA: 408 m² / Heating: 9,5 kWh/(m²a) / Cooling: 3,9 kWh/(m²a) / PER: 84,6 kWh/(m²a)

**Selection of climate data**

| | |
|---|---|
| Country: | ud-User Data |
| Region: | All |
| | 1-Sortierung: Alphabetisch |
| Climate data set: | ud---01-Ljubljana, Eko sklad 2018 |
| Climate zone: | 3: Cool-temperate |

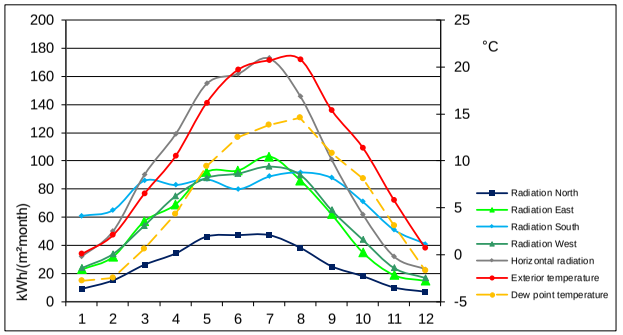
**Altitude**

| | | |
|---|---|---|
| Weather station: | 309,0 | m |
| Building location: | 309 | m |

**Result overview**

| | | |
|---|---|---|
| Annual heating demand | 9,5 | kWh/(m²a) |
| Heating load | 10,3 | W/m² |
| Frequency of overheating | - | % |
| Sensible cooling | 3,8 | kWh/(m²a) |
| Latent cooling | 0,0 | kWh/(m²a) |
| Cooling load | 5,7 | W/m² |
| PER demand | 84,6 | kWh/(m²a) |

| | Data for heating Annual method | Data from monthly balance Heating | Cooling | |
|---|---|---|---|---|
| Heating / cooling period | 188 | 151 | 153 | d/a |
| Heating / cooling degree hours | 71 | 63 | -26 | kKh/a |
| Radiation North | 94 | 70 | 226 | kWh/(m²a) |
| Radiation East | 201 | 146 | 436 | kWh/(m²a) |
| Radiation South | 383 | 304 | 436 | kWh/(m²a) |
| Radiation West | 215 | 153 | 430 | kWh/(m²a) |
| Horizontal radiation | 322 | 183 | 664 | kWh/(m²a) |




| | Month | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | Heating load Weather 1 | Heating load Weather 2 | Cooling load Weather 1 | Cooling load Weather 2 | PER factors | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Days | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 | | | | | | |
| | ud---01-Ljubljana, Eko sklad 2018 | Latitude ° | 46,1 | Longitude ° | 14,5 | Altitude [m] | 309 | Daily temperature swing Summer [K] | | | 9,9 | | | Radiation: [W/m²] | | Radiation: [W/m²] | | | |
| ° C | Exterior temperature | 0,1 | 2,1 | 6,5 | 10,5 | 16,2 | 19,7 | 20,7 | 20,8 | 15,4 | 11,4 | 5,8 | 0,7 | -6,8 | -5,9 | 25,9 | 25,9 | 1,30 | Household electri |
| kWh/(m²month) | Radiation North | 9 | 15 | 26 | 34 | 46 | 47 | 47 | 38 | 25 | 18 | 10 | 7 | 11 | 8 | 47 | 47 | 1,30 | Domestic hot wat |
| kWh/(m²month) | Radiation East | 23 | 32 | 57 | 69 | 92 | 93 | 103 | 86 | 62 | 35 | 19 | 15 | 29 | 9 | 114 | 114 | 1,80 | Heating |
| kWh/(m²month) | Radiation South | 61 | 65 | 86 | 83 | 87 | 80 | 89 | 92 | 88 | 71 | 51 | 41 | 88 | 39 | 131 | 131 | 1,10 | Cooling |
| kWh/(m²month) | Radiation West | 24 | 34 | 54 | 75 | 88 | 91 | 96 | 90 | 65 | 44 | 24 | 17 | 32 | 29 | 124 | 124 | 1,15 | Dehumidification |
| kWh/(m²month) | Horizontal radiation | 32 | 50 | 90 | 119 | 155 | 162 | 173 | 146 | 101 | 62 | 32 | 23 | 41 | 23 | 203 | 203 | | |
| ° C | Dew point temperature | -2,8 | -2,5 | 0,6 | 4,3 | 9,4 | 12,5 | 13,8 | 14,6 | 10,8 | 8,1 | 3,1 | -1,7 | | | 17,6 | 17,6 | | |
| ° C | Sky temperature | -11,2 | -10,4 | -6,4 | -1,9 | 4,0 | 8,2 | 9,2 | 9,9 | 5,4 | 2,6 | -3,3 | -9,4 | | | 15,2 | 17,6 | | |
| ° C | Ground temperature | 13,6 | 13,3 | 13,4 | 13,7 | 15,8 | 16,4 | 16,9 | 17,2 | 17,1 | 15,2 | 14,7 | 14,1 | 13,3 | 13,3 | 17,2 | 17,2 | | |
| | Comment: | Eko sklad, referenca | | | | | | | | | | | | | | | | | |

# Heat losses through the ground 2

Prizidava OŠ Polzela - 2. faza / Climate: Ljubljana, Eko sklad 2018 / TFA: 408 m² / Heating: 9,5 kWh/(m²a) / Cooling: 3,9 kWh/(m²a) / PER: 84,6 kWh/(m²a)

## Building section 2

| Ground characteristics | | | |
|---|---|---|---|
| Thermal conductivity | λ | 2,0 | W/(mK) |
| Heat capacity | ρc | 2,0 | MJ/(m³K) |
| Periodic penetration depth | δ | 3,17 | m |

| Building data | | | | U-value floor slab/basement ceiling | $U_f$ | 0,155 | W/(m²K) |
|---|---|---|---|---|---|---|---|
| Area of ground floor slab / basement | A | 281,9 | m² | TBs floor slab / basement ceiling | $\Psi_B$*l | 0,77 | W/K |
| Perimeter length | P | 38,5 | m | U-value floor slab / basement ceiling i | $U_f$' | 0,158 | W/(m²K) |
| Charact. dimension of floor slab | B' | 14,64 | m | Equivalent thickness floor | $d_t$ | 12,67 | m |

**Floor slab type (select only one)**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| x | **Slab on grade** | | | | | | |
| | Perimeter insulation width/depth | D | 1,10 | m | Orientation of perimeter insulation | horizontal | |
| | Perimeter insulation thickness | $d_n$ | 0,22 | m | (check only one field) | vertical | x |
| | Conductivity perimeter insulation | $\lambda_n$ | 0,035 | W/(mK) | | | |
| | **Heated basement or floor slab completely / partially below ground level** | | | | | | |
| | Basement wall height below ground le | z | | m | U-Value wall below ground | $U_{wB}$ | W/(m²K) |
| | **Unheated basement** | | | | | | |
| | Height aboveground wall | h | | m | U-Value wall above ground | $U_W$ | W/(m²K) |
| | Basement wall height below ground le | z | | m | U-Value wall below ground | $U_{WB}$ | W/(m²K) |
| | Air change unheated basement | n | | $h^{-1}$ | U-Value basement floor slab | $U_{fB}$ | W/(m²K) |
| | Air volume basement | V | | m³ | | | |
| | **Suspended floor above a ventilated crawl space (at max. 0.5 m below ground)** | | | | | | |
| | U-Value crawl space | $U_{Crawl}$ | | W/(m²K) | Area of ventilation openings | εP | m² |
| | Height of crawl space wall | h | | m | Wind velocity at 10 m height | v | 4,0 m/s |
| | U-Value crawl space wall | $U_W$ | | W/(m²K) | Wind shield factor | $f_W$ | 0,05 - |

| Additional thermal bridge heat losses at perimeter | | | | Steady-state fraction | $\Psi_{P,stat}$*l | | W/K |
|---|---|---|---|---|---|---|---|
| Phase shift | β | | Months | Harmonic fraction | $\Psi_{P,harm}$*l | 0,000 | W/K |

| Groundwater correction | | | | | | | |
|---|---|---|---|---|---|---|---|
| Depth of the groundwater table | $z_w$ | 3,0 | m | Groundwater correction factor | $G_w$ | 1,09310695 | - |
| Groundwater flow rate | $q_w$ | 0,05 | m/d | | | | |

**Interim results**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Phase shift | β | 1,41 | Months | Steady-state heat flow | $\Phi_{stat}$ | 247,1 | W |
| Steady-state transmittance | $L_S$ | 30,23 | W/K | Periodic heat flow | $\Phi_{harm}$ | 23,1 | W |
| Exterior periodic transmittance | $L_{pe}$ | 4,87 | W/K | Heat losses during heating period | $Q_{tot}$ | 1217 | kWh |
| Transmittance building | $L_0$ | 44,48 | W/K | | | | |

**Monthly average temperatures in the ground for monthly method (building assembly 2)**

| Month | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | Avg. value |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Winter | 13,6 | 13,3 | 13,4 | 13,7 | 14,2 | 14,8 | 15,3 | 15,6 | 15,5 | 15,2 | 14,7 | 14,1 | 14,4 |
| Summer | 15,2 | 14,9 | 15,0 | 15,3 | 15,8 | 16,4 | 16,9 | 17,2 | 17,1 | 16,8 | 16,3 | 15,7 | 16,0 |

| Design ground temperature for 'Heating load' worksheet | 13,3 | For 'Cooling load' worksheet | 17,2 |
|---|---|---|---|
| Reduction factor for 'Annual heating' worksheet | | | 0,38 |

# Areas determination

Prizidava OŠ Polzela - 2. faza / Climate: Ljubljana, Eko sklad 2018 / TFA: 408 m² / Heating: 9,5 kWh/(m²a) / Cooling: 3,9 kWh/(m²a) / PER: 84,6 kWh/(m²a)

## Summary

| Temp.-zone | Area group | Group no. | Area / Length | Unit | Comment | Building assembly overview | Average U-value [W/(m²K)] | Radiation-gains heating season [kWh/a] | Radiation-load cooling period [kWh/a] |
|---|---|---|---|---|---|---|---|---|---|
| | **Treated floor area** | 1 | **407,61** | m² | *Treated floor area according to PHPP manual* | | | 5 Months | 5 Months |
| A | **North windows** | 2 | **31,98** | m² | | **North windows** | **0,795** | **506** | **744** |
| A | **East windows** | 3 | **0,00** | m² | Results come from the 'Windows' worksheet. | **East windows** | | | |
| A | **South windows** | 4 | **21,87** | m² | Window areas are subtracted from individual opaque areas. | **South windows** | **0,783** | **1641** | **943** |
| A | **West windows** | 5 | **0,00** | m² | which is displayed in the 'Windows' worksheet. | **West windows** | | | |
| A | **Horizontal windows** | 6 | **6,75** | m² | | **Horizontal windows** | **0,935** | **360** | **573** |
| A | **Exterior door** | 7 | **7,50** | m² | *Please subtract area of door from respective building assembly* | **Exterior door** | **0,900** | | |
| A | **External wall - Ambient** | 8 | **216,57** | m² | *Temperature zone "A" is ambient air* | **External wall - Ambient** | **0,146** | **36** | **185** |
| B | **External wall - Ground** | 9 | **12,55** | m² | *Temperature zone "B" is the ground* | **External wall - Ground** | **0,157** | | |
| A | **Roof/Ceiling - Ambient** | 10 | **293,49** | m² | | **Roof/Ceiling - Ambient** | **0,085** | **-10** | **324** |
| B | **Floor slab / Basement ceiling** | 11 | **281,90** | m² | | **Floor slab / Basement ceiling** | **0,155** | | |
| | | 12 | **0,00** | m² | *Temperature zones "A", "B","P" and "X" may be used. NOT "I"* | | | | |
| | | 13 | **0,00** | m² | *Temperature zones "A", "B","P" and "X" may be used. NOT "I"* Factor for X | | | | |
| X | **Unheated** | 14 | **0,00** | m² | *Temperature zone "X": Please provide user-defined reduction factor ( 0 < fr < 1):* **35%** | **Unheated** | | | |
| | | | | | | **Thermal bridges - Overview** | **Ψ [W/(mK)]** | | |
| A | **Thermal bridges Ambient** | 15 | **31,16** | m | *Units in m* | **Thermal bridges Ambient** | **0,025** | | |
| P | **Perimeter thermal bridges** | 16 | **77,00** | m | *Units in m; temperature zone "P" is perimeter (see 'Ground' worksheet)* | **Perimeter thermal bridges** | **0,060** | | |
| B | **Thermal bridges FS/BC** | 17 | **0,00** | m | *Units in m* | **Thermal bridges FS/BC** | | | |
| I | **Building element towards neigh** | 18 | **0,00** | m² | *No heat losses, only considered for the heating load calculation* | **Building element towards neighbour** | | | |
| **Total thermal envelope** | | | **872,61** | **m²** | | **Average therm. envelope** | **0,187** | | |

Go to building components list

2-Sorting: BY ID

## Area input

| Area no. | Building assembly description | To group No. | Assigned to group | Quantity | | a [m] | | b [m] | | User determined [m²] | | User subtraction [m²] | | Subtraction window areas [m²] | | Area [m²] | Selection building assembly / Building system | U-Value [W/(m²K)] | Deviation from North | Angle of inclination from the horizontal | Orientation | Reduction factor shading | Exterior absorptivity | Exterior emissivity |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Projected building footprint | **0** | Projected building footprint | **1** | x ( | | x | | + | **281,90** | - | | ) | | = | 281,9 | | | | | | | | |
| | Treated floor area | **1** | Treated floor area | | x ( | | x | | + | | - | | ) | | = | 0,0 | | | | | | | | |
| | Exterior door | **7** | Exterior door | | x ( | | x | | + | | - | | ) - | | = | | Exterior door | | | | | | | |
| 1 | **tla na terenu 1 F novogradnja** | **11** | Floor slab / Basement ceiling | **0** | x ( | | x | | + | **459,60** | - | **0,00** | ) - | 0,0 | = | 0,0 | **03ud-Tlak na terenu, prostori** | **0,164** | **0** | **180** | Hor | | | |
| 2 | **tla na terenu 2 F novogradnja** | **11** | Floor slab / Basement ceiling | **1** | x ( | | x | | + | **281,90** | - | | ) - | 0,0 | = | 281,9 | **04ud-Tlak na terenu, kuhinja** | **0,155** | **0** | **180** | Hor | | | |
| 3 | **tla ješka dvigala** | **11** | Floor slab / Basement ceiling | **0** | x ( | **2,60** | x | **2,60** | + | | - | | ) - | 0,0 | = | 0,0 | **06ud-Tla na terenu, ješek** | **0,169** | **180** | **180** | Hor | | | |
| 4 | **vkopane stene jaška** | **9** | External wall - Ground | **0** | x ( | **10,40** | x | **1,20** | + | | - | | ) - | 0,0 | = | 0,0 | **05ud-Vkopana AB stena** | **0,157** | | **90** | | | | |
| 5 | **previs S 1F** | **10** | Roof/Ceiling - Ambient | **0** | x ( | | x | | + | **12,90** | - | | ) - | 0,0 | = | 0,0 | **10ud-Previsni del** | **0,114** | **0** | **180** | Hor | **0,00** | **0,80** | **0,80** |
| 6 | **previs SV 2F** | **10** | Roof/Ceiling - Ambient | **1** | x ( | **22,30** | x | **0,45** | + | | - | | ) - | 0,0 | = | 10,0 | **10ud-Previsni del** | **0,114** | **30** | **180** | Hor | **0,00** | **0,80** | **0,80** |
| 7 | **ravna streha SZ 1F** | **10** | Roof/Ceiling - Ambient | **0** | x ( | **5,80** | x | **3,20** | + | | - | | ) - | 0,0 | = | 0,0 | **09ud-Ravna streha** | **0,085** | **0** | **0** | Hor | **0,70** | **0,80** | **0,80** |
| 8 | **poševna streha S 1F** | **10** | Roof/Ceiling - Ambient | **0** | x ( | | x | | + | **363,70** | - | | ) - | 0,0 | = | 0,0 | **08ud-Poševna streha** | **0,084** | **0** | **15** | Hor | **0,70** | **0,80** | **0,80** |
| 9 | **poševna streha S 2F** | **10** | Roof/Ceiling - Ambient | **1** | x ( | | x | | + | **290,20** | - | | ) - | 6,8 | = | 283,5 | **08ud-Poševna streha** | **0,084** | **30** | **15** | Hor | **0,70** | **0,80** | **0,80** |
| 10 | **fasada S 1F** | **8** | External wall - Ambient | **0** | x ( | **33,90** | x | **8,35** | + | **1,16** | - | **0,00** | ) - | 0,0 | = | 0,0 | **01ud-Zunanja AB stena, fasada** | **0,148** | **0** | **90** | North | **0,70** | **0,80** | **0,80** |
| 11 | **fasada Z 1F** | **8** | External wall - Ambient | **0** | x ( | **1,35** | x | **2,65** | + | **31,73** | - | **0,00** | ) - | 0,0 | = | 0,0 | **01ud-Zunanja AB stena, fasada** | **0,148** | **270** | **90** | West | **0,70** | **0,80** | **0,80** |
| 12 | **fasada V 1F** | **8** | External wall - Ambient | **0** | x ( | **1,60** | x | **2,65** | + | | - | **0,00** | ) - | 0,0 | = | 0,0 | **01ud-Zunanja AB stena, fasada** | **0,148** | **90** | **90** | East | **0,70** | **0,80** | **0,80** |
| 13 | **cokl S 1F** | **8** | External wall - Ambient | **0** | x ( | **33,90** | x | **0,70** | + | | - | | ) - | 0,0 | = | 0,0 | **02ud-Zunanja AB stena, cokl** | **0,135** | **0** | **90** | North | **0,70** | **0,80** | **0,80** |
| 14 | **cokl Z 1F** | **8** | External wall - Ambient | **0** | x ( | **11,05** | x | **0,70** | + | | - | | ) - | 0,0 | = | 0,0 | **02ud-Zunanja AB stena, cokl** | **0,135** | **270** | **90** | West | **0,70** | **0,80** | **0,80** |
| 15 | **cokl V 1F** | **8** | External wall - Ambient | **0** | x ( | **1,60** | x | **0,70** | + | | - | | ) - | 0,0 | = | 0,0 | **02ud-Zunanja AB stena, cokl** | **0,135** | **90** | **90** | East | **0,70** | **0,80** | **0,80** |
| 16 | **podzidek SVZ 1F** | **9** | External wall - Ground | **0** | x ( | **37,55** | x | **0,50** | + | | - | | ) - | 0,0 | = | 0,0 | **05ud-Vkopana AB stena** | **0,157** | | **90** | | **0,70** | **0,80** | **0,80** |
| 17 | **fasada S 2F** | **8** | External wall - Ambient | **1** | x ( | **8,80** | x | **8,35** | + | | - | **6,16** | ) - | **16,1** | = | 51,2 | **01ud-Zunanja AB stena, fasada** | **0,148** | **0** | **90** | North | **0,70** | **0,80** | **0,80** |
| 18 | **fasada SV 2F** | **8** | External wall - Ambient | **1** | x ( | **13,50** | x | **8,35** | + | | - | **16,95** | ) - | **15,9** | = | 79,9 | **01ud-Zunanja AB stena, fasada** | **0,148** | **30** | **90** | North | **0,70** | **0,80** | **0,80** |
| 19 | **fasada JV 2F** | **8** | External wall - Ambient | **1** | x ( | **2,80** | x | **8,35** | + | | - | **1,96** | ) - | 0,0 | = | 21,4 | **01ud-Zunanja AB stena, fasada** | **0,148** | **120** | **90** | East | **0,70** | **0,80** | **0,80** |
| 20 | **cokl S 2F** | **8** | External wall - Ambient | **1** | x ( | **8,80** | x | **0,70** | + | | - | | ) - | 0,0 | = | 6,2 | **02ud-Zunanja AB stena, cokl** | **0,135** | **0** | **90** | North | **0,70** | **0,80** | **0,80** |
| 21 | **cokl SV 2F** | **8** | External wall - Ambient | **1** | x ( | **13,50** | x | **0,70** | + | | - | | ) - | 0,0 | = | 9,5 | **02ud-Zunanja AB stena, cokl** | **0,135** | **30** | **90** | North | **0,70** | **0,80** | **0,80** |
| 22 | **cokl JV 2F** | **8** | External wall - Ambient | **1** | x ( | **2,80** | x | **0,70** | + | | - | | ) - | 0,0 | = | 2,0 | **02ud-Zunanja AB stena, cokl** | **0,135** | **120** | **90** | East | **0,70** | **0,80** | **0,80** |
| 23 | **podzidek S SV JV 2F** | **9** | External wall - Ground | **1** | x ( | **25,10** | x | **0,50** | + | | - | | ) - | 0,0 | = | 12,6 | **05ud-Vkopana AB stena** | **0,157** | | **90** | | **0,70** | **0,80** | **0,80** |
| 24 | **fasada J 2F** | **8** | External wall - Ambient | **1** | x ( | **13,40** | x | **5,10** | + | | - | **9,38** | ) - | **21,9** | = | 37,1 | **01ud-Zunanja AB stena, fasada** | **0,148** | **180** | **90** | South | **0,70** | **0,80** | **0,80** |
| 25 | **cokl J 2F** | **8** | External wall - Ambient | **1** | x ( | **13,40** | x | **0,70** | + | | - | | ) - | 0,0 | = | 9,4 | **02ud-Zunanja AB stena, cokl** | **0,135** | **180** | **90** | South | **0,70** | **0,80** | **0,80** |
| 26 | **vrata ZV2 1F** | **7** | Exterior door | **0** | x ( | **2,00** | x | **2,30** | + | | - | | ) - | 0,0 | = | 0,0 | **03ud-Door external** | **0,900** | **0** | **90** | North | **0,70** | **0,80** | **0,80** |
| 27 | **vrata ZV3 2F** | **7** | Exterior door | **1** | x ( | **1,90** | x | **2,50** | + | | - | | ) - | 0,0 | = | 4,8 | **03ud-Door external** | **0,900** | **30** | **90** | North | **0,70** | **0,80** | **0,80** |
| 28 | **vrata ZV4 2F** | **7** | Exterior door | **1** | x ( | **1,10** | x | **2,50** | + | | - | | ) - | 0,0 | = | 2,8 | **03ud-Door external** | **0,900** | **30** | **90** | North | **0,70** | **0,80** | **0,80** |
| 29 | **fasada Z 1F proti 2F začasno** | **8** | External wall - Ambient | **0** | x ( | | x | | + | **43,00** | - | | ) - | 0,0 | = | 0,0 | **01ud-Zunanja AB stena, fasada** | **0,148** | **90** | **90** | East | **0,70** | **0,80** | **0,80** |
| 30 | | | | | x ( | | x | | + | | - | | ) - | 0,0 | = | | | | | | | | | |
| 31 | | | | | x ( | | x | | + | | - | | ) - | 0,0 | = | | | | | | | | | |
| 32 | | | | | x ( | | x | | + | | - | | ) - | 0,0 | = | | | | | | | | | |
| 33 | | | | | x ( | | x | | + | | - | | ) - | 0,0 | = | | | | | | | | | |
| 34 | | | | | x ( | | x | | + | | - | | ) - | 0,0 | = | | | | | | | | | |
| 35 | | | | | x ( | | x | | + | | - | | ) - | 0,0 | = | | | | | | | | | |
| 36 | | | | | x ( | | x | | + | | - | | ) - | 0,0 | = | | | | | | | | | |
| 37 | | | | | x ( | | x | | + | | - | | ) - | 0,0 | = | | | | | | | | | |
| 38 | | | | | x ( | | x | | + | | - | | ) - | 0,0 | = | | | | | | | | | |
| 39 | **1F** | | | | x ( | | x | **2030,84** | + | **629,92** | - | | ) - | 0,0 | = | | | | | | | | | |
| 40 | **P** | **1** | Treated floor area | **0** | x ( | | x | **1140,77** | + | **329,29** | - | | ) - | 0,0 | = | 0,0 | | | | | | | | |
| 41 | **N** | **1** | Treated floor area | **0** | x ( | | x | **890,07** | + | **300,63** | - | | ) - | 0,0 | = | 0,0 | | | | | | | | |
| 42 | | | | | x ( | | x | | + | | - | | ) - | 0,0 | = | | | | | | | | | |
| 43 | | | | | x ( | | x | | + | | - | | ) - | 0,0 | = | | | | | | | | | |
| 44 | **2F** | | | | x ( | | x | **1237,86** | + | **407,61** | - | | ) - | 0,0 | = | | | | | | | | | |
| 45 | **P** | **1** | Treated floor area | **1** | x ( | | x | **474,00** | + | **152,99** | - | | ) - | 0,0 | = | 153,0 | | | | | | | | |
| 46 | **N** | **1** | Treated floor area | **1** | x ( | | x | **763,86** | + | **254,62** | - | | ) - | 0,0 | = | 254,6 | | | | | | | | |
| 47 | | | | | x ( | | x | | + | | - | | ) - | 0,0 | = | | | | | | | | | |
| 48 | **neto površina** | | | | x ( | | x | | + | **1037,53** | - | | ) - | 0,0 | = | | | | | | | | | |
| 49 | **neto prostornina** | | | | x ( | | x | | + | **3268,70** | - | | ) - | 0,0 | = | | | | | | | | | |
| 50 | **višina** | | | | x ( | | x | | + | **3,15** | - | | ) - | 0,0 | = | | | | | | | | | |
| 51 | | | | | x ( | | x | | + | | - | | ) - | 0,0 | = | | | | | | | | | |
| 52 | | | | | x ( | | x | | + | | - | | ) - | 0,0 | = | | | | | | | | | |
| 53 | **1F** | | | | x ( | **506338,00** | x | **126216,00** | + | **290,00** | - | | ) - | 0,0 | = | | | | | | | | | |
| 54 | **2F** | | | | x ( | **506360,00** | x | **126204,00** | + | **290,00** | - | | ) - | 0,0 | = | | | | | | | | | |
| 55 | | | | | x ( | | x | | + | | - | | ) - | 0,0 | = | | | | | | | | | |
| 56 | | | | | x ( | | x | | + | | - | | ) - | 0,0 | = | | | | | | | | | |
| 57 | | | | | x ( | | x | | + | | - | | ) - | 0,0 | = | | | | | | | | | |
| 58 | | | | | x ( | | x | | + | | - | | ) - | 0,0 | = | | | | | | | | | |
| 59 | | | | | x ( | | x | | + | | - | | ) - | 0,0 | = | | | | | | | | | |
| 60 | | | | | x ( | | x | | + | | - | | ) - | 0,0 | = | | | | | | | | | |
| 61 | | | | | x ( | | x | | + | | - | | ) - | 0,0 | = | | | | | | | | | |
| 62 | | | | | x ( | | x | | + | | - | | ) - | 0,0 | = | | | | | | | | | |
| 63 | | | | | x ( | | x | | + | | - | | ) - | 0,0 | = | | | | | | | | | |
| 64 | | | | | x ( | | x | | + | | - | | ) - | 0,0 | = | | | | | | | | | |
| 65 | | | | | x ( | | x | | + | | - | | ) - | 0,0 | = | | | | | | | | | |
| 66 | | | | | x ( | | x | | + | | - | | ) - | 0,0 | = | | | | | | | | | |
| 67 | | | | | x ( | | x | | + | | - | | ) - | 0,0 | = | | | | | | | | | |
| 68 | | | | | x ( | | x | | + | | - | | ) - | 0,0 | = | | | | | | | | | |
| 69 | | | | | x ( | | x | | + | | - | | ) - | 0,0 | = | | | | | | | | | |
| 70 | | | | | x ( | | x | | + | | - | | ) - | 0,0 | = | | | | | | | | | |
| 71 | | | | | x ( | | x | | + | | - | | ) - | 0,0 | = | | | | | | | | | |
| 72 | | | | | x ( | | x | | + | | - | | ) - | 0,0 | = | | | | | | | | | |
| 73 | | | | | x ( | | x | | + | | - | | ) - | 0,0 | = | | | | | | | | | |
| 74 | | | | | x ( | | x | | + | | - | | ) - | 0,0 | = | | | | | | | | | |
| 75 | | | | | x ( | | x | | + | | - | | ) - | 0,0 | = | | | | | | | | | |
| 76 | | | | | x ( | | x | | + | | - | | ) - | 0,0 | = | | | | | | | | | |
| 77 | | | | | x ( | | x | | + | | - | | ) - | 0,0 | = | | | | | | | | | |
| 78 | | | | | x ( | | x | | + | | - | | ) - | 0,0 | = | | | | | | | | | |
| 79 | | | | | x ( | | x | | + | | - | | ) - | 0,0 | = | | | | | | | | | |
| 80 | | | | | x ( | | x | | + | | - | | ) - | 0,0 | = | | | | | | | | | |
| 81 | | | | | x ( | | x | | + | | - | | ) - | 0,0 | = | | | | | | | | | |
| 82 | | | | | x ( | | x | | + | | - | | ) - | 0,0 | = | | | | | | | | | |
| 83 | | | | | x ( | | x | | + | | - | | ) - | 0,0 | = | | | | | | | | | |
| 84 | | | | | x ( | | x | | + | | - | | ) - | 0,0 | = | | | | | | | | | |
| 85 | | | | | x ( | | x | | + | | - | | ) - | 0,0 | = | | | | | | | | | |
| 86 | | | | | x ( | | x | | + | | - | | ) - | 0,0 | = | | | | | | | | | |
| 87 | | | | | x ( | | x | | + | | - | | ) - | 0,0 | = | | | | | | | | | |
| 88 | | | | | x ( | | x | | + | | - | | ) - | 0,0 | = | | | | | | | | | |
| 89 | | | | | x ( | | x | | + | | - | | ) - | 0,0 | = | | | | | | | | | |
| 90 | | | | | x ( | | x | | + | | - | | ) - | 0,0 | = | | | | | | | | | |
| 91 | | | | | x ( | | x | | + | | - | | ) - | 0,0 | = | | | | | | | | | |
| 92 | | | | | x ( | | x | | + | | - | | ) - | 0,0 | = | | | | | | | | | |
| 93 | | | | | x ( | | x | | + | | - | | ) - | 0,0 | = | | | | | | | | | |
| 94 | | | | | x ( | | x | | + | | - | | ) - | 0,0 | = | | | | | | | | | |
| 95 | | | | | x ( | | x | | + | | - | | ) - | 0,0 | = | | | | | | | | | |
| 96 | | | | | x ( | | x | | + | | - | | ) - | 0,0 | = | | | | | | | | | |
| 97 | | | | | x ( | | x | | + | | - | | ) - | 0,0 | = | | | | | | | | | |
| 98 | | | | | x ( | | x | | + | | - | | ) - | 0,0 | = | | | | | | | | | |
| 99 | | | | | x ( | | x | | + | | - | | ) - | 0,0 | = | | | | | | | | | |
| 100 | | | | | x ( | | x | | + | | - | | ) - | 0,0 | = | | | | | | | | | |

Aend

To thermal bridge list

Sortierung ändern

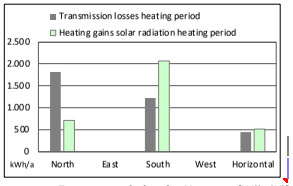
## Thermal bridge inputs

| No. | Thermal bridge - denomination | Group No. | Assigned to group | Quantity | | Length [m] | - | Subtraction length [m] | )= | Length ℓ [m] | User determined psi value [W/(mK)] | User determined $t_{Rsi=0,25}$ (optional) | | or | Selection building system | Ψ-Value [W/(mK)] | $f_{Rsi}$-Requirement met? |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | **vgradnja senčil** | **15** | Thermal bridges Ambient | **1** | x ( | **31,16** | - | | ) = | 31,16 | **0,025** | | | or | | **0,025** | |
| 2 | **temeljna plošča 1F** | **16** | Perimeter thermal bridges | **0** | x ( | **36,85** | - | | ) = | 0,00 | **0,020** | | | or | | **0,020** | |
| 3 | **atika** | **15** | Thermal bridges Ambient | **0** | x ( | **36,85** | - | | ) = | 0,00 | **0,040** | | | or | | **0,040** | |
| 4 | **atika** | **16** | Perimeter thermal bridges | **1** | x ( | **38,50** | - | | ) = | 38,50 | **0,100** | | | or | | **0,100** | |
| 5 | **temeljna plošča 2F** | **16** | Perimeter thermal bridges | **1** | x ( | **38,50** | - | | ) = | 38,50 | **0,020** | | | or | | **0,020** | |
| 6 | | | | | x ( | | - | | ) = | | | | | or | | | |

# Windows

Prizidava OŠ Polzela - 2. faza / Climate: Ljubljana, Eko sklad 2018 / TFA: 408 m² / Heating: 9,5 kWh/(m²a) / Cooling: 3,9 kWh/(m²a) / PER: 84,6 kWh/(m²a)

| Window area orientation | Global radiation (main orientations) | Shading | Dirt | Non-vertical radiation incidence | Glazing fraction | g-Value | Solar irradiation reduction factor | Window area | Window U-Value | Glazing area | Average global radiation | | Transmission losses heating period | Heating gains solar radiation heating period |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Standard values → | kWh/(m²a) | 0,75 | 0,95 | 0,85 | | | | m² | W/(m²K) | m² | kWh/(m²a) | | kWh/a | kWh/a |
| North | 94 | 0,81 | 0,95 | 0,85 | 0,70 | 0,50 | 0,45 | 31,98 | 0,80 | 22,26 | 98 | North | 1815 | 714 |
| East | 201 | 1,00 | 0,95 | 0,85 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 201 | East | 0 | 0 |
| South | 383 | 0,86 | 0,95 | 0,85 | 0,71 | 0,50 | 0,49 | 21,87 | 0,78 | 15,45 | 383 | South | 1223 | 2065 |
| West | 215 | 1,00 | 0,95 | 0,85 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 215 | West | 0 | 0 |
| Horizontal | 322 | 0,94 | 0,95 | 0,85 | 0,75 | 0,51 | 0,57 | 6,75 | 0,93 | 5,08 | 261 | Horizontal | 450 | 515 |
| Total or average value for all windows. | | | | | | 0,50 | 0,48 | 60,60 | 0,81 | 42,80 | | | 3488 | 3293 |




Heating degree hours [kKh/a]: 71,4

Go to glazing list

Go to window frames list

Recommendation for $U_{w,installed}$ [W/(m²K)]: 0,85 | 1,00 | 1,10 | 0,52

| Quantity | Description | Deviation from north | Angle of inclination from the horizontal | Orientation | Window rough openings: Width | Window rough openings: Height | Installed in: Selection from 'Areas' worksheet | Glazing: Selection from 'Components' worksheet | Frame: Selection from 'Components' worksheet | g-Value: Perpendicular radiation | U-Value: Glazing | U-Value: Frames (avg.) | Ψ Glazing edge (Avg.) | Installation situation: left | right | bottom | top | Ψ Installation (Avg.) | Results: Window Area | Glazing area | $U_w$ installed | Glazed fraction per window |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | ° | ° | | m | m | | 1-Sorting: LIKE LIST | 1-Sorting: LIKE LIST | - | W/(m²K) | W/(m²K) | W/(mK) | W/(mK) or 1/0 | | | | W/(mK) | m² | m² | W/(m²K) | % |
| 0 | str 1F | 0 | 15 | Horizontal | 1,500 | 1,500 | 8-poševna streha S 1F | 06ud-Velux GGU | 06ud-Velux GGL GGU | 0,51 | 0,50 | 1,20 | 0,090 | 1 | 1 | 1 | 1 | 0,020 | | | | |
| 0 | | 0 | 15 | Horizontal | 1,000 | 1,500 | 8-poševna streha S 1F | 06ud-Velux GGU | 06ud-Velux GGL GGU | 0,51 | 0,50 | 1,20 | 0,090 | 1 | 1 | 1 | 1 | 0,020 | | | | |
| 3 | str 2F | 30 | 15 | Horizontal | 1,500 | 1,500 | 9-poševna streha S 2F | 06ud-Velux GGU | 06ud-Velux GGL GGU | 0,51 | 0,50 | 1,20 | 0,090 | 1 | 1 | 1 | 1 | 0,020 | 6,8 | 5,08 | 0,93 | 75% |
| 0 | 1F o1 | 0 | 90 | North | 1,009 | 2,260 | 10-fasada S 1F | 02ud-PVC stekla | 02ud-PVC elementi | 0,50 | 0,50 | 1,10 | 0,038 | 0 | 1 | 1 | 1 | 0,010 | | | | |
| 0 | | 0 | 90 | North | 1,009 | 2,260 | 10-fasada S 1F | 02ud-PVC stekla | 02ud-PVC elementi | 0,50 | 0,50 | 1,10 | 0,038 | 0 | 0 | 1 | 1 | 0,010 | | | | |
| 0 | | 0 | 90 | North | 1,009 | 2,260 | 10-fasada S 1F | 02ud-PVC stekla | 02ud-PVC elementi | 0,50 | 0,50 | 1,10 | 0,038 | 1 | 0 | 1 | 1 | 0,010 | | | | |
| 0 | 1F o2 | 0 | 90 | North | 0,865 | 2,260 | 10-fasada S 1F | 02ud-PVC stekla | 02ud-PVC elementi | 0,50 | 0,50 | 1,10 | 0,038 | 0 | 1 | 1 | 1 | 0,010 | | | | |
| 0 | | 0 | 90 | North | 0,865 | 2,260 | 10-fasada S 1F | 02ud-PVC stekla | 02ud-PVC elementi | 0,50 | 0,50 | 1,10 | 0,038 | 1 | 0 | 1 | 1 | 0,010 | | | | |
| 0 | 1F zv1 | 0 | 90 | North | 1,200 | 2,300 | 10-fasada S 1F | 01ud-Alu stekla | 01ud-Alu elementi | 0,50 | 0,50 | 1,40 | 0,040 | 0 | 1 | 1 | 1 | 0,010 | | | | |
| 0 | | 0 | 90 | North | 1,200 | 2,300 | 10-fasada S 1F | 01ud-Alu stekla | 01ud-Alu elementi | 0,50 | 0,50 | 1,40 | 0,040 | 1 | 0 | 1 | 1 | 0,010 | | | | |
| 0 | 1F zpv1 | 0 | 90 | North | 1,030 | 2,950 | 10-fasada S 1F | 02ud-PVC stekla | 02ud-PVC elementi | 0,50 | 0,50 | 1,10 | 0,038 | 0 | 1 | 1 | 1 | 0,010 | | | | |
| 0 | | 0 | 90 | North | 1,000 | 2,950 | 10-fasada S 1F | 02ud-PVC stekla | 02ud-PVC elementi | 0,50 | 0,50 | 1,10 | 0,038 | 0 | 0 | 1 | 1 | 0,010 | | | | |
| 0 | | 0 | 90 | North | 1,015 | 2,950 | 10-fasada S 1F | 01ud-Alu stekla | 01ud-Alu elementi | 0,50 | 0,50 | 1,40 | 0,040 | 0 | 0 | 1 | 1 | 0,010 | | | | |
| 0 | | 0 | 90 | North | 1,015 | 2,950 | 10-fasada S 1F | 01ud-Alu stekla | 01ud-Alu elementi | 0,50 | 0,50 | 1,40 | 0,040 | 0 | 0 | 1 | 1 | 0,010 | | | | |
| 0 | | 0 | 90 | North | 1,015 | 2,950 | 10-fasada S 1F | 01ud-Alu stekla | 01ud-Alu elementi | 0,50 | 0,50 | 1,40 | 0,040 | 0 | 0 | 1 | 1 | 0,010 | | | | |
| 0 | | 0 | 90 | North | 1,015 | 2,950 | 10-fasada S 1F | 01ud-Alu stekla | 01ud-Alu elementi | 0,50 | 0,50 | 1,40 | 0,040 | 0 | 0 | 1 | 1 | 0,010 | | | | |
| 0 | | 0 | 90 | North | 1,000 | 2,950 | 10-fasada S 1F | 02ud-PVC stekla | 02ud-PVC elementi | 0,50 | 0,50 | 1,10 | 0,038 | 0 | 0 | 1 | 1 | 0,010 | | | | |
| 0 | | 0 | 90 | North | 1,030 | 2,950 | 10-fasada S 1F | 02ud-PVC stekla | 02ud-PVC elementi | 0,50 | 0,50 | 1,10 | 0,038 | 1 | 0 | 1 | 1 | 0,010 | | | | |
| 1 | 2F o3 | 30 | 90 | North | 1,030 | 1,700 | 18-fasada SV 2F | 02ud-PVC stekla | 02ud-PVC elementi | 0,50 | 0,50 | 1,10 | 0,038 | 0 | 1 | 1 | 1 | 0,010 | 1,8 | 1,20 | 0,81 | 68% |
| 1 | | 30 | 90 | North | 1,030 | 1,700 | 18-fasada SV 2F | 02ud-PVC stekla | 02ud-PVC elementi | 0,50 | 0,50 | 1,10 | 0,038 | 1 | 0 | 1 | 1 | 0,010 | 1,8 | 1,20 | 0,81 | 68% |
| 0 | 1F o4 | 0 | 90 | North | 1,030 | 2,614 | 10-fasada S 1F | 02ud-PVC stekla | 02ud-PVC elementi | 0,50 | 0,50 | 1,10 | 0,038 | 0 | 1 | 1 | 1 | 0,010 | | | | |
| 0 | | 0 | 90 | North | 1,030 | 2,614 | 10-fasada S 1F | 02ud-PVC stekla | 02ud-PVC elementi | 0,50 | 0,50 | 1,10 | 0,038 | 1 | 0 | 1 | 1 | 0,010 | | | | |
| 0 | 1F o5 | 0 | 90 | North | 1,007 | 2,000 | 10-fasada S 1F | 02ud-PVC stekla | 02ud-PVC elementi | 0,50 | 0,50 | 1,10 | 0,038 | 0 | 1 | 1 | 1 | 0,010 | | | | |
| 0 | | 0 | 90 | North | 1,007 | 2,000 | 10-fasada S 1F | 02ud-PVC stekla | 02ud-PVC elementi | 0,50 | 0,50 | 1,10 | 0,038 | 0 | 0 | 1 | 1 | 0,010 | | | | |
| 0 | | 0 | 90 | North | 1,007 | 2,000 | 10-fasada S 1F | 02ud-PVC stekla | 02ud-PVC elementi | 0,50 | 0,50 | 1,10 | 0,038 | 1 | 0 | 1 | 1 | 0,010 | | | | |
| 0 | 1F o6 | 0 | 90 | North | 1,020 | 2,000 | 10-fasada S 1F | 02ud-PVC stekla | 02ud-PVC elementi | 0,50 | 0,50 | 1,10 | 0,038 | 0 | 1 | 1 | 1 | 0,010 | | | | |
| 0 | | 0 | 90 | North | 1,020 | 2,000 | 10-fasada S 1F | 02ud-PVC stekla | 02ud-PVC elementi | 0,50 | 0,50 | 1,10 | 0,038 | 0 | 0 | 1 | 1 | 0,010 | | | | |
| 0 | | 0 | 90 | North | 1,020 | 2,000 | 10-fasada S 1F | 02ud-PVC stekla | 02ud-PVC elementi | 0,50 | 0,50 | 1,10 | 0,038 | 1 | 0 | 1 | 1 | 0,010 | | | | |
| 0 | 1F o7 | 0 | 90 | North | 1,006 | 2,000 | 10-fasada S 1F | 02ud-PVC stekla | 02ud-PVC elementi | 0,50 | 0,50 | 1,10 | 0,038 | 0 | 1 | 1 | 1 | 0,010 | | | | |
| 0 | | 0 | 90 | North | 1,006 | 2,000 | 10-fasada S 1F | 02ud-PVC stekla | 02ud-PVC elementi | 0,50 | 0,50 | 1,10 | 0,038 | 0 | 0 | 1 | 1 | 0,010 | | | | |
| 0 | | 0 | 90 | North | 1,006 | 2,000 | 10-fasada S 1F | 02ud-PVC stekla | 02ud-PVC elementi | 0,50 | 0,50 | 1,10 | 0,038 | 1 | 0 | 1 | 1 | 0,010 | | | | |
| 1 | 2F o9 | 0 | 90 | North | 1,008 | 2,000 | 17-fasada S 2F | 02ud-PVC stekla | 02ud-PVC elementi | 0,50 | 0,50 | 1,10 | 0,038 | 0 | 1 | 1 | 1 | 0,010 | 2,0 | 1,40 | 0,80 | 70% |
| 6 | | 0 | 90 | North | 1,008 | 2,000 | 17-fasada S 2F | 02ud-PVC stekla | 02ud-PVC elementi | 0,50 | 0,50 | 1,10 | 0,038 | 0 | 0 | 1 | 1 | 0,010 | 12,1 | 8,41 | 0,79 | 70% |
| 1 | | 0 | 90 | North | 1,008 | 2,000 | 17-fasada S 2F | 02ud-PVC stekla | 02ud-PVC elementi | 0,50 | 0,50 | 1,10 | 0,038 | 1 | 0 | 1 | 1 | 0,010 | 2,0 | 1,40 | 0,80 | 70% |
| 3 | 2F o10 | 30 | 90 | North | 1,030 | 2,000 | 18-fasada SV 2F | 02ud-PVC stekla | 02ud-PVC elementi | 0,50 | 0,50 | 1,10 | 0,038 | 0 | 1 | 1 | 1 | 0,010 | 6,2 | 4,33 | 0,80 | 70% |
| 3 | | 30 | 90 | North | 1,030 | 2,000 | 18-fasada SV 2F | 02ud-PVC stekla | 02ud-PVC elementi | 0,50 | 0,50 | 1,10 | 0,038 | 1 | 0 | 1 | 1 | 0,010 | 6,2 | 4,33 | 0,80 | 70% |
| 1 | 2F o11 | 180 | 90 | South | 1,300 | 2,500 | 24-fasada J 2F | 02ud-PVC stekla | 02ud-PVC elementi | 0,50 | 0,50 | 1,10 | 0,038 | 0 | 1 | 1 | 1 | 0,010 | 3,3 | 2,46 | 0,74 | 76% |
| 1 | | 180 | 90 | South | 1,000 | 2,500 | 24-fasada J 2F | 02ud-PVC stekla | 02ud-PVC elementi | 0,50 | 0,50 | 1,10 | 0,038 | 1 | 0 | 1 | 1 | 0,010 | 2,5 | 1,78 | 0,78 | 71% |
| 1 | 2F o11 | 180 | 90 | South | 1,008 | 2,000 | 24-fasada J 2F | 02ud-PVC stekla | 02ud-PVC elementi | 0,50 | 0,50 | 1,10 | 0,038 | 0 | 1 | 1 | 1 | 0,010 | 2,0 | 1,40 | 0,80 | 70% |
| 6 | | 180 | 90 | South | 1,008 | 2,000 | 24-fasada J 2F | 02ud-PVC stekla | 02ud-PVC elementi | 0,50 | 0,50 | 1,10 | 0,038 | 0 | 0 | 1 | 1 | 0,010 | 12,1 | 8,41 | 0,79 | 70% |
| 1 | | 180 | 90 | South | 1,008 | 2,000 | 24-fasada J 2F | 02ud-PVC stekla | 02ud-PVC elementi | 0,50 | 0,50 | 1,10 | 0,038 | 1 | 0 | 1 | 1 | 0,010 | 2,0 | 1,40 | 0,80 | 70% |

# Calculation of shading coefficients

Prizidava OŠ Polzela - 2. faza / Climate: Ljubljana, Eko sklad 2018 / TFA: 408 m² / Heating: 9,5 kWh/(m²a) / Cooling: 3,9 kWh/(m²a) / PER 84,6 kWh/(m²a)

Latitude: 46,07 °

| Orientation | Glazing area [m²] | Reduction factor winter $r_c$ | Reduction factor cooling $r_{c,1}$ | Reduction factor cooling load $r_{c,2}$ | Solar load [kWh/(m²$_{glazing}$a)] |
|---|---|---|---|---|---|
| North | 22,26 | 81% | 35% | 28% | 33 |
| East | 0,00 | 100% | 100% | 100% | 0 |
| South | 15,45 | 86% | 33% | 27% | 61 |
| West | 0,00 | 100% | 100% | 100% | 0 |
| Horizontal | 5,08 | 94% | 39% | 32% | 113 |

| | | | | | | | | Horizon | | Lateral reveal | | Reveal / Overhang | | | | | | | | Reduction factors for shading in winter | | | | Reduction factors for shading in summer | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Quantity | Description | Deviation from North | Angle of inclination from the horizontal | Orientation | Glazing width | Glazing height | Glazing area | Height of the shading object | Horizontal distance | Window reveal depth | Distance from glazing edge to reveal | Overhang depth | Distance from upper glazing edge to overhang | Additional reduction factor winter shading | Additional reduction factor summer shading | Reduction factor z for temporary sun protection | Regulated / transparent | Horizon | Reveal | Overhang | Total for heating case | Horizon | Reveal | Overhang | Total for cooling case | Total for cooling load |
| | | [Degree] | [Degree] | | $w_G$ [m] | $h_G$ [m] | $A_G$ [m²] | $h_{Hori}$ [m] | $d_{Hori}$ [m] | $o_{Reveal}$ [m] | $d_{Reveal}$ [m] | $o_{Over}$ [m] | $d_{Over}$ [m] | $r_{other,W}$ [%] | $r_{other,S}$ [%] | z [%] | | $r_H$ [%] | $r_R$ [%] | $r_O$ [%] | $r_S$ [%] | $r_H$ [%] | $r_R$ [%] | $r_O$ [%] | $r_{S,1}$ [%] | $r_{S,2}$ [%] |
| 0 | str 1F | 0 | 15 | Horizontal | 1,31 | 1,29 | | | | 0,05 | 0,05 | 0,05 | 0,05 | | | 25% | x | | | | | | | | |
| 0 | | 0 | 15 | Horizontal | 0,81 | 1,29 | | | | 0,05 | 0,05 | 0,05 | 0,05 | | | 25% | x | | | | | | | | |
| 3 | str 2F | 30 | 15 | Horizontal | 1,31 | 1,29 | 5,1 | | | 0,05 | 0,05 | 0,05 | 0,05 | | | 25% | x | | 97% | 97% | 94% | | 98% | 99% | 39% | 32% |
| 0 | 1F o1 | 0 | 90 | North | 0,79 | 2,04 | | | | 0,25 | 0,14 | 0,25 | 0,14 | | | 25% | x | | | | | | | | |
| 0 | | 0 | 90 | North | 0,79 | 2,04 | | | | 0,25 | 0,14 | 0,25 | 0,14 | | | 25% | x | | | | | | | | |
| 0 | | 0 | 90 | North | 0,79 | 2,04 | | | | 0,25 | 0,14 | 0,25 | 0,14 | | | 25% | x | | | | | | | | |
| 0 | 1F o2 | 0 | 90 | North | 0,65 | 2,04 | | | | 0,25 | 0,14 | 0,25 | 0,14 | | | 25% | x | | | | | | | | |
| 0 | | 0 | 90 | North | 0,65 | 2,04 | | | | 0,25 | 0,14 | 0,25 | 0,14 | | | 25% | x | | | | | | | | |
| 0 | 1F zv1 | 0 | 90 | North | 0,96 | 2,06 | | | | 0,25 | 0,14 | 0,25 | 0,14 | | | 25% | x | | | | | | | | |
| 0 | | 0 | 90 | North | 0,96 | 2,06 | | | | 0,25 | 0,14 | 0,25 | 0,14 | | | 25% | x | | | | | | | | |
| 0 | 1F zpv1 | 0 | 90 | North | 0,81 | 2,73 | | | | 0,25 | 0,14 | 0,25 | 0,14 | | | 25% | x | | | | | | | | |
| 0 | | 0 | 90 | North | 0,78 | 2,73 | | | | 0,25 | 0,14 | 0,25 | 0,14 | | | 25% | x | | | | | | | | |
| 0 | | 0 | 90 | North | 0,78 | 2,71 | | | | 0,25 | 0,14 | 0,25 | 0,14 | | | 25% | x | | | | | | | | |
| 0 | | 0 | 90 | North | 0,78 | 2,71 | | | | 0,25 | 0,14 | 0,25 | 0,14 | | | 25% | x | | | | | | | | |
| 0 | | 0 | 90 | North | 0,78 | 2,71 | | | | 0,25 | 0,14 | 0,25 | 0,14 | | | 25% | x | | | | | | | | |
| 0 | | 0 | 90 | North | 0,78 | 2,71 | | | | 0,25 | 0,14 | 0,25 | 0,14 | | | 25% | x | | | | | | | | |
| 0 | | 0 | 90 | North | 0,78 | 2,73 | | | | 0,25 | 0,14 | 0,25 | 0,14 | | | 25% | x | | | | | | | | |
| 0 | | 0 | 90 | North | 0,81 | 2,73 | | | | 0,25 | 0,14 | 0,25 | 0,14 | | | 25% | x | | | | | | | | |
| 1 | 2F o3 | 30 | 90 | North | 0,81 | 1,48 | 1,2 | | | 0,25 | 0,14 | 0,25 | 0,14 | | | 25% | x | | 86% | 92% | 80% | | 89% | 97% | 35% | 28% |
| 1 | | 30 | 90 | North | 0,81 | 1,48 | 1,2 | | | 0,25 | 0,14 | 0,25 | 0,14 | | | 25% | x | | 86% | 92% | 80% | | 89% | 97% | 35% | 28% |
| 0 | 1F o4 | 0 | 90 | North | 0,81 | 2,39 | | | | 0,25 | 0,14 | 0,25 | 0,14 | | | 25% | x | | | | | | | | |
| 0 | | 0 | 90 | North | 0,81 | 2,39 | | | | 0,25 | 0,14 | 0,25 | 0,14 | | | 25% | x | | | | | | | | |
| 0 | 1F o5 | 0 | 90 | North | 0,79 | 1,78 | | | | 0,25 | 0,14 | 0,25 | 0,14 | | | 25% | x | | | | | | | | |
| 0 | | 0 | 90 | North | 0,79 | 1,78 | | | | 0,25 | 0,14 | 0,25 | 0,14 | | | 25% | x | | | | | | | | |
| 0 | | 0 | 90 | North | 0,79 | 1,78 | | | | 0,25 | 0,14 | 0,25 | 0,14 | | | 25% | x | | | | | | | | |
| 0 | 1F o6 | 0 | 90 | North | 0,80 | 1,78 | | | | 0,25 | 0,14 | 0,25 | 0,14 | | | 25% | x | | | | | | | | |
| 0 | | 0 | 90 | North | 0,80 | 1,78 | | | | 0,25 | 0,14 | 0,25 | 0,14 | | | 25% | x | | | | | | | | |
| 0 | | 0 | 90 | North | 0,80 | 1,78 | | | | 0,25 | 0,14 | 0,25 | 0,14 | | | 25% | x | | | | | | | | |
| 0 | 1F o7 | 0 | 90 | North | 0,79 | 1,78 | | | | 0,25 | 0,14 | 0,25 | 0,14 | | | 25% | x | | | | | | | | |
| 0 | | 0 | 90 | North | 0,79 | 1,78 | | | | 0,25 | 0,14 | 0,25 | 0,14 | | | 25% | x | | | | | | | | |
| 0 | | 0 | 90 | North | 0,79 | 1,78 | | | | 0,25 | 0,14 | 0,25 | 0,14 | | | 25% | x | | | | | | | | |
| 1 | 2F o9 | 0 | 90 | North | 0,79 | 1,78 | 1,4 | | | 0,25 | 0,14 | 0,25 | 0,14 | | | 25% | x | | 87% | 93% | 81% | | 88% | 98% | 34% | 28% |
| 6 | | 0 | 90 | North | 0,79 | 1,78 | 8,4 | | | 0,25 | 0,14 | 0,25 | 0,14 | | | 25% | x | | 87% | 93% | 81% | | 88% | 98% | 34% | 28% |
| 1 | | 0 | 90 | North | 0,79 | 1,78 | 1,4 | | | 0,25 | 0,14 | 0,25 | 0,14 | | | 25% | x | | 87% | 93% | 81% | | 88% | 98% | 34% | 28% |
| 3 | 2F o10 | 30 | 90 | North | 0,81 | 1,78 | 4,3 | | | 0,25 | 0,14 | 0,25 | 0,14 | | | 25% | x | | 86% | 93% | 81% | | 89% | 98% | 35% | 28% |
| 3 | | 30 | 90 | North | 0,81 | 1,78 | 4,3 | | | 0,25 | 0,14 | 0,25 | 0,14 | | | 25% | x | | 86% | 93% | 81% | | 89% | 98% | 35% | 28% |
| 1 | 2F o11 | 180 | 90 | South | 1,08 | 2,28 | 2,5 | | | 0,25 | 0,14 | 0,25 | 0,14 | | | 25% | x | | 92% | 97% | 89% | | 89% | 96% | 34% | 28% |
| 1 | | 180 | 90 | South | 0,78 | 2,28 | 1,8 | | | 0,25 | 0,14 | 0,25 | 0,14 | | | 25% | x | | 90% | 97% | 87% | | 87% | 96% | 33% | 27% |
| 1 | 2F o11 | 180 | 90 | South | 0,79 | 1,78 | 1,4 | | | 0,25 | 0,14 | 0,25 | 0,14 | | | 25% | x | | 90% | 96% | 86% | | 87% | 93% | 32% | 26% |
| 6 | | 180 | 90 | South | 0,79 | 1,78 | 8,4 | | | 0,25 | 0,14 | 0,25 | 0,14 | | | 25% | x | | 90% | 96% | 86% | | 87% | 93% | 32% | 26% |
| 1 | | 180 | 90 | South | 0,79 | 1,78 | 1,4 | | | 0,25 | 0,14 | 0,25 | 0,14 | | | 25% | x | | 90% | 96% | 86% | | 87% | 93% | 32% | 26% |

# Ventilation data

Prizidava OŠ Polzela - 2. faza / Climate: Ljubljana, Eko sklad 2018 / TFA: 408 m² / Heating: 9,5 kWh/(m²a) / Cooling: 3,9 kWh/(m²a) / PER: 84,6 kWh/(m²a)

| | | | | |
|---|---|---|---|---|
| Treated floor area $A_{TFA}$ | m² | 408 | | *('Areas' worksheet)* |
| Room height h | m | 3,15 | 3,15 | |
| Volume of ventilated space ($A_{TFA}$*h) : $V_V$ | m³ | 1284 | | *(Worksheet 'Annual heating')* |

## Ventilation type

Please select: **1-Balanced PH ventilation with HR**

## Infiltration air change rate

| Wind protection coefficients e and f | | |
|---|---|---|
| Coefficient e for wind protection class | Several side exposed | One side exposed |
| No protection | 0,10 | 0,03 |
| Moderate protection | 0,07 | 0,02 |
| High protection | 0,04 | 0,01 |
| Coefficient f | 15 | 20 |

| | | | For annual demand: | For heating load: | | | | |
|---|---|---|---|---|---|---|---|---|
| Wind protection coefficient, e | | | 0,07 | 0,18 | | | | |
| Wind protection coefficient, f | | | 15 | 15 | Net air volume for press. test | $V_{n50}$ | Air permeability | $q_{50}$ |
| Air change rate at press. test | $n_{50}$ | 1/h | 0,60 | 0,60 | 1486 | m³ | 1,02 | m³/(hm²) |

| | | | For annual demand: | For heating load: |
|---|---|---|---|---|
| Excess extract air | | 1/h | 0,00 | 0,00 |
| Infiltration air change rate | $n_{V,Rest}$ | 1/h | **0,049** | **0,121** |

## Selection of ventilation input - Results

PHPP offers two methods for dimensioning air quantities and choosing the ventilation unit. With "Standard data input for balanced ventilation", supply or extract air quantities for residential buildings and parameters for ventilation systems with a maximum of 1 ventilation unit can be planned. Projects with up to 10 different ventilation units and air quantities determined according to rooms or zones can be entered in the 'Addl vent' worksheet. Please select your design method here:

| | Ventilation unit / Heat recovery efficiency design | | Average air flow rate m³/h | Average air change rate 1/h | Extract air excess (extract air system) 1/h | Effective heat recovery efficiency unit [-] | Humidity recovery efficiency [-] | Specific power input Wh/m³ | Heat recovery efficiency SHX [-] |
|---|---|---|---|---|---|---|---|---|---|
| x | Standard design | *('Ventilation' worksheet, see below)* | **669** | **0,52** | **0,00** | **72,6%** | **N/A** | **0,25** | **0,0%** |
| | Multiple ventilation units, non-res | *('Addl vent' worksheet)* | | | | | | | |

| Cooling recovery | Efficiency SHX $\eta^*_{SHX}$ |
|---|---|
| | 0% |

**Average interior humidity during winter operation**

| Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 25% | 26% | 31% | - | - | - | - | - | - | - | 37% | 27% |

# Standard data input for balanced ventilation

Dimensioning of ventilation system with only one ventilation unit

| | | | | | | |
|---|---|---|---|---|---|---|
| Occupancy | m²/P | 8 | | | | |
| Number of occupants | P | 50,0 | | | | |
| Supply air per person | m³/(P*h) | 30 | | | | |
| Supply air requirement | m³/h | 1500 | | Bathroom | | |
| Extract air rooms | | Kitchen | Bathroom | (shower only) | WC | Sum |
| Quantity | | | | | | 1 |
| Extract air requirement per room | m³/h | 60 | 40 | 20 | 20 | 1500 |
| Total extract air requirement | m³/h | 1500 | | | | |

Design air flow rate (maximum) m³/h **1500** Recommended: 1500 m³/h

**Average air change rate calculation**

| Type of operation | Daily operation times h/d | Factors referenced to maximum | Air flow rate m³/h | Air change rate 1/h |
|---|---|---|---|---|
| maximum | 10,0 | 1,00 | 1500 | 1,17 |
| Standard | | 0,77 | 1154 | 0,90 |
| Basic ventilation | | 0,50 | 750 | 0,58 |
| Minimum | 14,0 | 0,05 | 75 | 0,06 |
| | | | Average air flow rate (m³/h) | Average air change rate (1/h) |
| | Average value | 0,45 | 669 | 0,52 |

**Selection of ventilation unit with heat recovery**

Location of ventilation unit: **2-Outside of thermal envelope**

| | Go to ventilation units list<br>1-Sorting: LIKE LIST | Heat recovery efficiency | Humidity recovery efficiency | Specific efficiency [Wh/m³] | Application [m³/h] | Frost power input |
|---|---|---|---|---|---|---|
| Ventilation unit selection | 11ud-uteženo povprečje naprav | 0,77 | N/A | 0,25 | N/A | N/A |

| | | | |
|---|---|---|---|
| Conductivity supply air duct | Ψ | W/(mK) | 0,664 |
| Length of supply air duct | | m | 10 |
| Conductivity extract air duct | Ψ | W/(mK) | 0,664 |
| Length of extract air duct | | m | 10 |
| Temperature of mechanical services room | | °C | 4,9 |
| (Enter only if the central unit is outside of the thermal envelope) | | | |

| | |
|---|---|
| Implementation of frost protection | 2-Elec. |
| Limit temperature [°C] | -8 |
| Useful energy [kWh/a] | 30 |
| Room temperature (°C) | 20 |
| Avg. ambient temp. heat. period (°C | 4,9 |
| Avg. ground temp (°C) | 11,8 |

Effective heat recovery efficiency $\eta_{HR,eff}$ **72,6%**

**Effective heat recovery efficiency subsoil heat exchanger**

| | | |
|---|---|---|
| SHX efficiency | $\eta^*_{SHX}$ | 0% |
| Heat recovery efficiency SHX | $\eta_{SHX}$ | 0% |

## Ventilation units with heat recovery

| | Recommended specifications to start planning: Frost protection: Yes; Humidity recovery: Yes | 75 % | | 0,45 | | |
|---|---|---|---|---|---|---|
| ID | Description | Effective heat recovery efficiency | Humidity recovery efficiency | Electric efficiency | Application range | |
| | User defined area | % | % | Wh/m³ | m³/h | m³/h |
| 11ud | uteženo povprečje naprav | 77,1% | | 0,25 | | 17400 |
| 12ud | KN1 šola | 80,4% | 0% | 0,21 | | 10500 |
| 13ud | KN2 kuhinja | 72,0% | 0% | 0,30 | | 3900 |
| 14ud | KN3 pomivanje | 72,0% | 0% | 0,30 | | 3000 |

# Summer ventilation

Prizidava OŠ Polzela - 2. faza / Climate: Ljubljana, Eko sklad 2018 / TFA: 408 m² / Heating: 9,5 kWh/(m²a) / Cooling: 3,9 kWh/(m²a) / PER: 84,6 kWh/(m²a)

| | | | | | |
|---|---|---|---|---|---|
| Building volume: | 1284 | m³ | Building type: | CC-SI 12630 | |
| Max. indoor absolute humidity: | 12 | g/kg | Heat recovery efficiency: | 73% | |
| Internal humidity sources: | 10 | g/(P*h) | Humidity recovery efficiency: | 0% | |
| | | | Subsoil heat exchanger efficiency: | 0% | |

| Results passive cooling | | | Results active cooling | | |
|---|---|---|---|---|---|
| Frequency of overheating: | 18,6% | at the overheating limit $\vartheta_{max}$ = 25 °C | Useful cooling demand: | 3,8 | kWh/(m²a) |
| max. humidity: | 13,2 | g/kg | Dehumidification demand: | 0,0 | kWh/(m²a) |
| Frequency of exceeded humidity: | 0,3% | | Frequency of exceeded humidity: | 0,0% | |

## Summer basic ventilation to ensure adequate air quality

| | | | | |
|---|---|---|---|---|
| Air change rate via vent. system with supply ai | 0,52 | 1/h | HRV/ERV in summer (check only one field) | |
| | | | None | |
| | | | Automatic bypass, controlled by temperature difference | x |
| | | | Automatic bypass, controlled by enthalpy difference | |
| | | | Always | |
| Air change rate via extract air system: | | 1/h | | |
| | | | Specific power consumption (for extract air system) | 0,20 Wh/m³ |
| Window ventilation air change rate: | | 1/h | | |

**Effective air change rate**

| | $n_{V,system}$ 1/h | | $\eta^*_{SHX}$ | | $\eta_{HP}$ | | $n_{V,equi,fraction}$ 1/h |
|---|---|---|---|---|---|---|---|
| Exterior $n_{V,e}$ | 0,521 | *(1- | 0% | )*(1- | 0,73 | ) = | 0,143 |
| without HR | 0,521 | *(1- | 0% | ) | | = | 0,521 |
| Ground $n_{L,g}$ | 0,521 | * | 0% | *(1- | 0,73 | ) = | 0,000 |
| without HR | 0,521 | * | 0% | | | = | 0,000 |

**Ventilation conductance**

| | $V_V$ m³ | | $n_{V,equi,fraction}$ 1/h | | $c_{Air}$ Wh/(m³K) | | | |
|---|---|---|---|---|---|---|---|---|
| exterior $H_{V,e}$ | 1284 | * | 0,143 | * | 0,33 | = | 60,5 | W/K |
| without HR | 1284 | * | 0,521 | * | 0,33 | = | 220,7 | W/K |
| ground $H_{V,g}$ | 1284 | * | 0,000 | * | 0,33 | = | 0,0 | W/K |
| without HR | 1284 | * | 0,000 | * | 0,33 | = | 0,0 | W/K |
| Infiltration, window, extract air system | 1284 | * | 0,049 | * | 0,33 | = | 20,6 | W/K |

## Additional summer ventilation for cooling

**Additional ventilation regulation**

Minimum acceptable indoor temp. 20,0 °C

**Type of additional ventilation**

| | | | | | |
|---|---|---|---|---|---|
| Window night ventilation, manual | | Night ventilation value | | 1/h | |
| Mechanical, automatically Controlled ventilation | | Corresponding air change rate during operation, in addition to basic air change | | 1/h | Controlled by (please check) |
| | | Specific power consumption | 0,30 | Wh/m³ | Temperature diff. x / Humidity diff. |

# Summer: Passive cooling

Prizidava OŠ Polzela - 2. faza / Climate: Ljubljana, Eko sklad 2018 / TFA: 408 m² / Heating: 9,5 kWh/(m²a) / Cooling: 3,9 kWh/(m²a) / PER: 84,6 kWh/(m²a)

| | | | | | |
|---|---|---|---|---|---|
| Building type: | CC-SI 12630 | | Treated floor area $A_{TFA}$: | 407,6 | m² |
| Upper temperature limit: | 25 | °C | Building volume: | 1284 | m³ |
| Nominal humidity: | 12 | g/kg | Internal humidity sources: | 1,2 | g/(m²h) |
| Spec. capacity: | 204 | Wh/(m²K) | | | |

| Building assembly | Temperature zone | Area m² | | U-Value W/(m²K) | | Red. factor $f_{T,Summer}$ | | $H_{Summer}$ heat conductance |
|---|---|---|---|---|---|---|---|---|
| External wall - Ambient | A | 216,6 | * | 0,146 | * | 1,00 | = | 31,7 |
| External wall - Ground | B | 12,6 | * | 0,157 | * | 1,00 | = | 2,0 |
| Roof/Ceiling - Ambient | A | 293,5 | * | 0,085 | * | 1,00 | = | 25,0 |
| Floor slab / Basement ceiling | B | 281,9 | * | 0,155 | * | 1,00 | = | 43,7 |
| | A | | * | | * | 1,00 | = | |
| | A | | * | | * | 1,00 | = | |
| Unheated | X | | * | | * | 0,35 | = | |
| Windows | A | 60,6 | * | 0,806 | * | 1,00 | = | 48,9 |
| Exterior door | A | 7,5 | * | 0,900 | * | 1,00 | = | 6,8 |
| Exterior TB (length/m) | A | 31,2 | * | 0,025 | * | 1,00 | = | 0,8 |
| Perimeter TB (length/m) | P | 77,0 | * | 0,060 | * | 1,00 | = | 4,6 |
| Ground TB (length/m) | B | | * | | * | 1,00 | = | |

| | | |
|---|---|---|
| **Exterior thermal transmittance, $H_{T,e}$** | 113,1 | W/K |
| **Ground thermal transmittance, $H_{T,g}$** | 50,3 | W/K |

## Summer ventilation

from 'SummVent' worksheet

**Ventilation unit conductance**

| | | |
|---|---|---|
| exterior $H_{V,e}$ | 60,5 | W/K |
| without HR | 220,7 | W/K |
| ground $H_{V,g}$ | 0,0 | W/K |
| without HR | 0,0 | W/K |

**Ventilation conductance, others**

| | | |
|---|---|---|
| exterior | 20,6 | W/K |

**Ventilation parameter**

| | | |
|---|---|---|
| Temperature amplitude summer | 9,9 | K |
| Minimum acceptable indoor temperature | 20,0 | °C |
| Heat capacity air | 0,33 | Wh/(m³K) |
| Supply air changes | 0,52 | 1/h |
| Outdoor air changes | 0,05 | 1/h |
| Window night ventilation air change rate, manual @ 1K | 0,00 | 1/h |
| Air change rate due to mech. automatically controlled vent. | 0,00 | 1/h |
| Specific power consumption for | 0,30 | Wh/m³ |
| $\eta_{HR}$ | 73% | |
| $\eta_{ERV}$ | 0% | |
| $\eta^*_{SHX}$ | 0% | |

**Summer ventilation regulation**

| | HRV/ERV |
|---|---|
| None | |
| Controlled by temperature | x |
| Controlled by enthalpy | |
| Always | |
| | Additional ventilation |
| Controlled by temperature | x |
| Controlled by humidity | |

| Orientation of the area | Angle factor Summer | | Shading factor Summer | | Shading dirt | | g-Value (perp. radiation) | | Area m² | | Portion of glazing | | Aperture m² |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| North | 0,9 | * | 0,28 | * | 0,95 | * | 0,50 | * | 32,0 | * | 70% | = | 2,7 |
| East | 0,9 | * | 1,00 | * | 0,95 | * | 0,00 | * | 0,0 | * | 0% | = | 0,0 |
| South | 0,9 | * | 0,27 | * | 0,95 | * | 0,50 | * | 21,9 | * | 71% | = | 1,8 |
| West | 0,9 | * | 1,00 | * | 0,95 | * | 0,00 | * | 0,0 | * | 0% | = | 0,0 |
| Horizontal | 0,9 | * | 0,32 | * | 0,95 | * | 0,51 | * | 6,8 | * | 75% | = | 0,7 |
| Sum opaque areas | | | | | | | | | | | | | 1,8 |

| **Solar aperture** | | m²/m² |
|---|---|---|
| Total | 7,0 | 0,02 |

| **Internal heat gains $Q_I$** | Specif. power $q_I$ W/m² | | $A_{TFA}$ m² | | W | W/m² |
|---|---|---|---|---|---|---|
| | 4,6 | * | 408 | = | 1875 | 4,6 |

**Frequency of overheating $h_{\vartheta \geq Jmax}$** 18,6%

**At the overheating limit $\vartheta_{max}$ = 25 °C**

If the "frequency over 25°C" exceeds 10%, additional measures to protect against the heat during the summer are necessary.

**Daily internal temperature fluctuation**

| Transmission kWh/d | | Ventilation kWh/d | | Solar load kWh/d | | 1/k | | Spec. capacity Wh/(m²K) | | $A_{TFA}$: m² | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ( 13,4 | + | 28,7 | + | 16,9 | ) * | 1000 | / ( | 204 | * | 408 | ) = | 0,7 K |

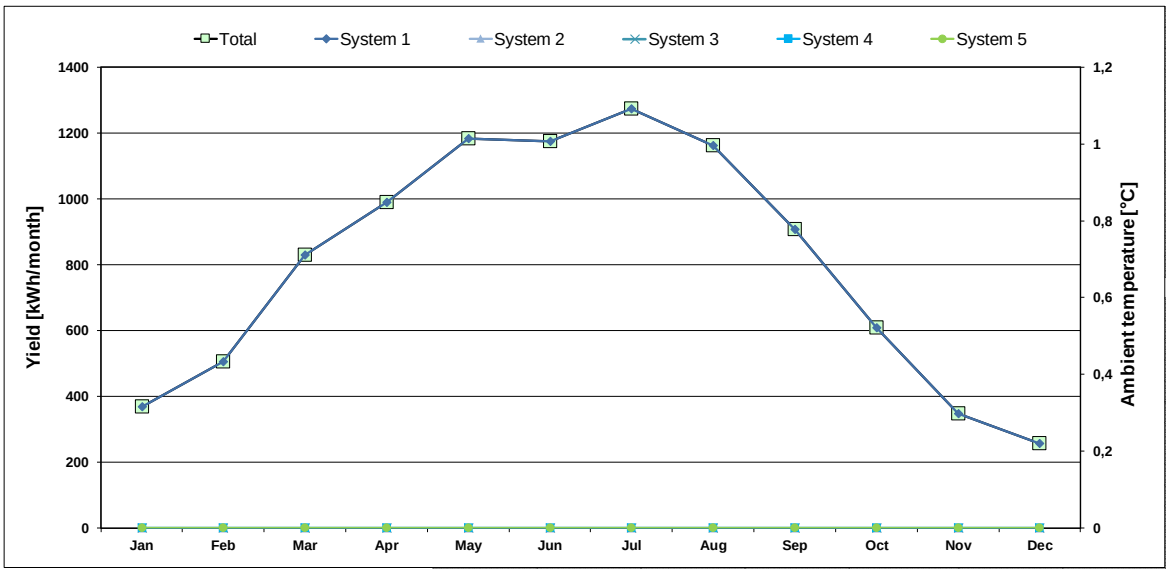
# Photovoltaic systems



| | |
|---|---|
| Climate data set: | ud---01-Ljubljana, Eko sklad 2018 |
| Building type: | CC-SI 12630 |
| Projected building footprint: | 281,9 m² |

| Name of system | | System 1 | System 2 | System 3 | System 4 | System 5 | Reference PV syst. | |
|---|---|---|---|---|---|---|---|---|
| Location: Selection in 'Areas' worksheet | | 8-poševna streha S 1F | | | | | 6-poševna streha JZ | |
| Size of selected area | | 0,0 | | | | | 10,0 | m² |
| Deviation from North | | 180 | | | | | 30 | ° |
| Angle of inclination from horizontal | | 30 | | | | | 180 | ° |
| Alternative input: Deviation from North | | 180 | | | | | | ° |
| Alternative input: Angle of inclination from the horizontal | | 30 | | | | | | ° |
| **Information from the module data sheet** | | | | | | | | |
| Technology | | 5-Poly-Si | | | | | 4-Mono-Si | |
| Nominal current | $I_{MPP0}$ | 10,98 | | | | | 7,71 | A |
| Nominal voltage | $U_{MPP0}$ | 41,00 | | | | | 30,50 | V |
| Nominal power | $P_n$ | 450 | 0 | 0 | 0 | 0 | 235 | Wp |
| Temperature coefficient short-circuit current | $\alpha$ | 0,040 | | | | | 0,040 | %/K |
| Temperature coefficient open-circuit voltage | $\beta$ | -0,340 | | | | | -0,340 | %/K |
| Module dimensions: Height | | 2,100 | | | | | 1,658 | m |
| Module dimensions: Width | | 1,040 | | | | | 0,994 | m |
| | | | | | | | 1,6 | Module area [m²] |
| **Further specifications** | | | | | | | | |
| Number of modules | $n_M$ | 21 | | | | | 0,0 | |
| Height of module array | | | | | | | 1 | m |
| Height of horizon | $h_{Hori}$ | | | | | | 0 | m |
| Horizontal distance | $a_{Hori}$ | | | | | | 1000,0 | m |
| Additional reduction factor shading | $r_{other}$ | 95% | | | | | 100% | |
| Efficiency of the inverter | $\eta_{HRV}$ | 95% | | | | | 95% | |
| **Results** | | | | | | | | |
| Area of module field | | 45,9 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | m² |
| Free area on the selected building element | | -45,9 | | | | | #N/A | m² |
| Allocation to building element | | #DIV/0! | | | | | #N/A | |
| Annual losses due to shading | | 506 | | | | | | kWh |

| | | | | | | | | Total | |
|---|---|---|---|---|---|---|---|---|---|
| **Annual electricity yield after the inverter, absolute** | | 9606 | | | | | | 9606 | kWh/a |
| Related to projected building footprint area | | 34,1 | | | | | | 34 | kWh/m²$A_{Proje}$ |
| CO2-equivalent emissions according to 2-CO2 factors user determined | | 0,0 | | | | | | 0,0 | kg/a |
| PE-factor according to 8-PE factors user determined | | 0,00 | | | | | 0,0 | 0,00 | $kWh_{prim}$/kWh |



# Aux Electricity

Prizidava OŠ Polzela - 2. faza / Climate: Ljubljana, Eko sklad 2018 / TFA: 408 m² / Heating: 9,5 kWh/(m²a) / Cooling: 3,9 kWh/(m²a) / PER: 84,6 kWh/(m²a)

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Treated floor area | 408 | m² | Heat recovery efficiency ventilation unit | 0,73 | | Annual space heating demand | 9 | kWh/(m²a) |
| Heating period | 188 | d | Operation vent. system Winter | 4,50 | kh/a | Boiler rated power | 15 | kW |
| Air volume | 1284 | m³ | Operation vent. system Summer | 4,26 | kh/a | DHW system heating demand | 8724 | kWh/a |
| Dwelling units | 1 | HH | Air change rate | 0,52 | h⁻¹ | Design forward flow temperature | 35 | °C |

| Column no. | 1 | 2 | 3 | | 4 | | 5 | | 6 | | 7 | 8 | | 9 | | 10 | 11 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Application | Existing [1/0] | Within the thermal envelope [1/0] | Norm demand | | Utilisation factor | | Period of operation | | Reference size | | Electricity demand [kWh/a] | Available as interior heat | | Utilisation period [h/a] | | Internal heat gains winter [W] | Internal heat gains summer [W] |
| **Ventilation system** | | | | | | | | | | | | | | | | | |
| Winter ventilation | 1 | | 0,25 | Wh/m³ * | 0,52 | h⁻¹ * | 4,5 | kh/a * | 1284 | m³ = | 741 | considered in heat recovery efficiency | | | | | |
| Defroster HX | 1 | 1 | Data entries in 'Ventilation' worksheet or in 'Addl vent' | | | | | | | | 30 | * 0,3 | / | 4,50 | = | 2 | |
| Summer ventilation | 1 | 0,10 | 0,25 | Wh/m³ * | 0,52 | h⁻¹ * | 4,3 | kh/a * | 1284 | m³ = | 700 | * 1,0 | / | 4,26 | = | | 16 |
| | | | | | | | | | | | | Internal heat sources ' Additional summer ventilation' | | | | | 0,0 |
| Additional vent. summer | 0 | 0,10 | 0,30 | Wh/m³ * | 0,00 | h⁻¹ * | 4,3 | kh/a * | 1284 | m³ = | 0 | * 1,0 | / | 4,26 | = | | 0,0 |
| **Heating system** | | | Controlled / non controlled [1/0] | | | | | | | | | | | | | | |
| Enter the rated power of the pump | | | | W | 1 | | | | | | | | | | | | |
| Circulator pump heating | 1 | 1 | 159 | W * | 0,7 | * | 4,5 | kh/a * | 1 | = | 527 | * 1,0 | / | 4,50 | = | 117 | |
| Boiler electricity consumption at 30% load | | | | W | | | | | | | | | | | | | |
| Aux. energy - Heat. boiler | 0 | 0 | 55 | W * | 1,00 | * | 0,00 | kh/a * | 1 | = | 0 | * 1,0 | / | 4,50 | = | 0 | |
| Aux. energy - Wood fired/Pellet boiler | 0 | 0 | Data entries in 'Boiler' worksheet. Aux. energy demand including possible drinking water production. | | | | | | | | 0 | * 1,0 | / | 4,50 | = | 0 | |
| **DHW system** | | | | | | | | | | | | | | | | | |
| Enter average power consumption of pump | | | | W | | | | | | | | | | | | | |
| Circulation pump DHW | 1 | 1 | 31 | W * | 1,00 | * | 5,9 | kh/a * | 1 | = | 183 | * 1,0 | / | 8,76 | = | 21 | 21 |
| Enter the rated power of the pump | | | | W | | | | | | | | | | | | | |
| Storage load pump DHW | 1 | 1 | 75 | W * | 1,00 | * | 0,6 | kh/a * | 1 | = | 44 | * 1,0 | / | 8,76 | = | 5 | 5 |
| Boiler electricity consumption at 100% load | | | | W | | | | | | | | | | | | | |
| DHW boiler aux. energy | 0 | 0 | 165 | W * | 1,00 | * | 0,0 | kh/a * | 1 | = | 0 | * 1,0 | / | 8,76 | = | 0 | 0 |
| Enter the rated power of the solar DHW pump | | | | W | | | | | | | | | | | | | |
| Solar aux. electricity | 0 | 1 | 56 | W * | 1,00 | * | 1,8 | kh/a * | 1 | = | 0 | * 1,0 | / | 8,76 | = | 0 | 0 |
| **Aux. electricity cooling and dehumidification** | | | | | | | | | | | | | | | | | |
| Aux. electricity cooling | 1 | 1 | 29 | kWh/a * | 1,00 | * | 1,0 | * | 1 | = | 29 | * 1,0 | / | 4,26 | = | | 7 |
| Aux. electricity dehum. | 1 | 1 | 29 | kWh/a * | 1,00 | * | 1,0 | * | 1 | = | 29 | * 1,0 | / | 4,26 | = | | 7 |
| **Misc. aux. electricity** | | | | | | | | | | | | | | | | | |
| Misc. aux. electricity | | | | kWh/a * | 1,00 | * | 1,0 | * | 1 | = | 0 | * 1,0 | / | 8,76 | = | 0 | 0 |
| **Total** | | | | | | | | | | | 2283 | | | | | 145 | 56 |
| **Specific demand** | kWh/(m²a) (treated floor area) | | | | | | | | | | 5,6 | | | | | | |

# Primary Energy Renewable PER

Prizidava OŠ Polzela - 2. faza / Climate: Ljubljana, Eko sklad 2018 / TFA: 408 m² / Heating: 9,5 kWh/(m²a) / Cooling: 3,9 kWh/(m²a) / PER: 84,6 kWh/(m²a)

| | | | | | |
|---|---|---|---|---|---|
| | | | | Building type: | CC-SI 12630 |
| | | | | Treated floor area $A_{TFA}$: | 408 m² |
| **Selection of heat generation system(s)** | **Contribution margin (useful energy)** | | | Projected building footprint $A_{Projected}$: | 282 m² |
| **Primary heat generation type** | **Heating** | **DHW** | **Addl. input in following worksheets** | Heating demand incl. distribution & hydr. frost protection | 10 kWh/(m²a) |
| 2-Heat pump(s) | 100% | 100% | HP, possibly HP ground | Cooling energy dem. incl. dehumidification | 4 kWh/(m²a) |
| **Secondary heat generation type (optional & different)** | | | | DHW demand including distribution: | 21 kWh/(m²a) |
| - | 0% | 0% | - | | |

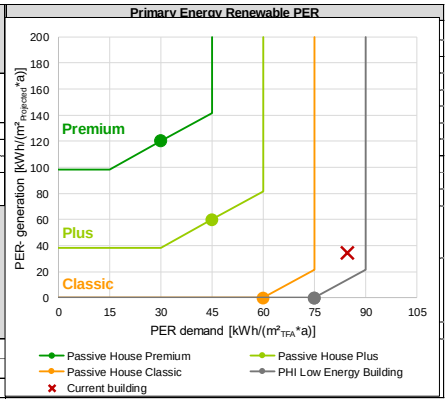
| **Energy demand** | **Efficiency** | | **Final energy** | | **PER** | | | **PE** | | **$CO_2$** | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Reference: Treated floor area** | Calculation | User defined value | Contribution (final energy) | **Final energy demand** | PER factor | Effective PER factor (including biomass | **PER specific value** | PE factor | PE value | $CO_2$ emissions factor ($CO_2$-eq) | $CO_2$eq emissions |
| | - | - | | kWh/(m²a) | kWh/kWh | kWh/kWh | kWh/(m²a) | kWh/kWh | kWh/(m²a) | kg/kWh | kg/(m²a) |
| | | | | | | | | 8-PE factors user determined | | 2-CO2 factors user determined | |
| | | | | | | | **84,6** | | 166,7 | | 35,3 |
| **Heating** | | | 100% | | | 1,10 | **7,8** | 2,50 | **17,6** | | **3,7** |
| Electricity (HP compact unit) | | | | | 1,80 | | | 2,50 | | 0,530 | |
| Electricity (heat pump) | 2,49 | | 100% | 3,9 | 1,80 | 1,10 | 4,3 | 2,50 | 9,7 | 0,530 | 2,1 |
| District heating: 1-None | | | | | 2,8\|4,5\|3,3 | | | | | 0,000 | |
| Pelletfeuerung indirekt: 50-Pellets | | | | | 1,10 | | | 0,10 | | 0,000 | |
| Natural gas / RE gas | | | | | 1,75 | | | 1,10 | | 0,200 | |
| Heating oil / RE methanol | | | | | 2,30 | | | 1,10 | | 0,280 | |
| Solar thermal system | | | | | | | | 0,00 | | 0,000 | |
| Electricity (direct) | | | | | 1,80 | | | 2,50 | | 0,530 | |
| | | | | | | | | | | | |
| Aux. electricity (heating, wintertime ventilation) | | | | 3,2 | 1,80 | 1,10 | 3,5 | 2,50 | 8,0 | 0,530 | 1,7 |
| **Cooling and dehumidification** | | | | | 1,10 | | **3,3** | | **7,5** | | **1,6** |
| Electricity cooling (heat pump) | 3,50 | | | 1,1 | 1,10 | | 1,2 | 2,50 | 2,8 | 0,530 | 0,6 |
| Auxiliary electricity cooling, ventilation summer | | | | 1,8 | 1,10 | | 2,0 | 2,50 | 4,5 | 0,530 | 0,9 |
| Electricity dehumidification (heat pump) | 3,50 | | | 0,0 | 1,15 | | 0,0 | 2,50 | 0,0 | 0,530 | 0,0 |
| Auxiliary electricity (dehumidification) | | | | 0,1 | 1,15 | | 0,1 | 2,50 | 0,2 | 0,530 | 0,0 |
| **DHW generation** | | | 100% | | | 1,30 | **14,6** | 2,50 | **28,1** | | **6,0** |
| Electricity (HP compact unit) | | | | | 1,30 | | | 2,50 | | 0,530 | |
| Electricity (heat pump) | 2,00 | | 100% | 10,7 | 1,30 | 1,30 | 13,9 | 2,50 | 26,7 | 0,530 | 5,7 |
| District heating: 1-None | | | | | 2,8\|4,5\|3,3 | | | | | 0,000 | |
| Pelletfeuerung indirekt: 50-Pellets | | | | | 1,10 | | | 0,10 | | 0,000 | |
| Natural gas / RE gas | | | | | 1,75 | | | 1,10 | | 0,200 | |
| Heating oil / Methanol | | | | | 2,30 | | | 1,10 | | 0,280 | |
| Solar thermal system | | | | | | | | 0,00 | | 0,000 | |
| Electricity (direct) | | | | | 1,30 | | | 2,50 | | 0,530 | |
| | | | | | | | | | | | |
| Aux. electricity (DHW + solar DHW) | | | | 0,6 | 1,30 | 1,30 | 0,7 | 2,50 | 1,4 | 0,530 | 0,3 |
| **Household electricity** | | | | **45,3** | | 1,30 | **59,0** | | **113,4** | | **24,0** |
| Electricity (household or non-residential lighting, etc.) | | | | 45,3 | 1,30 | 1,30 | 59,0 | 2,50 | 113,4 | 0,530 | 24,0 |
| Auxiliary electricity (other) | | | | | 1,30 | | | 2,50 | | 0,530 | |
| **Gas / RE gas dry/cook** | | | | **0,0** | 1,75 | | **0,0** | 2,50 | **0,0** | 0,215 | **0,0** |

| **Energy generation** | **Final energy** | | **PER** | | **PE** | | **$CO_2$** | |
|---|---|---|---|---|---|---|---|---|
| **Reference: Projected building footprint area** | Final energy generation | **Final energy generation** | PER factor | **PER specific value** | PE factor | PE Value | Emission factor ($CO_2$-eq) | $CO_2$eq emissions |
| | kWh/a | **kWh/(m²$A_{Projected}$*a)** | kWh/kWh | kWh/(m²$A_{Projected}$a) | kWh/kWh | kWh/(m²a) | kg/kWh | kg/a |
| | | | | **34,1** | | **0,0** | | **0,0** |
| PV electricity | 9606 | 34,1 | 1,00 | 34,1 | 0,00 | 0,0 | - | |
| Solar thermal system | 0 | 0,0 | - | 0,0 | 1,22 | 0,0 | 0,000 | 0,0 |
| | | 0,0 | | | | | | |

| | | | | |
|---|---|---|---|---|
| **PE demand requirement in case of verification through PE (non-renewable) [kWh/(m²a)]** | - | **Current building reaches following class** | 167 | **Requirement met?** - |

| **Achievable energy standard through the verification of renewable primary energy (assessment of individual aspects)** | **Useful energy, performance** | | | | **Airtightness** |
|---|---|---|---|---|---|
| | **Annual heat. dem.** Treated floor area kWh/(m²a) | **Heating load** Treated floor area W/m² | **Useful cool. energy** Treated floor area kWh/(m²a) | **Cooling load** Treated floor area W/m² | **$n_{50}$** 1/h |
| Requirement Passive House Premium | | | | | |
| Requirement Passive House Plus | 15 | 10 | 15 | 13 | 0,60 |
| Requirement Passive House Classic | | | | | |
| Requirement PHI Low Energy Building | 30 | | 30 | | 1,00 |
| **Current building reaches following class for aspe** | 9 | 10 | 4 | 6 | 0,6 |
| | Premium | | Premium | | Premium |

**Primary Energy Renewable PER**




| **Summary** | **Final energy** | **PER specific value** | **PE value** | **CO2eq emissions** | **$CO_2$eq substitution balance** |
|---|---|---|---|---|---|
| Though, from the scientific point of view, not entirely correct, different energy carriers will be added together here. This is done to meet the criteria of other energy standards. | MWh/a | MWh/a | 8-PE factors user determined MWh/a | 2-CO2 factors user determined kg/a | 2-CO2 factors user determined kg/a |
| **Demand** | **27,2** | **34,5** | 67,93 | 14402 | 14402 |
| **Generation** | **-9,6** | **-9,6** | 0,00 | 0 | 0 |
| **Demand, cumulative generation (annual balance)** | 17,57 | 24,88 | 67,93 | 14402 | 14402 |
| **Demand w/o household electricity** | **8,7** | **10,5** | 21,72 | 4605 | 4605 |
| **Demand w/o household electricity, cum. generation** | -0,92 | 0,85 | 21,72 | 4605 | 4605 |

# Heat pump

Prizidava OŠ Polzela - 2. faza / Climate: Ljubljana, Eko sklad 2018 / TFA: 408 m² / Heating: 9,5 kWh/(m²a) / Cooling: 3,9 kWh/(m²a) / PER: 84,6 kWh/(m²a)

| | | | | | |
|---|---|---|---|---|---|
| | | | Building type: | CC-SI 12630 | |
| | | | Treated floor area $A_{TFA}$: | 408 | m² |
| | Covered fraction of space heating demand | | *('PER' worksheet)* | 100% | |
| | Space heating demand + distribution losses | $Q_H+Q_{HL}$: | *(DHW+Distribution)* | 3935 | kWh/a |
| | Solar fraction for space heat | $\eta_{Solar,\ H}$ | *('SolarDHW' worksheet)* | 0% | |
| | **Effective annual heating demand** | $Q_{H,WI}=Q_H*(1-\eta_{Solar,\ H})$ | | **3935** | kWh/a |
| | Covered fraction of DHW demand | | *('PER' worksheet)* | 100% | |
| | Total heating demand of DHW system | $Q_{gDHW}$ | *(DHW+Distribution)* | 8724 | kWh/a |
| | Solar fraction for DHW | $\eta_{Solar,\ DHW}$ | *('SolarDHW' worksheet)* | 0% | |
| | **Effective DHW demand** | $Q_{DHW,WI}=Q_{DHW}*(1-\eta_{Solar,\ DHW})$ | | **8724** | kWh/a |
| | Number of heat pumps in the system | | | 2 | |
| | Functionality | | | Heating & DHW | |
| **Heating** | | | | | |
| | Selection of HP: 1-Standard air/water heat pump | Heat source: | | 1-Outdoor air | |
| | Selection of distribution system | | | 1-Underfloor heating | |
| | Design distribution temperature | $\theta_{design}$ | *(DHW+Distribution)* | 35,00 | °C |
| | Nominal power of distribution system | $P_{nom}$ | | 50,00 | kW |
| | **Distribution system (to be completed by experienced users only)** | | | | |
| | Nominal power of distribution system | $P_{nom}$ | | 50,00 | kW |
| | Radiator exponent | n | | 1,20 | |
| | Heat storage tank (buffer storage tank 'DHW+Distribution' worksheet) | | | 1-Yes | |
| | Specific heat losses storage | U * $A_{Storage}$ | | 1,3 | W/K |
| | Storage location in thermal envelope | | | 1-Inside | |
| | Room temperature (storage location: outside of thermal envelope) | | *(DHW+Distribution)* | 20,00 | °C |
| | Sink temperature of heat pump for heating | $\theta_{snk}$ | | 25,28 | °C |
| **Entries in relation to the domestic hot water system** | | | | | |
| | Selection of HP: 1-Standard air/water heat pump | Heat source: | | 1-Outdoor air | |
| | DHW temperature | | *(DHW+Distribution)* | 60,00 | °C |
| | Orientation of DHW storage tank ('storage 1' in 'DHW+Distribution' worksheet) | | | 1-Inside | |
| | Specific heat losses storage | U * $A_{Storage}$ | | 1,6 | W/K |
| | Room temperature (storage location: outside of thermal envelope) | | *(DHW+Distribution)* | 20,00 | °C |
| | Type of backup heater | | | 1-Elec. Immersion heater | |
| | Δθ of electric continuous flow water heater | | | | K |
| **Additional options in case of <u>one</u> heat pump for both functions: Heating & DHW** | | | | | |
| | Same heat pump's sink temperature for Heating and for DHW | | | 0-No | |
| | Heat pump priority | | *(Manufacturer, tech. data)* | 1-DHW-priority | |
| **Control strategy** | | | | | |
| | Heat pump control strategy | | | 2-Ideal | |
| **Heating** | | | | | |
| | Depth ground water / Ground collector / Ground probe | z | | | m |
| | Power of pump for ground heat exchanger | $P_{pump}$ | | | kW |

# Internal heat gains for non-residential buildings



Prizidava OŠ Polzela - 2. faza / Climate: Ljubljana, Eko sklad 2018 / TFA: 408 m² / Heating: 9,5 kWh/(m²a) / Cooling: 3,9 kWh/(m²a) / PER: 84,6 kWh/(m²a)

Utilisation: 21-School — IHG: 4,60 W/m² — Calculation results from this worksheet: 4,61 W/m²

Type of values used: 4-PHPP calculation ('IHG non-res' worksheet) — Enter here results from cell above: 4,60 W/m²

Persons: 50,0 P — Treated floor area: 407,61 m² — Heating period: 188 d/a — Room temperature: 20 °C — Internal heat gains aux. electricity: 145 W

| Persons | Selection of user profile | Select | Activity of persons | Planning 0 = according to ground area or usable zone 1 = according to occupancy | | Number of occupants | | Ground area of useful zone [m²] | | Average occupancy [Pers./m²] | | Heat emitted per person [W] | | Utilisation hours per year [h/a] | | Relative presence | | Utilisation period [h/a] | | Average heat release persons [W] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | 27 | | | | 9 | | 18 | | | | |
| Persons A | 1-Prostori | 3 | >10 yr., standing or light work | 1 | Planning with occupancy | { 0 }* | or | { | * | 0,459998528 | } * | 100 | * | 2160 | * | 0,70 | / | 8760 | = | 2 |
| Persons B | 2-Komunikacije | 3 | >10 yr., standing or light work | 1 | Planning with occupancy | { 0 }* | or | { | * | 0,459998528 | } * | 100 | * | 2160 | * | 0,70 | / | 8760 | = | 2 |
| Persons C | 1-Prostori | 3 | >10 yr., standing or light work | 1 | Planning with occupancy | { 45 }* | or | { | * | 0,459998528 | } * | 100 | * | 2160 | * | 0,70 | / | 8760 | = | 777 |
| Persons D | 2-Komunikacije | 3 | >10 yr., standing or light work | 1 | Planning with occupancy | { 5 }* | or | { | * | 0,459998528 | } * | 100 | * | 2160 | * | 0,70 | / | 8760 | = | 86 |
| Persons E | | | Invalid input | | | { }* | or | { | * | Not a standard value | } * | 0 | * | 0 | * | 1,00 | / | 8760 | = | 0 |
| Persons F | | | Invalid input | | | { }* | or | { | * | Not a standard value | } * | 0 | * | 0 | * | 1,00 | / | 8760 | = | 0 |
| Persons G | | | Invalid input | | | { }* | or | { | * | Not a standard value | } * | 0 | * | 0 | * | 1,00 | / | 8760 | = | 0 |
| Evaporation (person specific) | | | | | | 50 * | | | | | | -15 | * | 2160 | * | 0,70 | / | 8760 | = | -129 |

| Lighting / Equipment / Aux. electricity | Useful energy [kWh/a] | | Availability | | Utilisation period [h/a] | | Average heat release |
|---|---|---|---|---|---|---|---|
| **Lighting** | 880 | * | 1 | / | 8,76 | = | 101 |
| **Office applications** (within therm. envelope) | 256 | * | 1 | / | 8,76 | = | 29 |
| **Cooking** (within therm. envelope) | 12000 | * | 0,5 | / | 8,76 | = | 685 |
| **Dishwashing** (within therm. envelope) | 4800 | * | 0,3 | / | 8,76 | = | 164 |
| **Cooling** (within therm. envelope) | 548 | * | 1 | / | 8,76 | = | 63 |
| **Other** (within thermal envelope) | 0 | * | 1 | / | 8,76 | = | 0 |
| **Auxiliary appliances (see 'Aux Electricity' worksheet)** | | | | | | = | 145 |

| Heat loss due to cold water (calculation from column AJ) | On/Off [1 / 0] | | Predominant utilisation pattern of building (Data transferred from 'Electricity non-res' worksheet; input 2) | Number of WCs (user data) | Amount of WCs: Utilisation of standard values for schools? | Number of WCs (calculation value) | DT: Cold water temp. - Room temp. [K] | Occupied days per year [d/a] 8 | | Loss daytime [W] | | Loss night-time [W] | | Availability | Utilisation period [d/a] | | Average power cold water |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Cold water due to flushing WC** | 1 | 1 | Prostori | | x | 8 | -8,2 | 240 | * ( | -39 | + | -26 | ) * | 1 | / 365 | = | -43 |

| | | | |
|---|---|---|---|
| **Total IHG** | | W | 1881 |
| **Specific IHG** | | W/m² | 4,6 |
| **Heat available from internal sources** | 188 d/a | kWh/(m²a) | 21 |

# 10 PRIMERI DOKAZIL ZA PVC OKNA IN VRATA Z USTREZNIMI ENERGIJSKIMI LASTNOSTMI

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ODDELEK ZA GRADBENO FIZIKO
Laboratorij za toplotno zaščito in akustiko
Priglašeni preskusni laboratorij št. 1404 po CPR – Uredbi EU št. 305/2011

Ljubljana, 24. 2. 2020

SLOVENSKA AKREDITACIJA
SIST EN ISO/IEC 17025
LP-005

## POROČILO
## št. 191/20–520–1

o izračunu toplotne prehodnosti okenskih profilov
Aluplast Ideal 8000 po SIST EN ISO 10077-2:2017
in toplotne prehodnosti okna iz teh profilov po
SIST EN ISO 10077-1:2017

| | |
|---|---|
| Naročnik: | **OKNA FURMAN, proizvodnja, trgovina in storitve, d.o.o.**<br>**Sveti Jernej 22, 3215 Loče** |
| Naročilo: | **1/2020 z dne 20. 2. 2020** |
| Nosilec naloge: | **dr. Miha Jukić, univ. dipl. inž. grad.** |
| Vodja enote: | **dr. Sabina Jordan, univ. dipl. inž. arh.** |
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Obr. P.S. 12-001-1/3

# 1. Uvod

Naročnik, Okna Furman d.o.o., je Zavodu za gradbeništvo Slovenije naročil izračun toplotne prehodnosti PVC okenskih profilov z jeklenimi ojačitvami Aluplast Ideal 8000 na podlagi numeričnih simulacij prehoda toplote. Naročil je tudi izračun toplotne prehodnosti okna, sestavljenega iz teh profilov in troslojne zasteklitve, polnjene z argonom. Izračun toplotne prehodnosti okna je naročil za enokrilno okno dveh standardnih dimenzij: 123 cm × 148 cm in 148 cm × 218 cm. Izračun je bil izveden v skladu s standardoma SIST EN ISO 10077-2:2017 in SIST EN ISO 10077-1:2017 ter skladno s harmoniziranim produktnim standardom za okna in vrata SIST EN 14351-1:2006 + A2:2016 (točka 4.12) po sistemu 3 AVCP, kot ga določa uredba EU št. 305/2011 (CPR) z dopolnitvami, zlasti Delegirana uredba Komisije (EU) št. 568/2014.

Izračun ne upošteva osončenosti, ventilacijskih toplotnih izgub, točkovnih toplotnih mostov ter linijskih toplotnih mostov na stiku okna in stavbe (skladno s SIST EN ISO 10077-1:2017 in SIST EN ISO 10077-2:2017).

# 2. Metodologija

## 2.1 Izračun toplotne prehodnosti okenskih profilov – $U_f$

Toplotna prehodnost okenskih profilov, $U_f$, je bila določena v skladu s standardom SIST EN ISO 10077-2:2017 s pomočjo numerične simulacije prehoda toplote pri stacionarnih pogojih. Simulacija je bila izvedena s programom Physibel Bisco 11.0. Dvodimenzionalni numerični model je bil izdelan na podlagi načrta okenskega profila v formatu DWG, ki ga je dostavil naročnik (oznaka vzorca T 8 – 20, dodatek 1). Točkovni elementi (distančniki med zasteklitvijo in profilom) v modelu niso bili upoštevani.

Toplotne prevodnosti uporabljenih materialov so bile povzete po tabeli D.1 v standardu SIST EN ISO 10077-2:2017. Emisivnost jekla je bila povzeta po tabeli D.3 istega standarda. Za ostale materiale je bila privzeta emisivnost 0,9. Lastnosti materialov so zbrane v tabeli 1. Neprezračevane odprtine so bile obravnavane po natančnejši metodi v SIST EN ISO 10077-2:2017 (radiosity method), pri kateri se ločeno obravnava kondukcijsko-konvekcijski prenos toplote preko zraka in radiacijski prenos toplote med površinami posamezne odprtine.

Tabela 1: Toplotne prevodnosti in emisivnosti materialov, uporabljene v numeričnih simulacijah.

| Material | Toplotna prevodnost [W/mK] | Emisivnost |
|---|---|---|
| PVC | 0,17 | 0,9 |
| Jeklo | 50 | 0,3 |
| EPDM | 0,25 | 0,9 |
| Izolativni panel | 0,035 | 0,9 |

Tabela 2: Robni pogoji, uporabljeni v numeričnih simulacijah.

| Površina | Temperatura zraka [°C] | Površinska toplotna upornost [$m^2K/W$] |
|---|---|---|
| Zunanjost | 0 | 0,04 |
| Notranjost – ravne površine | 20 | 0,13 |
| Notranjost – vogali | 20 | 0,20 |

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V numeričnem modelu je bila zasteklitev nadomeščena z izolativnim panelom, ki je bil odrezan na razdalji 190 mm od roba profila. Na slikah v nadaljevanju izolativni panel ni prikazan v celoti zaradi boljše preglednosti.

Robni pogoji na notranji in zunanji strani profila so zbrani v tabeli 2. Površinske toplotne upornosti so bile določene skladno z aneksom E standarda SIST EN ISO 10077-2:2017. Na površini profila, ki je sicer v stiku s steno, in na nasprotnem robu, kjer je izolativni panel odrezan, je bil upoštevan adiabatni robni pogoj.

Numerične simulacije prehoda toplote so bile izvedene 20. februarja 2020.

### 2.2 Izračun toplotne prehodnosti okna – $U_W$

Izračun toplotne prehodnosti okna, $U_W$, je bil izveden v skladu s standardom SIST EN ISO 10077-1:2017. V izračunu je bila upoštevana toplotna prehodnost okenskih profilov, $U_f$, določena v skladu s točko 2.1. Toplotna prehodnost troslojne zasteklitve, polnjene z argonom, je znašala $U_g$ = 0,5 W/m$^2$K. Povzeta je bila po izjavi o lastnostih, ki jo je dostavil naročnik (dodatek 2). Za linijsko toplotno prehodnost medstekelnih distančnikov je bila uporabljena vrednost $\Psi_g$ = 0,038 W/mK, povzeta po podatkovnem listu, ki ga je dostavil naročnik (dodatek 3). To vrednost se sme uporabiti, ker obravnavnana konfiguracija okenskega profila in zasteklitve izpolnjuje omejitve iz smernice ift-Guideline WA-08engl/3 glede uporabe podatkovnih listov.

Izračun toplotne prehodnosti okna je bil izveden 21. februarja 2020.

## 3. Opis vzorca

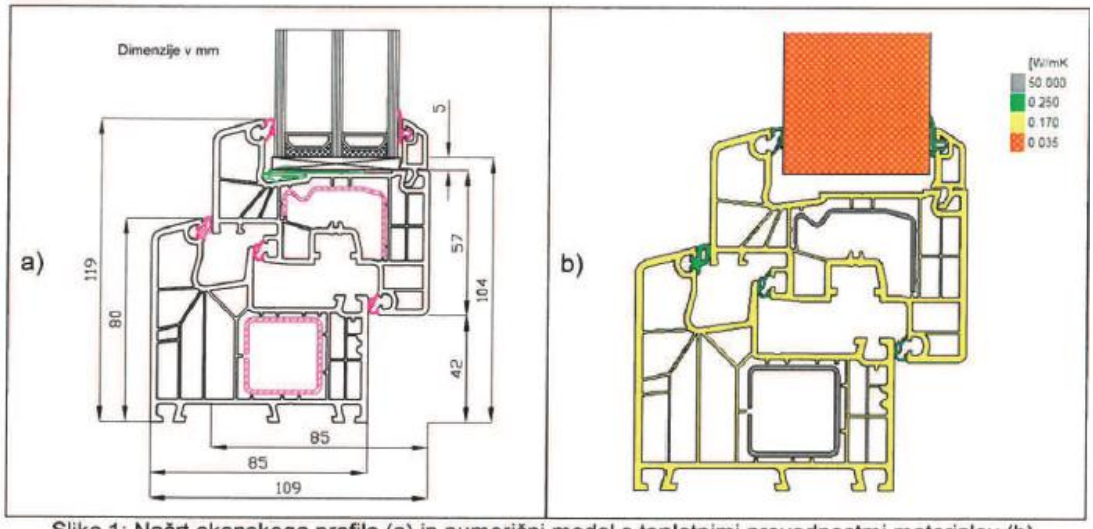
### 3.1 Okenski profil

Šestkomorni PVC okenski profil Aluplast Ideal 8000 ima dve jekleni ojačitvi, eno v okvirju in eno v okenskem krilu. Debelina okvirja in debelina krila znašata 85 mm. Notranja ($A_{f,i}$) in zunanja ($A_{f,e}$) projicirana površina okenskega profila, preračunani na 1 m dolžine profila, znašata $A_{f,i} = A_{f,e}$ = 0,119 m$^2$. V obravnavani konfiguraciji je uporabljena zasteklitvena letvica za zasteklitev debeline 48 mm. Globina vgraditve zasteklitve v profil znaša 15 mm. Slika 1 prikazuje načrt (a) in numerični model (b) obravnavanega profila. Načrt profila v merilu 1:1 je priložen v dodatku 1.

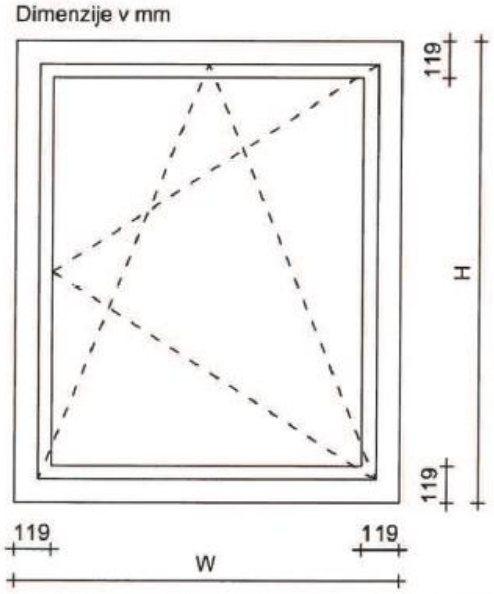
### 3.2 Okno

Izračun je bil izveden za enokrilno okno dveh standardnih dimenzij: W × H = 123 cm × 148 cm in W × H = 148 cm × 218 cm. Skica okna je prikazana na sliki 2. Na vseh štirih robovih je uporabljen okenski profil iz točke 3.1. Uporabljena je troslojna zasteklitev debeline 48 mm s stekli debeline 4 mm. Zunanji stekli imata na notranji strani nizkoemisijski nanos. Medstekelna prostora debeline 18 mm sta zapolnjena z argonom. Izjava o lastnostih zasteklitve je priložena v dodatku 2. Uporabljeni so toplotno izboljšani medstekelni distančniki znamke TGI Spacer. Podatkovni list je priložen v dodatku 3. Pri manjšem oknu znaša skupna površina okna $A_W$ = 1,82 m$^2$, površina vidnega dela zasteklitve $A_g$ = 1,23 m$^2$, površina profilov $A_f$ = 0,59 m$^2$ in dolžina oboda vidnega dela zasteklitve $l_g$ = 4,47 m. Pri večjem oknu znašajo te dimenzije $A_W$ = 3,23 m$^2$, $A_g$ = 2,41 m$^2$, $A_f$ = 0,81 m$^2$, $l_g$ = 6,37 m.

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Slika 1: Načrt okenskega profila (a) in numerični model s toplotnimi prevodnostmi materialov (b).



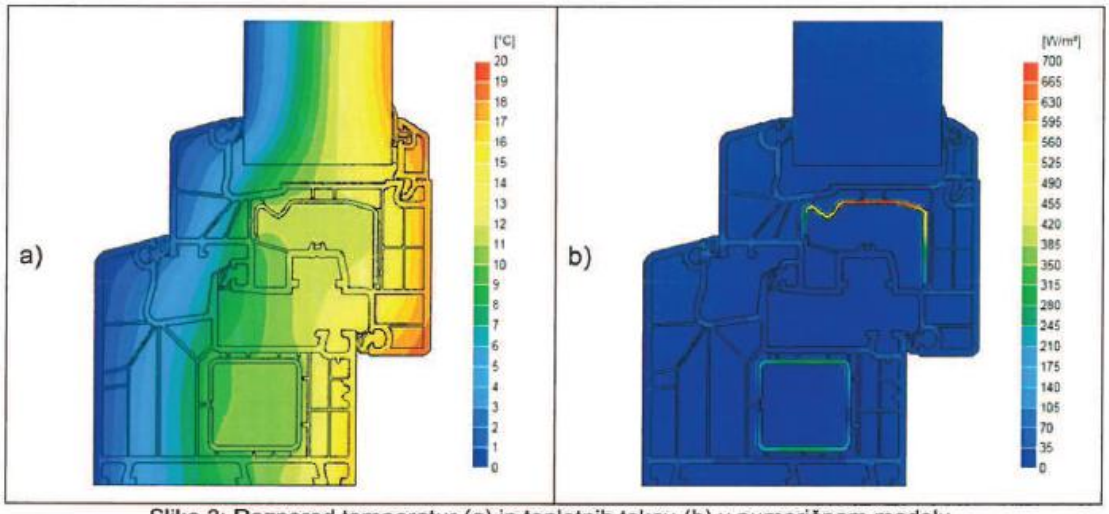

Slika 2: Skica enokrilnega okna širine W in višine H.

## 4. Rezultati

Slika 3 prikazuje razpored temperatur in toplotnih tokov v numeričnem modelu. Zaradi boljše preglednosti izolativni panel, ki nadomešča zasteklitev, ni prikazan v celoti. Izračunane vrednosti pomembnejših količin so zbrane v tabeli 3. Glavni rezultat je toplotna prehodnost okenskega profila, $U_f$ = 1,1 W/m$^2$K, ki je zaokrožena skladno s standardom SIST EN ISO 10077-2:2017. Minimalna temperatura notranje površine $\theta_{si,min}$ je dosežena na stiku okenskega krila in okvirja.

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Za oceno napake numeričnega izračuna je bil v skladu s standardom SIST EN ISO 10211:2017 izračun ponovljen z dvakrat redkejšo mrežo. Skupni toplotni tok skozi model ($\Phi_l$) se je razlikoval za 0,53 % (zahtevano manj kot 1 %), temperaturni faktor pa za 0,001 (zahtevano manj kot 0,005). Pri končnem modelu je relativna razlika med toplotnim tokom, ki vstopa v konstrukcijo, in toplotnim tokom, ki izstopa iz nje, znašala $8{,}3 \times 10^{-5}$ (zahtevano manj kot $10^{-4}$). Izračun izpolnjuje zahteve standarda SIST EN ISO 10211:2017 glede natančnosti.




Slika 3: Razpored temperatur (a) in toplotnih tokov (b) v numeričnem modelu.

Tabela 3: Rezultati numeričnih simulacij prehoda toplote.

| Količina | Oznaka | Vrednost |
|---|---|---|
| Število vozlišč v numeričnem modelu | [-] | 67369 |
| Toplotni tok skozi 2D model | $\Phi_l$ [W/m] | 5,111 |
| Koeficient toplotne sklopitve | $L_{2D}$ [W/mK] | 0,256 |
| Minimalna temperatura notranje površine | $\theta_{si,min}$ [°C] | 15,2 |
| Temperaturni faktor na mestu $\theta_{si,min}$ | $f_{Rsi}$ [-] | 0,759 |
| Toplotna prehodnost okenskega profila | $U_f$ [W/m$^2$K] | 1,1 |

Toplotna prehodnost enokrilnega okna iz točke 3.2 znaša: $U_W$ = 0,79 W/m$^2$K za okno dimenzij 123 cm × 148 cm in $U_W$ = 0,73 W/m$^2$K za okno dimenzij 148 cm × 218 cm. Vrednosti sta zaokroženi skladno s standardom SIST EN ISO 10077-1:2017.

## 5. Zaključek

Naročnik, Okna Furman d.o.o., je Zavodu za gradbeništvo Slovenije naročil izračun toplotne prehodnosti enokrilnega okna dveh standardnih dimenzij (123 cm × 148 cm in 148 cm × 218 cm) iz PVC okenskih profilov z jeklenimi ojačitvami Aluplast Ideal 8000 in troslojne zasteklitve s toplotno izboljšanimi distančniki TGI Spacer. Deklarirana toplotna prehodnost zasteklitve znaša $U_g$ = 0,5 W/m$^2$K, linijska toplotna prehodnost distančnikov pa $\Psi_g$ = 0,038 W/mK. Toplotna prehodnost okenskih profilov, $U_f$ = 1,1 W/m$^2$K, je bila določena na podlagi numeričnih simulacij prehoda toplote skladno s standardom SIST EN ISO 10077-2:2017. Toplotna prehodnost okna je bila izračunana skladno s standardom SIST EN ISO



PRIZIDAVA OŠ POLZELA

10077-1:2017 na podlagi toplotnih prehodnosti njegovih sestavnih delov. Za okno dimenzij 123 cm × 148 cm znaša toplotna prehodnost $U_W$ = 0,79 W/m$^2$K. V skladu s harmoniziranim produktnim standardom za okna in vrata SIST EN 14351-1:2006 + A2:2016 ta vrednost pokriva vsa okna enake zasnove z velikostjo do 2,3 m$^2$. Za okno dimenzij 148 cm × 218 cm znaša toplotna prehodnost $U_W$ = 0,73 W/m$^2$K. V skladu s harmoniziranim produktnim standardom za okna in vrata SIST EN 14351-1:2006 + A2:2016 ta vrednost pokriva vsa okna enake zasnove, večja od 2,3 m$^2$.

# 6. Dodatki

Dodatek 1: Načrt PVC okenskega profila z jeklenimi ojačitvami Aluplast Ideal 8000 v merilu 1:1 (1 stran, vir: Okna Furman d.o.o., 13. 2. 2020 po elektronski pošti).

Dodatek 2: Izjava o lastnostih za troslojno zasteklitev debeline 48 mm (1 stran, vir: Okna Furman d.o.o., 10. 2. 2020 po elektronski pošti).

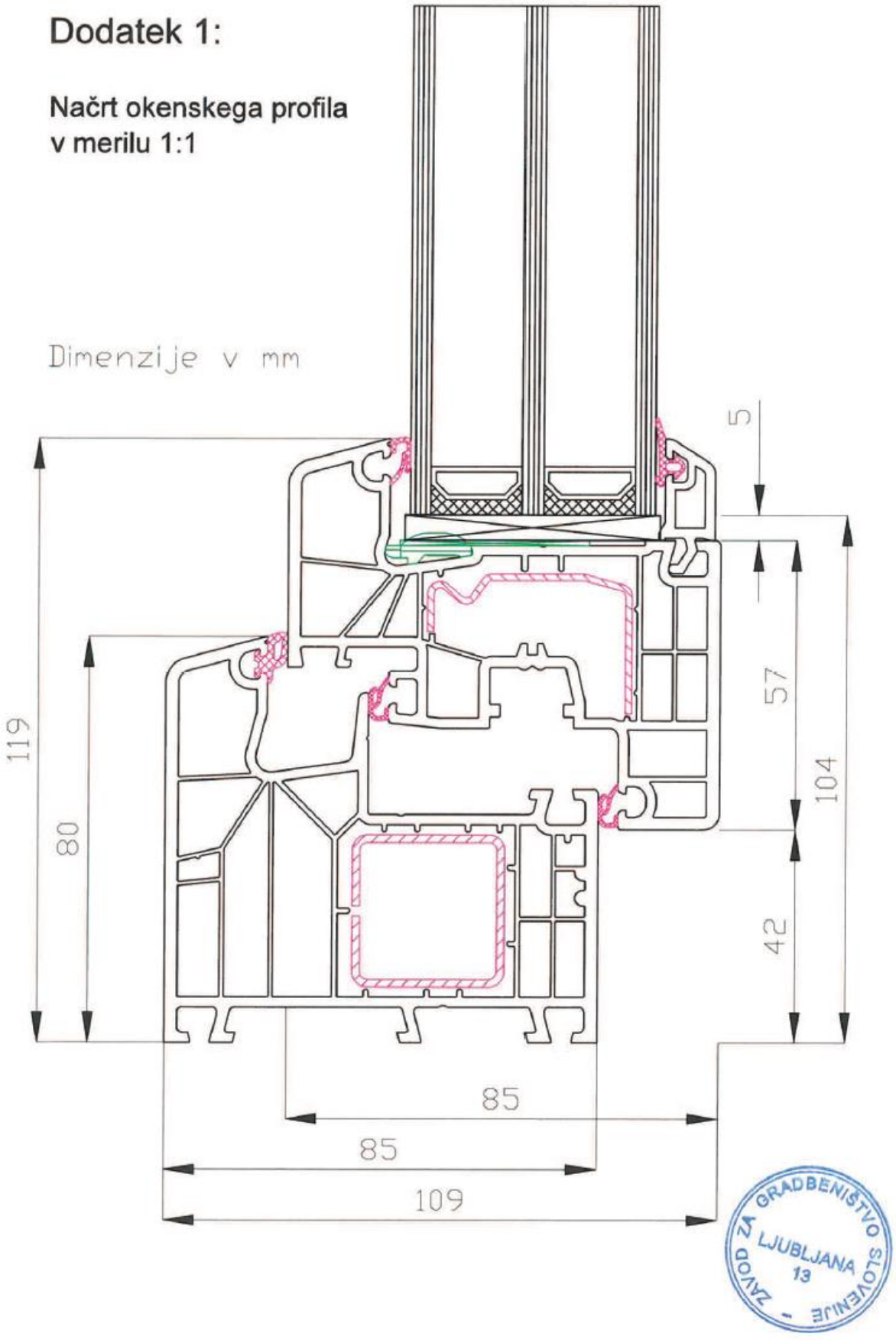
Dodatek 3: Podatkovni list za toplotno izboljšani distančnik TGI Spacer (1 stran, vir: Okna Furman d.o.o., 11. 2. 2020 po elektronski pošti).

Izračun in poročilo pripravil:

dr. Miha Jukić, univ. dipl. inž. grad.

# Dodatek 1:

## Načrt okenskega profila v merilu 1:1



CE

ertl glas

# IZJAVA O LASTNOSTIH
št. UNI6-05/2016

1. Izolacijsko steklo: UNIGLAS TOP 0,5
2. Tip: 4:/18/4/18/:4
3. Namen uporabe: Izolacijsko steklo za uporabo v zgradbah in gradbeništvu
4. Proizvajalec: ERTL GLAS STEKLO d.o.o.
   Kolodvorska ulica 22, 1310 Ribnica, Slovenija
5. Pooblaščenec: -
6. Sistem ocenjevanja lastnosti: 3
7. Harmoniziran produktni standard: EN 1279-5:2005+A2:2010
8. Akreditirani organ: KWA Product Cert GmbH

9. Lastnosti:

| | Bistvene značilnosti | Lastnost | Harmonizirane tehnične specifikacije |
|---|---|---|---|
| 9.1 | Odpornost na ogenj | NPD | EN 1279-5:2005+A2:2010, 4.3.2.2 |
| 9.2 | Obnašanje v primeru ognja | NPD | EN 1279-5:2005+A2:2010, 4.3.2.3 |
| 9.3 | Obnašanje ob obremenitvi z ognjem od zunaj | NPD | EN 1279-5:2005+A2:2010, 4.3.2.4 |
| 9.4 | Neprebojnost | NPD | EN 1279-5:2005+A2:2010, 4.3.2.5 |
| 9.5 | Zaščita pred eksplozijo | NPD | EN 1279-5:2005+A2:2010, 4.3.2.6 |
| 9.6 | Protivlomnost | NPD | EN 1279-5:2005+A2:2010, 4.3.2.7 |
| 9.7 | Test nihajnega telesa | NPD/NPD/NPD | EN 1279-5:2005+A2:2010, 4.3.2.8 |
| 9.8 | Odpornost na trenutne temperaturne spremembe in temperaturne razlike | 40K/40K/40K | EN 1279-5:2005+A2:2010, 4.3.2.9 |
| 9.9 | Odpornost na sneg, veter, trajne oziroma ostale obremenitve | 4/18/4/18/4 mm | EN 1279-5:2005+A2:2010, 4.3.2.10 |
| 9.10 | Direktna zvočna zaščita Rw (C,$C_{tr}$) | 34 (-2;-6) | EN 1279-5:2005+A2:2010, 4.3.2.11 |
| 9.11 | Termična lastnost $U_g$ | 0,5 (W/m2K) | EN 1279-5:2005+A2:2010, 4.3.2.12 |
| 9.12 | Prepustnost svetlobe<br>Refleksija svetlobe | 0,74<br>0,14 | EN 1279-5:2005+A2:2010, 4.3.2.13 |
| 9.13 | Refleksija energije<br>g – vrednost | 0,32<br>0,54 | EN 1279-5:2005+A2:2010, 4.3.2.14 |

NPD = no performance determined (ni deklarirane zahteve)

Lastnosti proizvoda, navedenega v točki 1 in 2, so v skladu z navedenimi lastnostmi iz točke 9.

Za izdajo te izjave o lastnostih je odgovoren izključno proizvajalec, naveden v točki 4.

Podpisal za in v imenu proizvajalca:

**Zoran Vasič, vodja prodaje**
Ribnica, 4.1.2016

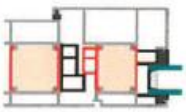
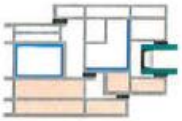
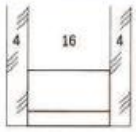
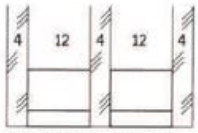
# Data sheet Psi values for windows

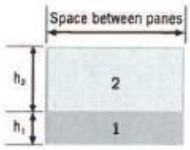
**based on determination of the equivalent thermal conductivity of spacers by measurement**

TECHNOFORM **GLASSINSULATION**

Technoform Glass Insulation GmbH
Matthäus-Merian-Str. 6
D - 34253 Lohfelden

| | Product name | Spacer height in mm | Material | Thickness d in mm |
|---|---|---|---|---|
| Cross-section | **TGI-Spacer**  | 6.9 | Stainless steel<br>Plastic | 0.10<br>0.6/0.8 |

| | | Metal with thermal break | Plastic | Wood | Wood / Metal |
|---|---|---|---|---|---|
| Representative frame profile | |  |  |  |  |
| Representative psi value double-sheet thermally insulating glass W/mK |   Double-sheet insulating glass $U_g$=1.1 W/m²K | 0.049 | 0.040 | 0.040 | 0.044 |
| Representative psi value triple-sheet thermally insulating glass W/mK |   Triple-sheet insulating glass $U_g$=0.7 W/m²K | 0.044 | 0.038 | 0.039 | 0.042 |

| Two Box model Characteristic values | | Space between panes in mm | $\lambda_{eq,2B}$ in W/mK | |
|---|---|---|---|---|
| | | | Box 1 · $h_1$ = 3 mm | Box 2 · $h_2$ = 6.9 mm |
| |   | Can be used for all spacer widths | 0.40 | 0.30 |

**Explanations**

The equivalent thermal conductivity has been determined in accordance with the ift guideline WA-17/1 "Thermally improved spacers – Determination of the equivalent thermal conductivity by measurement". The representative linear heat transfer coefficients calculated in this way (representative psi values) apply to typical frame profiles and glazing for the determination of the heat transfer coefficient UW of windows. They have been determined under the boundary conditions (frame profiles, glazing, glass mounting depth, back covering, primary and secondary sealant) defined in the ift guideline WA-08/2 "Thermally improved spacers – Part 1: Determination of the representative Psi value for window frame profiles". This guideline also governs the area of validity and application of the representative psi values. In order to avoid rounding errors, the psi values in the data sheet have been given at 0.001 W/mK. The method for the arithmetical determination of the psi values has an accuracy of ± 0.003 W/mK. Differences of less than 0.005 W/mK are not significant. For further information, refer to the Bulletin 004/2008 "Compass 'Warm Edge' for Windows" of Bundesverband Flachglas.

Ermittlung der Kennwerte durch:
Hochschule **Rosenheim**
University of Applied Sciences
ift ROSENHEIM

# 11 PRIMERI DOKAZIL ZA ALU STENE IN VRATA Z USTREZNIMI ENERGIJSKIMI LASTNOSTMI

CE

ertl glas

## IZJAVA O LASTNOSTIH

št. UNI6-05/2016

1. Izolacijsko steklo: UNIGLAS TOP 0,5
2. Tip: 4/18/4/18/4
3. Namen uporabe: Izolacijsko steklo za uporabo v zgradbah in gradbeništvu
4. Proizvajalec: ERTL GLAS STEKLO d.o.o.
   Kolodvorska ulica 22, 1310 Ribnica, Slovenija
5. Pooblaščenec: -
6. Sistem ocenjevanja lastnosti: 3
7. Harmoniziran produktni standard: EN 1279:2018
8. Akreditirani organ: KIWA Product Cert GmbH

9. Lastnosti:

| | Bistvene značilnosti | Lastnost | Harmonizirane tehnične specifikacije |
|---|---|---|---|
| 9.1 | Odpornost na ogenj | NPD | EN 1279:2018, 4.3.2.2 |
| 9.2 | Obnašanje v primeru ognja | NPD | EN 1279:2018, 4.3.2.3 |
| 9.3 | Obnašanje ob obremenitvi z ognjem od zunaj | NPD | EN 1279:2018, 4.3.2.4 |
| 9.4 | Neprebojnost | NPD | EN 1279:2018, 4.3.2.5 |
| 9.5 | Zaščita pred eksplozijo | NPD | EN 1279:2018, 4.3.2.6 |
| 9.6 | Protivlomnost | NPD | EN 1279:2018, 4.3.2.7 |
| 9.7 | Test nihajnega telesa | NPD/NPD/NPD | EN 1279:2018, 4.3.2.8 |
| 9.8 | Odpornost na trenutne temperaturne spremembe in temperaturne razlike | 40K/40K/40K | EN 1279:2018, 4.3.2.9 |
| 9.9 | Odpornost na sneg, veter, trajne oziroma ostale obremenitve | 4/18/4/18/4 mm | EN 1279:2018, 4.3.2.10 |
| 9.10 | Direktna zvočna zaščita Rw (C,$C_{tr}$) | 34 (-2;-6) | EN 1279:2018, 4.3.2.11 |
| 9.11 | Termična lastnost $U_g$ | 0,5 (W/m2K) | EN 1279:2018, 4.3.2.12 |
| 9.12 | Prepustnost svetlobe<br>Refleksija svetlobe | 0,74<br>0,14 | EN 1279:2018, 4.3.2.13 |
| 9.13 | Refleksija energije<br>g – vrednost | 0,32<br>0,54 | EN 1279:2018, 4.3.2.14 |

NPD = no performance determined (ni deklarirane zahteve)

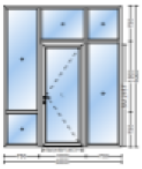
Lastnosti proizvoda, navedenega v točki 1 in 2, so v skladu z navedenimi lastnostmi iz točke 9.

Za izdajo te izjave o lastnostih je odgovoren izključno proizvajalec, naveden v točki 4.

Podpisal za in v imenu proizvajalca:

Zoran Vasič, vodja prodaje

| Pozicija: S10 | | | |
|---|---|---|---|
| Količina: | 1 Kos. | Obseg: | 11,0 m |
| Sistem: | Aluk Group C77K/D77 Standard Suha zasteklitev Seznam st. letvic: Squadrati | Površina: | 7,5 m² |
| Barva: | 20 Colori RAL Colori RAL | Okvir: | 2.500 x 3.000 mm |



Merilo: 1:150
Pogled: Notranji pogled

| Območje | Obseg [m] | psi vrednost [W/mK] | Površina [m²] | U vrednost [W/m²K] |
|---|---|---|---|---|
| **Profili** | | | **2,048** | **1,3** |
| - U28003 (Izjava sistemskega dobavitelja) | | | 0,673 | 1,2 |
| - U28602 (Izjava sistemskega dobavitelja) | | | 0,266 | 1,2 |
| - U52340, U52630, 002, K2069 (Izjava sistemskega dobavitelja) | | | 0,090 | 1,8 |
| - U28602, U52630, U52340 (Izjava sistemskega dobavitelja) | | | 1,019 | 1,4 |
| **Steklo** | | | **5,452** | **0,50** |
| - 4/18/4/18/4=48 mm, 4/18/4/18/4, g=0,00 (Izjava proizvajalca) | | | 5,452 | 0,50 |
| **Distančnik Steklo** | **24,55** | **0,031** | | |
| Swisspacer Ultimate (Izjava proizvajalca) | 24,55 | 0,031 | | |

| Skupaj | 24,55 | | 7,500 | 0,83 |
|---|---|---|---|---|

Die Wärmedurchgangskoeffizienten $U_D$ wurden für Türelemente nach EN ISO 10077-1:2017 bestimmt.

# 12 PRIMERI DOKAZIL ZA ZUNANJA VRATA Z USTREZNIMI ENERGIJSKIMI LASTNOSTMI

PIRNAR
AMAZING. AUDACIOUS. ADAMANT.

## IZJAVA O LASTNOSTIH

**DoP-Nr.: PPR2020-23546**

| | | |
|---|---|---|
| **1.** | Tip proizvoda | PPR2020-23546, OPTIMUM 90_0119 |
| **2.** | Predvidena uporaba | Vrata za uporabo v stanovanjski in nestanovanjski gradnji |
| **3.** | Proizvajalec | PIRNAR d.o.o.<br>Kolunić bb<br>BIH-77250 Bosanski Petrovac<br>Bosna in Hercegovina |
| **4.** | Zastopnik za EU | Pirnar d.o.o.<br>Bravničarjeva 20<br>SI-1000 Ljubljana<br>Slovenija |
| **5.** | Sistem ocenjevanja | 3 |
| **6.** | Harmonizirani standard | EN 14351-1:2006+A1:2010 |
| **7.** | Notificirani organ | IFT Rosenheim, NB Nr. 0757 |
| **8.** | Lastnosti: | |

| | |
|---|---|
| **Vodotesnost** | 2A |
| **Nevarne snovi** | brez |
| **Odpornost na veter** | C1 |
| **Odpornost na udarce** | 1 |
| **Nosilnost varnostnih naprav** | npd |
| **Višina** | <= 3m |
| **Zvočna zaščita** | 36 (-2;-5) dB |
| **Koeficient toplotne prevodnosti** | 0,77 W/m$^2$K |
| **"g" vrednost** | npd |
| **prepustnost svetlobe** | npd |
| **Prepustnost zraka** | 2 |

PIRNAR
AMAZING. AUDACIOUS. ADAMANT.

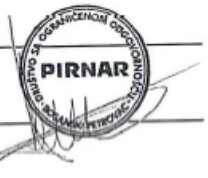
**9.** Lastnosti proizvoda, navedenega v točki 1, so v skladu z navedenimi lastnostmi iz točke 7.

Za izdajo izjave o lastnostih je odgovoren proizvajalec naveden v točki 3.

Podpisal za in v imenu proizvajalca:

Terzić Sandi
Ime in funkcija

18.05.2020
Kraj in datum



## 13 PRIMERI DOKAZIL ZA STREŠNO OKNO IN ELEMENT NODT Z USTREZNIMI ENERGIJSKIMI LASTNOSTMI

VELUX®

# IZJAVA O LASTNOSTIH

**No: GGL MK06 206221A 32BH08**

1. Enotna identifikacijska oznaka tipa proizvoda: GGL MK06 206221A 32BH08
2. Predvidena uporaba: Komunikacija na domačih in komercialnih lokacijah
3. Proizvajalec: VELUX A/S, Ådalsvej 99, DK-2970 Hørsholm, www.velux.com
5. Sistemi ocenjevanja in preverjanja nespremenljivosti lastnosti: Sistem 3
6. Harmonizirani standard: EN 14351-1:2006+A2:2016, Priglašeni organi: 0679, 0757, 0845, 1235*
7. Navedena lastnost:

| **Bistvene značilnosti** | **Lastnosti** | **§** | **NB*** |
|---|---|---|---|
| Odpornost na obremenitve z vetrom | razred C3 ** | 4.2 | 0757 |
| Odpornost proti obremenitvi s snegom | 8 mm toughened–10 mm–3 mm heat strengthened-10 mm-6,8 (33.2) laminated float heat strengthened | 4.3 | |
| Odziv na ogenj | razred E | 4.4.1 | 0845 |
| Zunanje ognjevarne lastnosti | NPD | 4.4.2 | |
| Vodotesnost | razred 9A | 4.5 | 0757 |
| Odpornost proti udarcu | razred 3 *** | 4.7 | 1235 |
| Nosilnost varnostnih naprav | passed | 4.8 | 1235 |
| Zvočna izolativnost | 40(-1;-4) dB | 4.11 | 0679 |
| Toplotna prehodnost | 0,83 W/m²K | 4.12 | 0757 |
| Prepustnost za sončno sevanje | 0,52 | 4.13 | 0757 |
| Prepustnost svetlobe | 0,70 | 4.13 | 0757 |
| Prepustnost zraka | razred 4 | 4.14 | 0757 |
| lastnost ni določena, passed: opravljeno<br>* Priglašeni organi: http://ec.europa.eu/growth/tools-databases/nando/<br>** Za širino okna > 1140 mm ali višino okna > 1398 mm: NPD<br>*** Za širino okna < 550 mm ali višino okna < 698 mm: NPD | | | |

Lastnosti proizvoda, navedenega zgoraj, so v skladu z navedenimi lastnostmi. Za izdajo te izjave o lastnostih je v skladu z Uredbo (EU) št. 305/2011 odgovoren izključno proizvajalec, naveden zgoraj.

Klaus Lorentzen, Vice President, Global Care & Cost
Ådalsvej 99, DK 2970 – Hørsholm, 2018-08-10

| CE 13 | **GGL MK06 206221A 32BH08**<br>Komunikacija na domačih in komercialnih lokacijah | Harmonizirani standard:<br>EN 14351-1:2006+A2:2016 | |
|---|---|---|---|
| **Bistvene značilnosti** | **Lastnosti** | **§** | **NB*** |
| Odpornost na obremenitve z vetrom | razred C3 ** | 4.2 | 0757 |
| Odpornost proti obremenitvi s snegom | 8 mm toughened–10 mm–3 mm heat strengthened-10 mm-6,8 (33.2) laminated float heat strengthened | 4.3 | |
| Odziv na ogenj | razred E | 4.4.1 | 0845 |
| Zunanje ognjevarne lastnosti | NPD | 4.4.2 | |
| Vodotesnost | razred 9A | 4.5 | 0757 |
| Odpornost proti udarcu | razred 3 *** | 4.7 | 1235 |
| Nosilnost varnostnih naprav | passed | 4.8 | 1235 |
| Zvočna izolativnost | 40(-1;-4) | 4.11 | 0679 |
| Toplotna prehodnost | 0,83 W/m$^2$K | 4.12 | 0757 |
| Prepustnost za sončno sevanje | 0,52 | 4.13 | 0757 |
| Prepustnost svetlobe | 0,70 | 4.13 | 0757 |
| Prepustnost zraka | razred 4 | 4.14 | 0757 |
| lastnost ni določena, passed: opravljeno<br>* Priglašeni organi: http://ec.europa.eu/growth/tools-databases/nando/<br>** Za širino okna > 1140 mm ali višino okna > 1398 mm: NPD<br>*** Za širino okna < 550 mm ali višino okna < 698 mm: NPD | | | |

# IZJAVA O LASTNOSTIH

**No: CSP 120120 1073Q 13BN03 + ISD 120120 0000**

1. Enotna identifikacijska oznaka tipa proizvoda: CSP 120120 1073Q 13BN03 + ISD 120120 0000
2. Predvidena uporaba: Prenos svetlobe za uporabo na ravnih in nagnjenih strehah zgradb + Prezračevalniki za odvod dima in toplote z naravnim prezračevanjem za nadzor dima in toplote pri gradbenih delih
3. Proizvajalec: VELUX A/S, Ådalsvej 99, DK-2970 Hørsholm, www.velux.com
5. Sistemi ocenjevanja in preverjanja nespremenljivosti lastnosti: Sistem 3 & 1
6. Harmonizirani standard: EN 1873:2005 (#1) + EN 12101-2:2003 (#2), Priglašeni organi: 1235, 0402, 0679, 0757, 0845 (#1) + 0402 (#2)[1]
7. Navedena lastnost:

| | **Essential characteristics** | **Performance** | **§** | **NB[1]** |
|---|---|---|---|---|
| #1 | Odpornost na največjo obremenitev | UL 1500 | 5.4.1 | 0402 |
| | Odpornost na najmanjšo obremenitev | DL 2500 | 5.4.2 | 0402 |
| | Odziv na ogenj | razred B-s1, d0 | 5.5 | 0845 |
| | Odpornost proti ognju | NPD | 5.6 | |
| | Zunanje ognjevarne lastnosti | NPD | 5.7 | |
| | Neprepustnost za vodo | passed | 5.3.1 | 0402 |
| | Odpornost proti udarcu - majhen trden predmet | passed | 5.4.3.1 | 0402 |
| | Odpornost proti udarcu - velik mehek predmet | SB 1200 | 5.4.3.2 | 0402 |
| | Neposredna izolirnost pred zvokom v zraku | 33 (-1;-4) dB | 5.10 | 0679 |
| | Toplotna prehodnost | 0.99 W/($m^2$K) [2] | 5.9.1 | 1235 |
| | Prepustnost svetlobe | 0.72 | 5.1 | 0757 |
| | Prepustnost zraka | razred 4 | 5.8.1 | 0402 |
| | Trajnost | NPD | 5.2 | |
| #2 | Nominalni sistem za aktiviranje/občutljivost | Passed | 4.1 + 4.2 | 0402 |
| | Zakasnitev odziva (odzivni čas) | < 60 s | 7.1.2 | 0402 |
| | Zanesljivost delovanja | Re1000 + 10000 | 7.1 | 0402 |
| | Aerodinamična površina $A_a$ [$m^2$] | 0.58 | 6 | 0402 |
| | Odpornost na toploto | B300 | 7.5 | 0402 |
| | Mehanska stabilnost | Passed | 7.5 | 0402 |
| | Odpiranje pod obremenitvijo | SL 500 | 7.2 | 0402 |
| | Nizka temperatura okolja | T(-15) | 7.3 | 0402 |
| | Stabilnost pod obremenitvijo z vetrom | WL 3000 | 7.4 | 0402 |
| | Odpornost na vibracije, ki jih povzroči veter (kjer so vključene) | - | 7.4 | |
| | Odziv na ogenj | class B-s1, d0 | 7.5.2.1 | 0402 |
| | lastnost ni določena, Passed: opravljeno<br>[1] Priglašeni organi: http://ec.europa.eu/growth/tools-databases/nando/<br>[2] Za referenčno velikost 1.2 x 1.2 m, 0° vgradnja, A: 3.4 $m^2$, v skladu z: EN 1873:2014+A1:2016 | | | |

Lastnosti proizvoda, navedenega zgoraj, so v skladu z navedenimi lastnostmi. Za izdajo te izjave o lastnostih je v skladu z Uredbo (EU) št. 305/2011 odgovoren izključno proizvajalec, naveden zgoraj.

Klaus Lorentzen, Vice President, Global Care & Cost
Ådalsvej 99, DK 2970 – Hørsholm, 2022-03-28

| CE 13 | **CSP 120120 1073Q 13BN03 + ISD 120120 0000**<br>Prenos svetlobe za uporabo na ravnih in nagnjenih strehah zgradb<br>Prezračevalniki za odvod dima in toplote z naravnim prezračevanjem za nadzor dima in toplote pri gradbenih delih | | **Harmonizirani standard:**<br>EN 1873:2005 (#1)<br>EN 12101-2:2003 (#2) |
|---|---|---|---|
| | **Essential characteristics** | **Performance** | **§** | **NB[1]** |
| #1 | Odpornost na največjo obremenitev | UL 1500 | 5.4.1 | 0402 |
| | Odpornost na najmanjšo obremenitev | DL 2500 | 5.4.2 | 0402 |
| | Odziv na ogenj | razred B-s1, d0 | 5.5 | 0845 |
| | Odpornost proti ognju | NPD | 5.6 | |
| | Zunanje ognjevarne lastnosti | NPD | 5.7 | |
| | Neprepustnost za vodo | passed | 5.3.1 | 0402 |
| | Odpornost proti udarcu - majhen trden predmet | passed | 5.4.3.1 | 0402 |
| | Odpornost proti udarcu - velik mehek predmet | SB 1200 | 5.4.3.2 | 0402 |
| | Neposredna izolirnost pred zvokom v zraku | 33 (-1;-4) dB | 5.10 | 0679 |
| | Toplotna prehodnost | 0.99 W/($m^2$K) [2] | 5.9.1 | 1235 |
| | Prepustnost svetlobe | 0.72 | 5.1 | 0757 |
| | Prepustnost zraka | razred 4 | 5.8.1 | 0402 |
| | Trajnost | NPD | 5.2 | |
| 2 | Nominalni sistem za aktiviranje/občutljivost | Passed | 4.1 + 4.2 | 0402 |
| | Zakasnitev odziva (odzivni čas) | < 60 s | 7.1.2 | 0402 |
| | Zanesljivost delovanja | Re1000 + 10000 | 7.1 | 0402 |
| | Aerodinamična površina $A_a$ [$m^2$] | 0.58 | 6 | 0402 |
| | Odpornost na toploto | B300 | 7.5 | 0402 |
| | Mehanska stabilnost | Passed | 7.5 | 0402 |
| | Odpiranje pod obremenitvijo | SL 500 | 7.2 | 0402 |
| | Nizka temperatura okolja | T(-15) | 7.3 | 0402 |
| | Stabilnost pod obremenitvijo z vetrom | WL 3000 | 7.4 | 0402 |
| | Odpornost na vibracije, ki jih povzroči veter (kjer so vključene) | - | 7.4 | |
| | Odziv na ogenj | class B-s1, d0 | 7.5.2.1 | 0402 |
| | lastnost ni določena, Passed: opravljeno<br>[1] Priglašeni organi: http://ec.europa.eu/growth/tools-databases/nando/<br>[2] Za referenčno velikost 1.2 x 1.2 m, 0° vgradnja, A: 3.4 $m^2$, v skladu z: EN 1873:2014+A1:2016 | | | |

Grafitni EPS na coklu

FRAGMAT

# TEHNIČNI LIST

## NEOCOKL

### Toplotnoizolacijski proizvod za stavbe

**Opis izdelka**

**NEOCOKL** je toplotnoizolacijska plošča iz ekspandiranega polistirena (EPS). Ne vsebuje freonov (CFC free / FCKW frei) in ne vsebuje HBCD.

**Lastnosti izdelka**

Izdelek ustreza zahtevam standarda SIST EN 13163:2013+ A1:2015,

- Format: 1000 x 500 x $d_N$ [mm]
- Opis: siva plošča, ravni robovi
- Temperaturna obstojnost (dolgotrajna): 80° C

CE-oznaka:

**EPS-EN 13163-L(2)-W(2)-T(2)-S(2)-P(5)-BS150-CS(10)100-DS(N)2-DS(70,-)1-TR150-WL(T)3**

| Bistvene značilnosti | EN Metoda | Enota | Deklarirano SIST EN 13163:2013+ A1:2015 |
|---|---|---|---|
| Dolžina | EN 822 | mm | ± 2 |
| Širina | EN 822 | mm | ± 2 |
| Debelina | EN 823 | mm | ± 2 |
| Pravokotnost | EN 824 | mm | ± 2 |
| Ravnost | EN 825 | mm | ± 5 |
| Upogibna trdnost | EN 12089 | kPa | ≥ 150 |
| Natezna trdnost | EN 1607 | kPa | ≥ 150 |
| Tlačna trdnost | EN 826 | kPa | ≥ 100 |
| Dimenzijska stabilnost pri konstantnih laboratorijskih pogojih | EN 1603 | % | ± 0.2 |
| Dimenzijska stabilnost pri 70° C | EN 1604 | % | ≤ 1 |
| Deformacija pri tlačni in temperaturni obremenitvi | EN 1605 | % | / |
| Vodovpojnost | EN12087 | % | ≤ 3 |
| Odziv na ogenj | EN 13501-1 | / | E |
| Toplotna prevodnost | EN 12667 | W/m.K | 0.031 |

| Debelina (mm) | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 90 | 100 | 110 | 120 | 130 | 140 | 150 | 155 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| R ($m^2K/W$) | 0,60 | 0,95 | 1,25 | 1,60 | 1,90 | 2,25 | 2,55 | 2,90 | 3,20 | 3,50 | 3,85 | 4,15 | 4,50 | 4,80 | 5,00 |
| λ/d ($W/m^2.K$) | 1,55 | 1,03 | 0,78 | 0,62 | 0,52 | 0,44 | 0,39 | 0,34 | 0,31 | 0,28 | 0,26 | 0,24 | 0,22 | 0,21 | 0,20 |

| Debelina (mm) | 160 | 170 | 180 | 190 | 200 | 210 | 220 | 230 | 240 | 250 | 260 | 270 | 280 | 290 | 300 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| R ($m^2K/W$) | 5,15 | 5,45 | 5,80 | 6,10 | 6,45 | 6,75 | 7,05 | 7,40 | 7,70 | 8,05 | 8,35 | 8,70 | 9,00 | 9,35 | 9,65 |
| λ/d ($W/m^2.K$) | 0,19 | 0,18 | 0,17 | 0,16 | 0,16 | 0,15 | 0,14 | 0,13 | 0,13 | 0,12 | 0,12 | 0,11 | 0,11 | 0,11 | 0,10 |

# XPS na vkopani steni, podzidku in tleh jaška

## IZJAVA O LASTNOSTIH

DoP-No.: N° INSES0103

| | | |
|---|---|---|
| 1. | Enotna identifikacijska oznaka tipa proizvoda | **FRAGMAT XPS 500 GL** |
| 2. | Predvidena uporaba gradbenega proizvoda | Toplotna izolacija za stavbe |
| 3. | Ime in naslov proizvajalca | SOPREMA – 14 rue de Saint-Nazaire, CS 60121, 67025 Strasbourg Cedex, Francija |
| 4. | Pooblaščeni zastopnik | FRAGMAT TIM d.o.o.<br>Spodnja Rečica 77, 3270 Laško |
| 5. | Sistem AVCP | sistem 3 |
| 6. | Harmonizirani standard,<br>Priglašeni organ | EN 13164:2012+A1:2015<br>1168; 1169; 1722; 0751; 0071; 0370; 1136; 1640 |

| 7. | Bistvene značilnosti | | Metode | Lastnosti |
|---|---|---|---|---|
| | Toplotna upornost - $R_D$ | Toplotna prevodnost $\lambda_D$ | EN 12667 | $\lambda_D$ W/(m.K) $d_N$ mm $R_D$ m².K/W<br>0,033 40-60 1,20 – 1,80<br>0,035 65-200 1,85 – 5,70<br>0,036 210-300 5,80 – 8,30 |
| | | Debelina - $d_N$ | EN 823 | T1 |
| | Reakcija na ogenj | Reakcija na ogenj | EN 13501-1 | E |
| | Trajnost odziva na ogenj glede na vročino, vpliv vremenskih razmer, staranje/razkroj | Lastnost (a) | EN 13501-1 | E |
| | Trajnost toplotne prehodnosti na vročino, vpliv vremenskih razmer, staranje/razkroj | Toplotna upornost in toplotna prevodnost (b) | EN 12667 | $\lambda_D$ W/(m.K) $d_N$ mm $R_D$ m².K/W<br>0,033 40-60 01,20 – 1,80<br>0,035 65-200 1,85 – 5,70<br>0,036 210-300 5,80 – 8,30 |
| | | Lastnost | / | DS(70,90) |
| | | Odpornost na zmrzovanje/odtaljevanje | EN 12091 | FTCD1 |
| | Tlačna trdnost | Tlačna trdnost pri 10% deformaciji (c) | EN 826 | CS(10/Y)500 |
| | Natezna trdnost | Natezna trdnost pravokotno na površino | EN 1607 | TR200 |
| | Tlačna trdnost glede na staranje/razkroj | Lezenje pod tlačno obremenitvijo | EN 1606 | CC(2/1,5/50)180 |
| | Prepustnost vlage | Dolgotrajno vpijanje vode pri popolno potopitvi | EN 12087 | WL(T)0,7 |
| | | Dolgotrajno vpijanje vode z difuzijo vodne pare | EN 12088 | WD(V)3 (40-55 mm)<br>WD(V)2 (60-95 mm)<br>WD(V)1 (100-300 mm) |
| | Prepustnost za vodno paro | Upornost difuziji vodne pare | EN 12086 | MU150 |
| | Emisije nevarnih snovi v zgradbah | Izpust nevarnih snovi (d) | / | (d) |
| | Neprekinjeno tlenje | Neprekinjeno tlenje (d) | / | (d) |

NPD = lastnost ni deklarirana
(a) polarna odpornost proizvodov iz XPS-a se s časom ne spreminja
(b) samo za dimenzijsko stabilne debeline
(c) ta karakteristika zajema tudi izvedbo in montažo
(d) enotna Evropska metoda preizkusa je v pripravi
(e) veljavno in primerno tudi za uporabo v večslojih

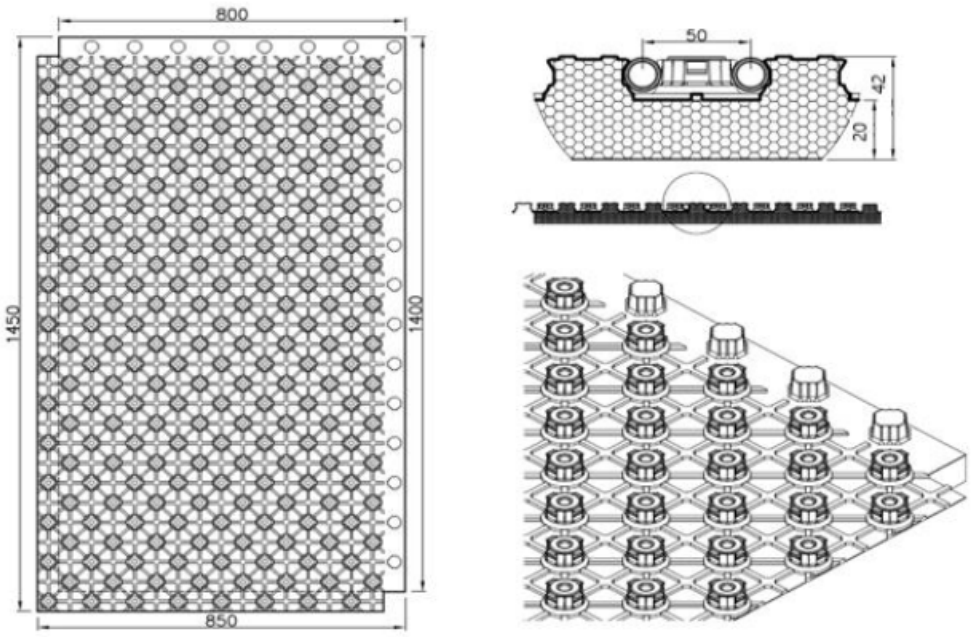
*Lastnosti zgoraj navedenega proizvoda so skladne z deklariranimi lastnostmi. Za izdajo te izjave v skladu z uredbo (EU) št. 305/2011 je odgovoren izključno proizvajalec naveden na začetku dokumenta*

Podpisal za in v imenu proizvajalca

Tehnični direktor
Rok Žgajnar

Laško, 1. 2. 2021

# STIROTERMAL DUO 20




| TEHNIČNI PODATKI- *TECHNISCHE DATEN- TECHNICAL DATA* | |
|---|---|
| Premer cevi – *Rohrdurchmesser* – Pipe diameter: | **14-18 mm** |
| Razdalja med cevmi – *Verlegeabstand* – Pipe spacing: | **50, 100, 150, 200 mm** |
| Izolacijski material – *Dämmstoff* – Insulation material: | **EPS** |
| Oznaka – *Bezeichnung* – Designation: | **EPS-EN 13163-L(3)-W(3)-T(2)-S(5)-P(10)-BS250-CS(10)150-DS(N)5** |
| Koristna velikost – *Nutzgröße* – Usable size: | **1400 x 800 mm** |
| Koristna površina – *Nutzoberfläche* – Usable surface: | **1.12 m²** |
| Skupna velikost – *Gesamtgröße* – Total size: | **1450 x 850 mm** |
| Skupna debelina – *Gesamtdicke* – Total tickness: | **42 mm** |
| Skupna debelina izolacije – *Gesamtisolationdicke* – Total insulation tickness: | **20 mm** |
| Koeficient toplotne prevodnosti – *Wärmeleitfähigkeit* – Thermal resistance factor: | **0.034 W/mK** |
| Toplotna upornost plošče – *Wärmedurchlasswiderstand* – Heat admission resistance: | **0.55 m²K/W** |
| Tlačna trdnost (10% def.) – *Drückspanung (bei 10% Stauchung)* – Compressive stress (10 % def.): | **≥ 150 kPa** |
| Dovoljena obtežba – *Zuläsige Druckbelastbarkeit* – Acceptable load: | **30kPa≈ 3000 kg/m²** |
| Temp. obstojnost oblike – *Wärmeformbeständigkeit* – Heat form resistance: | **80 °C** |
| Razred gorljivosti – *Brandverhalten* – Fire classification – EN 13501-1 / DIN 4102: | **E/ B1** |
| Folija (material, debelina) – *Folie (Stoff, Dicke)* – Foil (material, tickness): | **PS 0.6 mm** |
| Barva folije – *Folienfarben* – Foil colour: | **črna- schwarz- black** |
| Prekrivanje folije – *Folienüberlappung* – Foil overlap: | **50 mm** |
| Pakiranje kartonska škatla [kos] – *Verpackung Karton [Stück]* – Packaging carton box [pcs]- **1510x 865x 315 mm** | **10→ 11.2 m²** |

**Izdelek je v skladu z EN 131363:2013+A1:2015 in Uredbo (EU) št.305/2011. Izjava o lastnostih* ***DoP-01-TI- 114 / 24 - 01***

# TEHNIČNI LIST

## FRAGMAT NEO SUPER 100 (W 20 plus)

### Toplotnoizolacijski proizvod za stavbe

**Opis izdelka**

**FRAGMAT NEO SUPER 100 (W 20 plus)** je toplotnoizolacijska plošča iz ekspandiranega polistirena (EPS). Ne vsebuje freonov (CFC free / FCKW frei) in ne vsebuje HBCD.

**Lastnosti izdelka**

Izdelek ustreza zahtevam standarda SIST EN 13163:2013+ A1:2015, ÖNORM B 6000: 2018

- Format: od (von/from/da) 1000 x 500 x $d_N$ (mm) do (bis/up to/a) 4000 mm x 1600 mm x 1000 mm
- Opis: siva plošča*, ravni robovi
- Temperaturna obstojnost: kratkotrajna 80° C, dolgotrajna 70° C

baubook deklariert und validiert

CE-oznaka:

**EPS-EN 13163-L(3)-W(3)-T(2)-S(5)-P(5)-BS150-CS(10)100-DS(N)5-DS(70,-)3-DLT(1)5**

| Bistvene značilnosti | EN Metoda | Enota | Deklarirano SIST EN 13163:2013+ A1:2015 |
|---|---|---|---|
| Dolžina | EN 822 | mm | ± 3 |
| Širina | EN 822 | mm | ± 3 |
| Debelina | EN 823 | mm | ± 2 |
| Pravokotnost | EN 824 | mm | ± 5 |
| Ravnost | EN 825 | mm | ± 5 |
| Upogibna trdnost | EN 12089 | kPa | ≥ 150 |
| Natezna trdnost | EN 1607 | kPa | / |
| Tlačna trdnost | EN 826 | kPa | ≥ 100 |
| Dimenzijska stabilnost pri konstantnih laboratorijskih pogojih | EN 1603 | % | ± 0.5 |
| Dimenzijska stabilnost pri 70° C | EN 1604 | % | ≤ 3 |
| Deformacija pri tlačni in temperaturni obremenitvi | EN 1605 | % | ≤ 5 |
| Vodovpojnost | EN12087 | % | / |
| Odziv na ogenj | EN 13501-1 | / | E |
| Toplotna prevodnost | EN 12667 | W/m.K | 0.031 |

* Zaradi tehnologije izdelave je lahko do 2% površine drugače obarvane

| | |
|---|---|
| Dovoljena tlačna obremenitev: | 0,02 N/mm² = 2 t/m² |
| Linearni temperaturni razteznostni faktor: | 0,05 – 0,07 mm/mK |
| Faktor parapropustnosti: | 30 – 70 |
| Modul elastičnosti: | 6,0 N/mm² = 6000 kPa |

KNAUFINSULATION

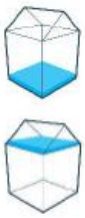
www.knaufinsulation.com

# Knauf Insulation DF

**Tehnični list / Januar 2023**



## UPORABA



## OPIS PRODUKTA

Knauf Insulation DF so talne izolacijske plošče iz kamene volne namenjene za toplotno, zvočno in požarno zaščito talnih konstrukcij. Namenjene so predvsem za toplotno zaščito zadnjih stropnih plošč na neogrevanih podstrešjih za primere pohodnih izvedb. Preko njih lahko neposredno položimo različne vrste pohodnih oblog ali zaščitni betonski estrih. Dimenzije plošč so 1000 x 600 mm in so na voljo v debelinah 100 mm, 120 mm in 150 mm.

**Oznaka po SIST EN 13162:**

**MW-EN 13162-T5-CS(10)30-WS-MU1**

## LASTNOSTI

**Toplotna izolativnost**

Toplotna prevodnost λ: **0.037 W/mK**

**Odziv na ogenj**

Razred gorljivosti: **A1**

**Mehanska odpornost**

Tlačna trdnost CS(10): **≥ 30 kPa**

## PREDNOSTI

- Odlična toplotna izolativnost
- Visoka požarna in zvočna zaščita
- Odlične mehanske lastnosti
- Enostavna in hitra vgradnja
- Kemijska nevtralnost in odpornost na mikroorganizme

## DIMENZIJE IN TOPLOTNE LASTNOSTI

| Debelina (mm) | Toplotna prevodnost λ (W/mK) | Toplotna upornost R (m²K/W) | Dolžina (mm) | Širina (mm) | Kosov plošč na paket | Površina na paket (m²) | Površina na paleto (m²) |
|---|---|---|---|---|---|---|---|
| 100 | 0.037 | 2.70 | 1000 | 600 | 3 | 1.80 | 28.80 |
| 120 | 0.037 | 3.20 | 1000 | 600 | 3 | 1.80 | 21.60 |
| 150 | 0.037 | 4.05 | 1000 | 600 | 2 | 1.20 | 21.60 |

TEHNIČNI LIST/19-02

FRAGMAT

# NEOCOKL

## Toplotnoizolacijski proizvod za stavbe

### Opis izdelka

**NEOCOKL** je toplotnoizolacijske plošča iz ekspandiranega polistirena (EPS). Ne vsebuje freonov (CFC free / FCKW frei).

### Lastnosti izdelka

CE 11

**NEOCOKL** ustreza zahtevam standarda SIST EN 13163.

- Format: 1000 x 500 x $d_N$ [mm]
- Izvedba: Ravni robovi
- Temperaturna obstojnost (dolgotrajna): 80° C

Kodna oznaka:

EPS-EN 13163-L(2)-W(2)-T(2)-S(2)-P(5)-BS150-CS(10)100-DS(N)2-DS(70,-)1-TR150-WL(T)3

| Bistvene značilnosti | EN Metoda | Enota | Deklarirano EN 13163:2012+A1:2015 |
|---|---|---|---|
| Dolžina | EN 822 | mm | ± 2 |
| Širina | EN 822 | mm | ± 2 |
| Debelina | EN 823 | mm | ± 2 |
| Pravokotnost | EN 824 | mm | ± 2 |
| Ravnost | EN 825 | mm | ± 5 |
| Upogibna trdnost | EN 12089 | kPa | ≥ 150 |
| Natezna trdnost | EN 1607 | kPa | ≥ 150 |
| Tlačna trdnost | EN 826 | kPa | ≥ 100 |
| Dimenzijska stabilnost pri konst. nor. lab. pogojih | EN 1603 | % | ± 0,2 |
| Dimenzijska stabilnost pri 70° C | EN 1604 | % | ≤ 1 |
| Dolgotrajno vpijanje vode pri popolni potopitvi | EN 12087 | % | ≤ 3 |
| Odziv na ogenj | EN 13501-1 | / | E |
| Toplotna prevodnost | EN 12667 | W/m.K | 0,031 |

| Debelina izolacije (mm) | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 90 | 100 | 110 | 120 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| R ($m^2K/W$) | 0,60 | 0,95 | 1,25 | 1,60 | 1,90 | 2,25 | 2,55 | 2,90 | 3,20 | 3,50 | 3,85 |
| λ/d ($W/m^2.K$) | 1,55 | 1,03 | 0,78 | 0,62 | 0,52 | 0,44 | 0,39 | 0,34 | 0,31 | 0,28 | 0,26 |

| Debelina izolacije (mm) | 125 | 130 | 135 | 140 | 150 | 160 | 170 | 180 | 200 | 220 | 250 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| R ($m^2K/W$) | 4,00 | 4,15 | 4,35 | 4,50 | 4,80 | 5,15 | 5,45 | 5,80 | 6,45 | 7,05 | 8,05 |
| λ/d ($W/m^2.K$) | 0,24 | 0,24 | 0,23 | 0,22 | 0,21 | 0,19 | 0,18 | 0,17 | 0,16 | 0,14 | 0,12 |

### Področje uporabe

Izdelek **NEOCOKL** se uporablja za toplotno izolacijo podzidka fasade nad nivojem zasutja, izolacijo robov AB plošč, preklad ter balkonov.

### Način vgradnje

Toplotno izolacijske plošče **NEOCOKL** se glede na način uporabe vgrajujejo z lepljenjem, mehanskim pritrjevanjem ali se prosto polagajo. Pri vgradnji je potrebno upoštevati navodila za vgradnjo ter veljavne strokovne in zakonske predpise.

### Skladiščenje

Zavitke je potrebno skladiščiti na suhi podlagi in jih zaščititi pred neposrednim sončnim sevanjem, vlago, zmrzaljo in snegom, mehanskimi poškodbami, umazanijo ter pred plamenom. Potrebno je preprečiti stik z nezdružljivimi materiali/kemikalijami.

### Pakiranje

Pakirano v PE folijo ca. 0,25 $m^3$, paletirano ca. 5 $m^3$.

### Ravnanje z odpadki

Z odpadnim izdelkom je potrebno ravnati v skladu z Uredbo o odpadkih. Ostanek oziroma odpadek izdelka se razvršča kot nenevarni odpadek in sicer kot gradbeni odpadek-plastika (17 02 03). Odpadna folija in EPS sodi med odpadno plastično embalažo (15 01 02) oziroma je potrebno ravnati v skladu Uredbo o ravnanju z embalažo in z odpadno embalažo.

### Certifikati

FIW München

PTD (ITT) na Inštitutu FIW München. Izdelek je v skladu z **EN 13163:2012+A1:2015** in **Uredbo (EU) št. 305/2011.** Sistem kakovosti in ravnanja z okoljem je v skladu z SIST EN ISO 9001 in SIST EN ISO 14001.

KNAUF INSULATION

www.knaufinsulation.com

# Knauf Insulation FKD-N Thermal

**Tehnični list / avgust 2020**



## UPORABA



## OPIS PRODUKTA

Knauf Insulation FKD-N Thermal so fasadno izolacijske plošče iz kamene volne namenjene za vgradnjo v kontaktnih toplotno izolacijskih fasadnih sistemih. Plošče odlikuje odlična toplotna prevodnost, priročne dimenzije ter dobre mehanske lastnosti. V prvi vrsti so namenjene energetskim sanacijam starejših objektov, uporabljajo se za toplotno izolacijsko oblogo na eno in več stanovanjskih objektih.

**Oznaka po SIST EN 13162:**

**MW-EN 13162-T5-CS(10)25-TR7,5-WS-WL(P)-MU1**

## LASTNOSTI

**Toplotna izolativnost**

| | |
|---|---|
| Toplotna prevodnost λ: | 0.034 W/mK |

**Odziv na ogenj**

| | |
|---|---|
| Razred gorljivosti: | A1 |

**Paropropustnost**

| | |
|---|---|
| Difuzijski upor vodni pari μ: | 1 |

**Mehanska odpornost**

| | |
|---|---|
| Razplastna trdnost TR | ≥ 7,5 kPa |

## PREDNOSTI

- Visoka požarna zaščita
- Odlična toplotna izolativnost
- Odlična zvočna zaščita
- Dobre mehanske lastnosti
- Visoka paropropustnost
- Kemijska nevtralnost in odpornost na mikroorganizme

## DIMENZIJE IN TOPLOTNE LASTNOSTI

| Debelina (mm) | Toplotna prevodnost λ (W/mK) | Toplotna upornost R (m²K/W) | Dolžina (mm) | Širina (mm) | Paketov na paleto | Površina na paleto (m²) |
|---|---|---|---|---|---|---|
| 50 | 0.034 | 1.45 | 1000 | 600 | 24 | 115.20 |
| 60 | 0.034 | 1.75 | 1000 | 600 | 28 | 100.80 |
| 80 | 0.034 | 2.35 | 1200 | 400 | 15 | 38.40 |
| 100 | 0.034 | 2.90 | 1200 | 400 | 15 | 28.80 |
| 120 | 0.034 | 3.50 | 1200 | 400 | 15 | 21.60 |
| 140 | 0.034 | 4.10 | 1200 | 400 | 15 | 21.60 |
| 150 | 0.034 | 4.40 | 1200 | 400 | 20 | 19.20 |
| 160 | 0.034 | 4.70 | 1200 | 400 | 20 | 19.20 |
| 180 | 0.034 | 5.25 | 1200 | 400 | 15 | 14.40 |
| 200 | 0.034 | 5.85 | 1200 | 400 | 15 | 14.40 |
| 220 | 0.034 | 6.45 | 1200 | 400 | 15 | 14.40 |
| 240 | 0.034 | 7.05 | 1000 | 600 | 44 | 26.40 |

Tehnični list SmartRoof Thermal

08/2024

# Knauf Insulation SmartRoof Thermal

## Opis produkta

**Knauf Insulation SmartRoof Thermal** so trde strešne plošče iz kamene volne, ki se zaradi svojih odličnih tehničnih lastnosti uporabljajo kot toplotna, zvočna in požarna izolacija v sistemih toplih zatesnjenih ravnih streh. Vgrajujejo se kot podložne plošče v kombinaciji s ploščami SmartRoof Top ali SmartRoof Hard. Plošče zaradi nekoliko nižje volumske mase odlikuje odlična toplotna izolativnost in lažja manipulacija pri vgradnji. Polagamo jih lahko na betonske konstrukcije ali profilirano trapezno pločevino..



## Lastnosti

- **Toplotna izolativnost:** Toplotna prevodnost $\lambda_d$ = 0,036 W/mK
- **Odziv na ogenj:** Razred gorljivosti A1
- **Mehanska odpornost:** Tlačna trdnost CS(10): ≥ 50 kPa
- **Paropropustnost:** Difuzijski upor vodni pari μ = 1

## Prednosti

- Visoka požarna zaščita
- Odlična toplotna izolativnost
- Visoka toplotna in dimenzijska stabilnost
- Visoka paropropustnost
- Dobre mehanske lastnosti
- Kemijska nevtralnost in odpornost na staranje

## Uporaba



## Standard

**Oznaka po SIST EN 13162:**
MW-EN 13162-T5-CS(10)50-TR10-PL(5)500-WS-WL(P)-MU1

## Izjava o lastnostih (DoP):

DOP šifra: R4308 KPCPR

## Certifikati

## Dimenzije in toplotne lastnosti

| Debelina | Toplotna prevodnost λ | Toplotna upornost R | Dolžina | Širina | Paketi | Površina na paleto |
|---|---|---|---|---|---|---|
| (mm) | (W/mK) | (m²K/W) | (mm) | (mm) | na paleto | na paleto (m²) |
| 60 | 0,036 | 1,65 | 1200 | 2000 | 22 | 52,80 |
| 80 | 0,036 | 2,20 | 1200 | 2000 | 16 | 38,40 |
| 100 | 0,036 | 2,75 | 1200 | 2000 | 13 | 31,20 |
| 120 | 0,036 | 3,30 | 1200 | 2000 | 11 | 26,40 |
| 140 | 0,036 | 3,85 | 1200 | 2000 | 9 | 21,60 |
| 150 | 0,036 | 4,15 | 1200 | 2000 | 8 | 19,20 |
| 160 | 0,036 | 4,40 | 1200 | 2000 | 8 | 19,20 |
| 180 | 0,036 | 5,00 | 1200 | 2000 | 7 | 16,80 |
| 200 | 0,036 | 5,55 | 600 | 2000 | 12 | 14,40 |

# Knauf Insulation SmartRoof Top

## Opis produkta

**Knauf Insulation SmartRoof Top** so trde strešne plošče iz kamene volne, ki se zaradi svojih odličnih tehničnih lastnosti uporabljajo kot toplotna, zvočna in požarna izolacija v sistemih toplih zatesnjenih ravnih streh. Vgrajujejo se lahko samostojno ali kot zgornji sloj v kombinaciji s podložnimi ploščami SmartRoof Thermal. Plošče imajo zaradi višje volumske mase odlične mehanske lastnosti. Polagamo jih lahko na betonske konstrukcije ali profilirano trapezno pločevino.



## Lastnosti

- **Toplotna izolativnost:** Toplotna prevodnost $\lambda_d$ = 0,038 W/mK
- **Odziv na ogenj:** Razred gorljivosti A1
- **Mehanska odpornost:** Tlačna trdnost CS(10): ≥ 70 kPa
- **Paropropustnost:** Difuzijski upor vodni pari μ = 1

## Prednosti

- Visoka požarna zaščita
- Odlična toplotna izolativnost
- Visoka toplotna in dimenzijska stabilnost
- Visoka paropropustnost
- Odlične mehanske lastnosti
- Kemijska nevtralnost in odpornost na staranje

## Uporaba



## Standard

**Oznaka po SIST EN 13162:**
MW-EN 13162-T5-CS(10)70-TR10-PL(5)650-WS-WL(P)-MU1

## Izjava o lastnostih (DoP):

DOP šifra: R4308 IPCPR

## Certifikati

## Dimenzije in toplotne lastnosti

| Debelina | Toplotna prevodnost λ | Toplotna upornost R | Dolžina | Širina | Paketi | Površina na paleto |
|---|---|---|---|---|---|---|
| (mm) | (W/mK) | (m²K/W) | (mm) | (mm) | na paleto | na paleto (m²) |
| 40 | 0,038 | 1,05 | 1200 | 2000 | 32 | 76,80 |
| 50 | 0,038 | 1,30 | 1200 | 2000 | 26 | 62,40 |
| 60 | 0,038 | 1,55 | 1200 | 2000 | 22 | 52,80 |
| 80 | 0,038 | 2,10 | 1200 | 2000 | 16 | 38,40 |
| 100 | 0,038 | 2,60 | 1200 | 2000 | 13 | 31,20 |
| 120 | 0,038 | 3,15 | 1200 | 2000 | 11 | 26,40 |
| 140 | 0,038 | 3,65 | 1200 | 2000 | 9 | 21,60 |
| 150 | 0,038 | 3,90 | 1200 | 2000 | 8 | 19,20 |
| 160 | 0,038 | 4,20 | 1200 | 2000 | 8 | 19,20 |

# Knauf Insulation SmartRoof Top CTF1

## Opis produkta

**Knauf Insulation SmartRoof Top CTF1** so naklonske trde strešne plošče iz kamene volne, ki se v toplih zatesnjenih ravnih strehah uporabljajo za zagotavljanje odvodnjavanja meteornih voda. Uporabljajo se v kombinaciji s podložnimi ploščami SmartRoof Top, SmartRoof Hard in SmartRoof 1000 All-Fix. Poleg odvodnjavanja zagotavljajo toplotno, požarno in zvočno izolacijo v sestavi ravne strehe. Plošče izdelujemo v naklonih od 1 % do 3 % v debelinah od 20 mm do 160 mm.



## Lastnosti

- **Toplotna izolativnost:** Toplotna prevodnost $\lambda_d$ = 0,040 W/mK
- **Odziv na ogenj:** Razred gorljivosti A1
- **Mehanska odpornost:** Tlačna trdnost CS(10): ≥ 60 kPa
- **Paropropustnost:** Difuzijski upor vodni pari $\mu$ = 1

## Prednosti

- Visoka požarna zaščita
- Dobra toplotna izolativnost
- Visoka toplotna in dimenzijska stabilnost
- Visoka paropropustnost
- Dobre mehanske lastnosti
- Kemijska nevtralnost in odpornost na staranje

## Uporaba

## Standard

**Oznaka po SIST EN 13162:**
MW-EN 13162-T5-CS(10)60-TR10-PL(5)600-WS-MU1

## Izjava o lastnostih (DoP):

DOP šifra: R4309 GPCPR

## Certifikati

## Dimenzije in toplotne lastnosti

| Debelina | Toplotna prevodnost λ | Toplotna upornost R | Dolžina | Širina | Paketi | Površina na paleto |
|---|---|---|---|---|---|---|
| (mm) | (W/mK) | (m²K/W) | (mm) | (mm) | na paleto | na paleto (m²) |
| 20 - 160 | 0,040 | 0,50 - 4,00 | 1000 | 1000 | po dogovoru | po dogovoru |

KNAUFINSULATION

www.knaufinsulation.com

# Knauf Insulation AKUSTIK ROLL

**Tehnični list / Februar 2021**




## UPORABA



## OPIS PRODUKTA

Izolacijski filc iz mineralne steklene volne AKUSTIK ROLL se dobavlja v obliki rol standardnih dimenzij. Izdelan je po novi Ecose® tehnologiji z vezivi na bio osnovi in vsebuje več kot 70% recikliranega stekla. Proizvod je negorljiv, kemijsko nevtralen, vlaknasta struktura materiala poleg odlične toplotne izolativnosti, zagotavlja zelo dobro zvočno zaščito.

**Oznaka po SIST EN 13162:**

**MW-EN 13162-T2-AF5-MU1**

## LASTNOSTI

### Toplotna izolativnost

| | |
|---|---|
| Toplotna prevodnost λ: | **0.039 W/mK** |

### Odziv na ogenj

| | |
|---|---|
| Razred gorljivosti: | **A1** |

### Paropropustnost

| | |
|---|---|
| Difuzijski upor vodni pari μ: | **1** |

### Zvočna izolativnost

| | |
|---|---|
| Upornost zračnemu toku AF: | **≥ 5 kPa.s/m²** |

## PREDNOSTI

- ✓ Visoka požarna zaščita
- ✓ Odlična zvočna izolativnost
- ✓ Dobra toplotna izolativnost
- ✓ Dimenzijska stabilnost izolacije
- ✓ Enostavna in prijetna za vgradnjo
- ✓ Izboljšuje kakovost zraka v prostoru

## DIMENZIJE IN TOPLOTNE LASTNOSTI

| Debelina | Toplotna prevodnost λ | Toplotna upornost R | Kosov na paket x Dolžina | Širina | Paketov | Količina | Količina |
|---|---|---|---|---|---|---|---|
| (mm) | (W/mK) | (m²K/W) | (mm) | (mm) | na paleto | na paket (m²) | na paleto (m²) |
| 50 | 0.039 | 1.25 | 4 x 7000 | 625 | 24 | 17.50 | 420.00 |
| 75 | 0.039 | 1.90 | 4 x 4600 | 625 | 24 | 11.50 | 276.00 |
| 100 | 0.039 | 2.55 | 2 x 7000 | 625 | 24 | 8.75 | 210.00 |

**KRONOTERM Produktni list**
Sistem ADAPT$^{MAX}$



| NAPRAVA | Enota | ADAPT$^{MAX}$ 10035 | ADAPT$^{MAX}$ 10070 | ADAPT$^{MAX}$ 10105 | ADAPT$^{MAX}$ 10140 |
|---|---|---|---|---|---|
| **SEZONSKA ENERGIJSKA UČINKOVITOST PRI OGREVANJU PROSTOROV PO UREDBI (EU) 811/2013 – PODATKOVNI LIST** | | | | | |
| Temperaturni režim | °C | 35 / 55 | 35 / 55 | 35 / 55 | 35 / 55 |
| Razred sezonske energijske učinkovitosti | | A+++ / A+++ | A+++ / A+++ | A+++ / A+++ | A+++ / A+++ |
| Nazivna izhodna toplotna moč Pdesignh, povprečno klimatsko področje | kW | 27 / 27 | 53 / 53 | 80 / 80 | 106 / 106 |
| Sezonska energijska učinkovitost ogrevanja prostorov ηs, povprečno klimatsko področje | % | 230 / 171 | 229 / 171 | 229 / 171 | 229 / 171 |
| Letna poraba energije, povprečno klimatsko področje | kWh | 9406 / 12562 | 18854 / 25178 | 28316 / 38081 | 37765 / 50814 |
| Raven zvočne moči $L_{WA}$, notranja | dB | - | - | - | - |
| Nazivna izhodna toplotna moč Pdesign, hladno klimatsko področje | kW | 31 / 31 | 62 / 62 | 94 / 93 | 125 / 125 |
| Nazivna izhodna toplotna moč toplota Pdesign, toplo klimatsko področje | kW | 32 / 32 | 64 / 64 | 97 / 96 | 129 / 128 |
| Sezonska energijska učinkovitost ogrevanja prostorov ηs, hladno klimatsko področje | % | 193 / 150 | 193 / 150 | 193 / 149 | 193 / 149 |
| Sezonska energijska učinkovitost ogrevanja prostorov ηs, toplo klimatsko področje | % | 303 / 216 | 302 / 216 | 302 / 216 | 302 / 216 |
| Letna poraba energije, toplo klimatsko področje | kWh | 15514 / 20008 | 31386 / 40095 | 47153 / 60264 | 62827 / 81016 |
| Letna poraba energije, toplo klimatsko področje | kWh | 5632 / 7796 | 11359 / 15635 | 16924 / 23466 | 22623 / 31288 |
| Raven zvočne moči $L_{WA}$, zunanja | dB | 49 / 50 | 52 / 53 | 54 / 55 | 55 / 56 |
| **SEZONSKA ENERGIJSKA UČINKOVITOST PRI OGREVANJEU PROSTOROV PO UREDBI (EU) 811/2013 – PODATKOVNI LIST ZA KOMPLETE GRELNIKOV PROSTORA** | | | | | |
| Model krmilnika | | KSM | KSM | KSM | KSM |
| Temperaturni režim | °C | 35 / 55 | 35 / 55 | 35 / 55 | 35 / 55 |
| Razred krmilnika za uravnavanje temperature | | VI | VI | VI | VI |
| Prispevek krmilnika za uravnavanje temperature k sezonski učinkovitosti | % | 4,0 | 4,0 | 4,0 | 4,0 |
| Razred sezonske energijske učinkovitosti za komplete grelnikov prostora | | A+++ / A+++ | A+++ / A+++ | A+++ / A+++ | A+++ / A+++ |
| Sezonska energijska učinkovitost ogrevanja prostorov ηs kompleta grelnika prostorov, povprečno klimatsko področje | % | 234 / 175 | 233 / 175 | 233 / 175 | 233 / 175 |
| Sezonska energijska učinkovitost ogrevanja prostorov ηs kompleta grelnika prostorov, hladno klimatsko področje | % | 197 / 154 | 197 / 154 | 197 / 153 | 197 / 153 |
| Sezonska energijska učinkovitost ogrevanja prostorov ηs kompleta grelnika prostorov, toplo klimatsko področje | % | 307 / 220 | 306 / 220 | 306 / 220 | 306 / 220 |
| **SEZONSKA ZMOGLJIVOST V REŽIMU OGREVANJA PO EN 14825** | | | | | |
| Nazivna izhodna toplotna moč $P_{designh}$ 35 °C / 55 °C – povprečno klimatsko področje | kW / kW | 27 / 27 | 53 / 53 | 80 / 80 | 106 / 106 |
| SCOP, 35 °C/55 °C – povprečno klimatsko področje | | 5,82 / 4,36 | 5,81 / 4,35 | 5,80 / 4,34 | 5,80 / 4,34 |
| Nazivna izhodna toplotna moč $P_{designh}$ 35 °C/55 °C – toplo klimatsko področje | kW / kW | 32 / 32 | 64 / 64 | 97 / 96 | 129 / 128 |
| SCOP, 35 °C/55 °C – toplo klimatsko področje | | 7,64 / 5,48 | 7,62 / 5,47 | 7,62 / 5,47 | 7,62 / 5,47 |
| Nazivna izhodna toplotna moč $P_{designh}$ 35 °C/55 °C – hladno klimatsko področje | kW / kW | 31 / 31 | 62 / 62 | 94 / 93 | 125 / 125 |
| SCOP, 35 °C/55 °C – hladno klimatsko področje | | 4,91 / 3,82 | 4,90 / 3,81 | 4,89 / 3,80 | 4,89 / 3,80 |
| **SEZONSKA ZMOGLJIVOST V REŽIMU OGREVANJA PO EN 14825** | | | | | |
| Nazivna izhodna hladilna moč $P_{designc}$ 7°C/18°C | kW / kW | 30 / 30 | 61 / 60 | 91 / 90 | 121 / 120 |
| SEER, 7°C / 18°C | | 5,43 / 8,01 | 5,41 / 8,00 | 5,41 / 7,98 | 5,41 / 7,98 |

| NAPRAVA | Enota | ADAPT$^{MAX}$ 10035 | ADAPT$^{MAX}$ 10070 | ADAPT$^{MAX}$ 10105 | ADAPT$^{MAX}$ 10140 |
|---|---|---|---|---|---|
| **ELEKTRIČNI PODATKI*** | | | | | |
| **ELEKTRIČNI PODATKI** | | | | | |
| Nazivna napetost | V/Hz | 3N~400; 50 | 3N~400; 50 | 3N~400; 50 | 3N~400; 50 |
| Max. obratovalni tok | A | 24,9 | 49,8 | 74,7 | 99,6 |
| Max prikl. električna moč | kW | 16,4 | 32,8 | 49,2 | 56,6 |
| Varovalke | A | 3 x 25 | 3 x 50 | 3 x 80 | 3 x 100 |
| Napajalni električni kabel*** | mm² | 5 x 6 (H05VV-F) | 5 x 16 (Baker) | 5 x 25 (Baker) | 5 x 35 (Baker) |
| **KOMUNIKACIJA** | | | | | |
| Povezava med zunanjo in notranjo enoto | | FTP 5e kabel / 2x2x0,6 mm² (LiYCY) | 2x FTP 5e kabel / 2x2x0,6 mm² (LiYCY) | 3x FTP 5e kabel / 2x2x0,6 mm² (LiYCY) | 4x FTP 5e kabel / 2x2x0,6 mm² (LiYCY) |
| **HLADILNIŠKI SISTEM** | | | | | |
| Hladivo – vrsta | | R290 | R290 | R290 | R290 |
| Hladivo - industrijsko poimenovanje | | HC-290 (R290) | HC-290 (R290) | HC-290 (R290) | HC-290 (R290) |
| GWP hladiva (potencial globalnega segrevanja hladiva) | | 0,02 | 2x 0,02 | 3x 0,02 | 4x 0,02 |
| Skupni $CO_2$ ekvivalent napolnjenega hladiva | | 0,075 | 2 x 0,075 | 3 x 0,075 | 4 x 0,075 |
| Hladivo – količina | kg | 3,75 | 2 x 3,75 | 3 x 3,75 | 4 x 3,75 |
| Max. obratovalni tlak | MPa | 3,2 | 3,2 | 3,2 | 3,2 |
| **PRIMARNA STRAN (VIR TOPLOTE) – ZRAK** | | | | | |
| Pretok zraka | m³/h | do 12.000 | do 24.000 | do 36.000 | do 48.000 |
| **SEKUNDARNA STRAN (PONOR TOPLOTE) – VODA** | | | | | |
| **VGRAJENA OBTOČNA ČRPALKA** | | | | | |
| Nazivni pretok pri maksimalni toplotni moči in dT 5K po EN 14511 | m³/h | 6,13 | 12,26 | 18,39 | 24,50 |
| Maksimalni razpoložljiv zunanji padec tlaka pri nominalnem pretoku vode | kPa | 60 | 50 | 50 | 50 |
| **OGREVANJE** | | | | | |
| Območje delovanja – min./max. temperatura zraka | °C | -25 / 40 | -25 / 40 | -25 / 40 | -25 / 40 |
| **HLAJENJE** | | | | | |
| Območje delovanja – min./max. temperatura zraka | °C | 5 / 45 | 5 / 45 | 5 / 45 | 5 / 45 |
| **DIMENZIJE IN MASA – TRANSPORTNA** | | | | | |
| Dimenzije (Š x V x G) | mm | 1670 x 1752 x 1100 | 3406 x 1715 x 1059 | 5036 x 1715 x 1059 | 6666 x 1715 x 1059 |
| Masa | kg | 538 | 1315 | 1919 | 2523 |
| **DIMENZIJE IN MASA – NETO** | | | | | |
| Dimenzije (Š x V x G) | mm | 1575 x 1575 x 960 | 3375 x 1683 x 960 | 5000 x 1683 x 960 | 6625 x 1683 x 960 |
| Masa | kg | 500 | 1300 | 1900 | 2500 |

* Za priključno moč sistema, napajalne kable in dimenzije varovalk glejte Navodila za pripravo vgradnje.
** Tu = 0 °C/Tk = 60 °C/f = 120 Hz«

## TEHNIČNI PODATKI - NOTRANJA ENOTA

| NAPRAVA | | WR KSM 2 | WR KSM+ | WR KSM C |
|---|---|---|---|---|
| **ELEKTRIČNI PODATKI *** | | | | |
| Nazivna napetost; Frekvenca | V/Hz | ~ 230; 50 | ~ 230; 50 | ~ 230; 50 |
| Max. obratovalni tok | A | 2,2 | 2,2 | 2,2 |
| Max prikl. električna moč | kW | 0,5 | 0,5 | 0,5 |
| Varovalke | A | 1 x C10 | 1 x C10 | 1 x C10 |
| Napajalni kabel | 3 x 1,5 | 3 x 1,5 | 3 x 1,5 | 3 x 1,5 |
| Tip napajalnega električnega kabla | | H05VV-F | H05VV-F | H05VV-F |
| **Za priključno moč sistema, napajalne kable in dimenzije varovalk glejte navodila za pripravo vgradnje.* | | | | |
| **DIMENZIJE IN MASA – TRANSPORTNA** | | | | |
| Dimenzije (Š x V x G) | mm | 420 X 370 X 120 | 220 X 370 X 120 | 220 X 370 X 120 |
| Masa | kg | 5 | 2,5 | 2,8 |
| **DIMENZIJE IN MASA – NETO** | | | | |
| Dimenzije (Š x V x G) | mm | 400 X 350 X 90 | 200 X 350 X 90 | 200 X 350 X 90 |
| Masa | kg | 4,3 | 2,3 | 2,6 |
| **KOMUNIKACIJA** | | | | |
| Povezava med zun. in stensko krmilno enoto | | FTP 5e kabel / 2x2x0,6 mm2 (LiYCY) | FTP 5e kabel / 2x2x0,6 mm2 (LiYCY) | FTP 5e kabel / 2x2x0,6 mm2 (LiYCY) |
| Priključitev na BMS | | MODBUS protokol (UTP kabel - priključek RJ45) - RS 485 | MODBUS protokol (UTP kabel - priključek RJ45) - RS 485 | MODBUS protokol (UTP kabel - priključek RJ45) - RS 485 |
| Priključitev na internet | | UTP kabel - priključek RJ45 - Ethernet | UTP kabel - priključek RJ45 - Ethernet | UTP kabel - priključek RJ45 - Ethernet |

# Tehnični podatki

| Naprava | | WPB-65-1 XHT |
|---|---|---|
| **Izvedba** | | |
| Vir toplote[1] | | Geotermalna energija[2] |
| Ponor toplote | | Voda[3] |
| Možnost hlajenja | | Da (hidravlično prekrmiljenje) |
| Krmilnik | | TERMOTRONIC 3000 WEB |
| Možnost oddaljenega krmiljenja/dostopa | | Da (serijsko) |
| Postavitev naprave | | Notranja |
| Postavitev krmilne en. | | Vgrajena v toplotni črpalki |
| Kompresor | | 1 x scroll (hermetični) |
| Uparjalnik | | Plošč ni prenosnik toplote (AISI 316L) |
| Kondenzator | | Plošč ni prenosnik toplote (AISI 316L) |
| St. hladilnih krogov | | 1 |
| Regulacija moči | | Stopenjsko (0 / 100 %) |
| Električno grelo | | / |
| Mehki zagon | | Da (opcijsko) |
| Zvočno in toplotno izolirano ohišje | | Da (serijsko) |
| Dušilni organ hl. sistema | | Elektronski ekspanzijski ventil |
| Obtočna črpalka, primar | | / |
| Obtočna črpalka, sekundar | | / |
| | | |
| **Zmogljivosti** | | |
| **Ogrevanje** | | **Grelna moč / električna moč / COP[8]** |
| W12/W65 | kW / kW / - | 31,7 / 12,3 / 2,57 |
| W25/W65 | kW / kW / | 46,4 / 12,4 / 3,76 |
| W35/W65 | kW / kW / | 60,5 / 12,5 / 4,84 |
| W35/W78 | kW / kW / | 54,7 / 16,6 / 3,30 |
| W45/W65 | kW / kW / | 78,7 / 12,9 / 6,10 |
| W45/W78 | kW / kW / | 70,4 / 16,8 / 4,19 |
| | | |
| **Električni podatki** | | |
| Nazivna napetost | | 3N~ 400 V; 50 Hz |
| Max. obratovalni tok | A | 32,3 |
| Max. električna moč[5] | kW | 18,3 |
| Varovalke[11] | A | 3 x C40 |
| $Z_{max}$[10] | Ω | 0,010 |
| | | |
| **Hladilniški sistem** | | |
| Olje – tip | | POE (Emkarate RL 32 3MAF) |
| Olje – količina | l | 3,38 |
| **WPG H** | | |
| Hladivo – vrsta | | R134a |
| Hladivo – količina | kg | 6,0 |
| Max. obratovalni tlak | MPa | 3,2 |
| | | |
| **Primarna stran[1] (vir toplote) – voda** | | |
| Min. / Max. tlak v sistemu | MPa | 0,1 / 0,6 (1,0 / 6,0 bar) |
| Cevni priključki | | R 2" (zun. n.) |
| Nazivni pretok | $m^3$ / h | 11,3 |
| Tlačni padec pri nazivnem pretoku | kPa | 31 |
| Maksimalna temp. na izstopu | °C | 40 |
| Minimalna temp. na izstopu | °C | 5 |
| | | |
| **Sekundarna stran[1] (ponor toplote) – voda[3]** | | |
| Min. / Max. tlak v sistemu | MPa | 0,1 / 0,6 (1,0 / 6,0 bar) |
| Cevni priključki | | R 2" (zun. n.) |
| Nazivni pretok | $m^3$ / h | 8,5 |
| Tlačni padec pri nazivnem pretoku | kPa | 26 |
| Maksimalna temp. na izstopu | °C | 82 |
| Minimalna temp. na izstopu | °C | 25 |

Mono Multi Solutions

THE

# TALLMAX™

FRAMED 144 LAYOUT MODULE



**144 LAYOUT**
MONOCRYSTALLINE MODULE

**435-460W**
POWER OUTPUT RANGE

**21.0%**
MAXIMUM EFFICIENCY

**0~+5W**
POSITIVE POWER TOLERANCE

| PRODUCTS | POWER RANGE |
|---|---|
| TSM-DE17M(II) | 435-460W |

Founded in 1997, Trina Solar is the world's leading total solution provider for solar energy. With local presence around the globe, Trina Solar is able to provide exceptional service to each customer in each market and deliver our innovative, reliable products with the backing of Trina as a strong, bankable brand. Trina Solar now distributes its PV products to over 100 countries all over the world. We are committed to building strategic, mutually beneficial collaborations with installers, developers, distributors and other partners in driving smart energy together.

## Comprehensive Products and System Certificates

IEC61215/IEC61730/IEC61701/IEC62716
ISO 9001: Quality Management System
ISO 14001: Environmental Management System
ISO14064: Greenhouse Gases Emissions Verification
ISO45001: Occupational Health and Safety Management System

Trinasolar

## High power

- Up to 460W front power and 21.0% module efficiency with half-cut and MBB (Multi Busbar) technology bringing more BOS savings
- Lower resistance of half-cut and good reflection effect of MBB ensure high power

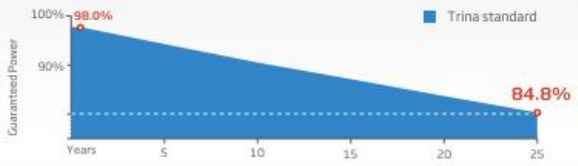
## High reliability

- Ensured PID resistance through cell process and module material control
- Resistant to salt, acid and ammonia
- Mechanical performance: Up to 5400 Pa positive load and 2400 Pa negative load

## High energy generation

- Excellent IAM and low light performance validated by 3rd party with cell process and module material optimization
- Better anti-shading performance and lower operating temperature

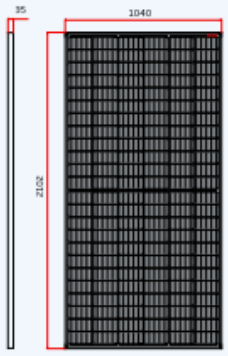
## PERFORMANCE WARRANTY



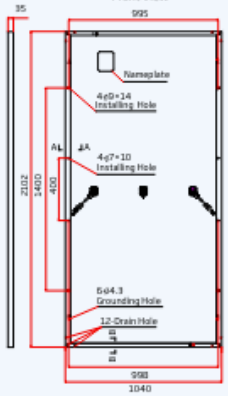
TALLMAX™

# 144 LAYOUT MODULE

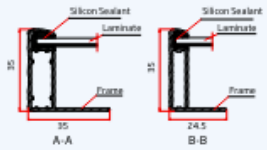
## DIMENSIONS OF PV MODULE(mm)



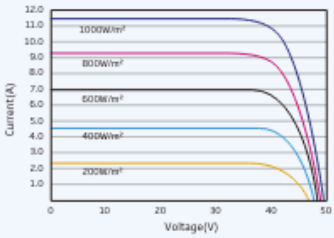

Front View



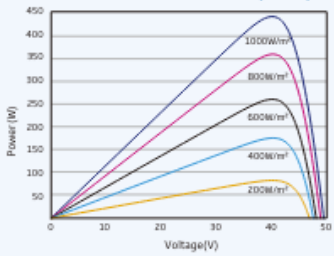

Back View




## I-V CURVES OF PV MODULE(445W)




## P-V CURVES OF PV MODULE(445W)




## ELECTRICAL DATA (STC)

| Peak Power Watts-$P_{MAX}$ (Wp)* | 435 | 440 | 445 | 450 | 455 | 460 |
|---|---|---|---|---|---|---|
| Power Tolerance-$P_{MAX}$ (W) | 0 ~ +5 | | | | | |
| Maximum Power Voltage-$V_{MPP}$ (V) | 40.5 | 40.7 | 40.8 | 41.0 | 41.2 | 41.3 |
| Maximum Power Current-$I_{MPP}$ (A) | 10.74 | 10.82 | 10.90 | 10.98 | 11.06 | 11.13 |
| Open Circuit Voltage-$V_{OC}$ (V) | 49.0 | 49.2 | 49.4 | 49.6 | 49.8 | 50.0 |
| Short Circuit Current-$I_{SC}$ (A) | 11.31 | 11.39 | 11.46 | 11.53 | 11.61 | 11.68 |
| Module Efficiency $\eta_m$ (%) | 19.9 | 20.1 | 20.4 | 20.6 | 20.8 | 21.0 |

STC: Irradiance 1000W/m², Cell Temperature 25°C, Air Mass AM1.5.
*Measuring tolerance: ±3%.

## ELECTRICAL DATA (NOCT)

| Maximum Power-$P_{MAX}$ (Wp) | 328 | 332 | 336 | 340 | 344 | 347 |
|---|---|---|---|---|---|---|
| Maximum Power Voltage-$V_{MPP}$ (V) | 38.2 | 38.4 | 38.5 | 38.7 | 38.9 | 39.1 |
| Maximum Power Current-$I_{MPP}$ (A) | 8.60 | 8.66 | 8.71 | 8.77 | 8.84 | 8.89 |
| Open Circuit Voltage-$V_{OC}$ (V) | 46.1 | 46.3 | 46.5 | 46.6 | 46.8 | 47.0 |
| Short Circuit Current-$I_{SC}$ (A) | 9.11 | 9.18 | 9.24 | 9.29 | 9.36 | 9.41 |

NOCT: Irradiance at 800W/m², Ambient Temperature 20°C, Wind Speed 1m/s.

## MECHANICAL DATA

| Solar Cells | Monocrystalline |
|---|---|
| Cell Orientation | 144 cells (6 × 24) |
| Module Dimensions | 2102 ×1040× 35 mm (82.76 × 40.94 × 1.38 inches) |
| Weight | 24.0 kg ( 52.9lb) |
| Glass | 3.2 mm (0.13 inches), High Transmission, AR Coated Heat Strengthened Glass |
| Encapsulant Material | EVA/POE |
| Backsheet | White |
| Frame | 35 mm ( 1.38 inches) Anodized Aluminium Alloy |
| J-Box | IP 68 rated |
| Cables | Photovoltaic Technology Cable 4.0mm² (0.006 inches²),<br>Portrait: N 280mm/P 280mm(11.02/11.02inches)<br>Landscape: N 1400 mm /P 1400 mm (55.12/55.12 inches) |
| Connector | MC4 EVO2 / TS4* |

*Please refer to regional datasheet for specified connector.

## TEMPERATURE RATINGS

| NOCT(Nominal Operating Cell Temperature) | 43°C (±2°C) |
|---|---|
| Temperature Coefficient of $P_{MAX}$ | - 0.34%/ °C |
| Temperature Coefficient of $V_{OC}$ | - 0.25%/ °C |
| Temperature Coefficient of $I_{SC}$ | 0.04%/ °C |

## MAXIMUMRATINGS

| Operational Temperature | -40~+85 °C |
|---|---|
| Maximum System Voltage | 1500V DC (IEC) |
| Max Series Fuse Rating | 20A |

(Do not connect Fuse in Combiner Box with two or more strings in parallel connection)

## WARRANTY

| 12 year Product Workmanship Warranty |
|---|
| 25 year Power Warranty |
| 2% first year degradation |
| 0.55% Annual Power Attenuation |

(Please refer to product warranty for details)

## PACKAGING CONFIGUREATION

| Modules per box: 31 pieces |
|---|
| Modules per 40' container: 682 pieces |

# 17 PRIMERI DOKAZIL ZA NAPRAVE ZA PREZRAČEVANJE Z USTREZNIMI ENERGIJSKIMI LASTNOSTMI

systemair

**Systemair d.o.o. - Ljubljana**
Brnčičeva ulica 41c
SI 1231 Ljubljana
Tel.: +386 (0)1 200 73 50
www.systemair.si
info@systemair.si

| | |
|---|---|
| Ponudba | |
| Z dne | 11.09.2024 |
| Projekt | OŠ Polzela |
| Pozicija | KN1.1 |
| | - |
| Količina | 1 |
| Calc. date | 28.03.2025 |
| Sodelavec | |
| Pisarna / Posre | |

EUROVENT CERTIFIED PERFORMANCE ENERGY EFFICIENCY
www.eurovent-certification.com
AHU 20.11.013
A+ A B C D E
A* 2016
Report to performance data

Odgovorni: **Maja Čanžek** e-pošta: **maja.canzek@systemair.si**

| | |
|---|---|
| Serija | KA NRVU BVU |
| Izvedba | Stacked unit |
| Izvedba | Zunanja enota |

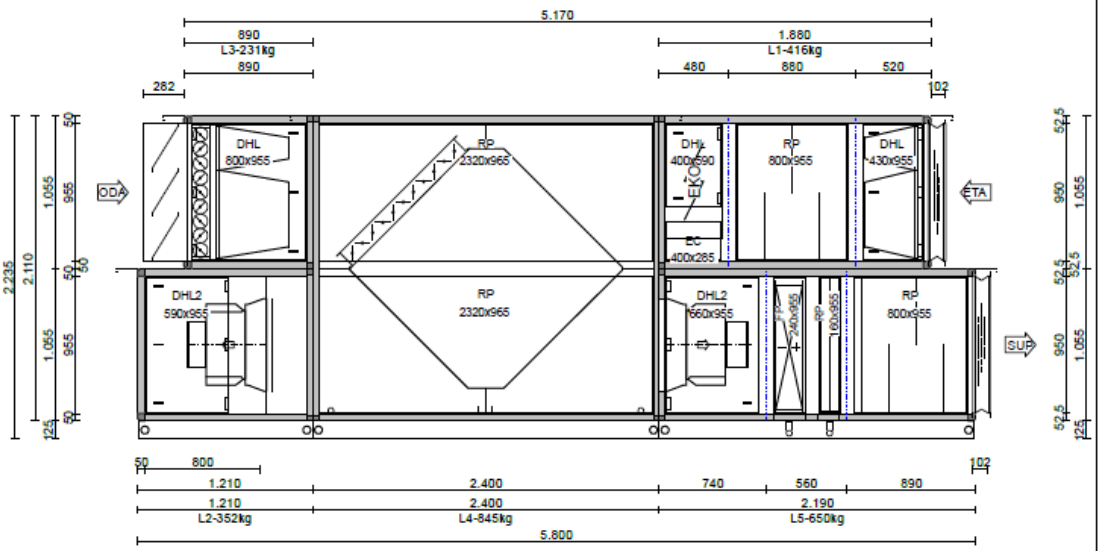
## KA HSO-5-3-D-R-50F-TB2-L2

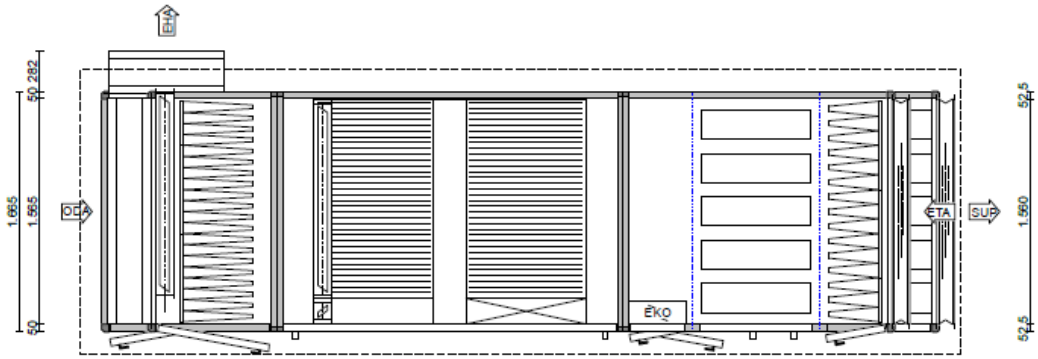
| | |
|---|---|
| Nadmorska višina [_m] | 0 |
| Specifična teža [kg/m3] | 1,20 |
| specifična moč motorja [w/(m3/s)] | 2.026 SFP4 |
| skupna teža [kg] | ~2.494 |

| | | | |
|---|---|---|---|
| Pretok | 10.500 m3/h | Pretok | 10.500 m3/h |
| Zun. tlak | 350 Pa | Zun. tlak | 350 Pa |
| Tot. tlak | 816 Pa | Tot. tlak | 710 Pa |
| Moč motorja | 1x4,600 kW | Moč motorja | 1x3,400 kW |
| Napajanje | 400V/3/50Hz | Napajanje | 400V/3/50Hz |
| Calibration fact | 355 | Calibration fact | 355 |
| Vodni hladilnik | 21,50 kW | Vračanje toplot | 95,94 / 19,82 kW |
| Vračanje toplot | 95,94 / 19,82 kW | | |

| | | | |
|---|---|---|---|
| | | Real | 2018 |
| Temperaturni izk. [% | 80,40 | min. | 73 |
| SFPint | 758 | max. | 1.022 |
| ErP ustrezno | | Da | |
| SFPv | 2.026 | SFPe | 2.098 |

Podstavek je 16mm krajši od širine in dolžine naprave. Širina profila je 40



systemair

| | | | |
|---|---|---|---|
| Odgovorni: | Maja Čanžek | Naročnik: | Projekt Forma d.o.o. |
| Calc. date: | 28.03.2025 | Ulica: | |
| | | Mesto: | |
| | | Projekt: | OŠ Polzela |
| | | Ulica: | |
| | | Mesto: | |
| | | Oddelek: | |

Številka projekta:
Pozicija: KN1.1 -

EUROVENT CERTIFIED PERFORMANCE
AHU No.: 20.11.013
Range: KA
www.eurovent-certification.com

# Dovodni zrak

| Podatki o enoti | | | | Ohišje: | Energetski razred | | |
|---|---|---|---|---|---|---|---|
| Velikost enote | KA 5-3 | | | Debelina | Mineralna volna 100kg/m3 | | 50,0 mm |
| Pretok [m3/h] | 10.500 | Dolžina [mm] | 5.480,0 | Mat. pokrova, znotraj | ZnAlMg ZM310 | | 0,80 |
| Zun. tlak [Pa] | 350 | Širina [mm] | 1.665,0 | Mat. pokrova, zunaj | ZnAlMg ZM310 | | 0,80 |
| Tot. tlak [Pa] | 816 | Višina [mm] | 1.055,0 | Mat. pokrova, dno | ZnAlMg ZM310 | | 0,80 |
| hitrost zraka [m/s] | 1,95 | Teža [kg] | ~1.726,0 | Profili | aluminium painted | SPECIAL | |
| Razred po EN 13053 | V3 | | | Vodila | ZnAlMg ZM310 | | |
| | | | | Fasteners int / ext | Galvanised / Galvanised | | |

| | | | | | |
|---|---|---|---|---|---|
| Razred prenosa toplote (M) | T2 | Razred puščanja -400Pa (M) | L2 | Razred mehanske stabilnosti ( | D1 |
| Razred toplotnega mosta (M) | TB2 | Razred puščanja +700Pa (M) | L2 | Puščanje filtra (M) | F9 |

| Filter | Dovodni zrak | 890,0 mm | 4,84 m2 | 231,00 kg | 146 Pa |
|---|---|---|---|---|---|

| | | | |
|---|---|---|---|
| Proizvajalec | Deltrian | dolžina filtra [mm] | 500,0 |
| Tip | KS85-500 | Filterska površina [m2] | 17,70 |
| Razred | F7 | celice št. x velikost | 2 x KS85-6/500/08 - 592,0x59 |
| Čisti dP [Pa] | 92 | | 1 x KS85-3/500/04 - 287,0x59 |
| Design dP [Pa] | 142 | | 2 x KS85-1/500/08 - 592,0x28 |
| Umazani dP [Pa] | 192 | | 1 x KS85-2/500/04 - 287,0x28 |
| Pretok [m3/h] | 10.500 2,26 m/s | Posluževanje filtra | S strani |
| ISO 16890 razred | ePM2.5 70% | | |
| ISO 16890 učinkovitost | | | |

| Regulacijska žaluzija: | Dimenzije [mm] | 1.390,0 x 900,0 x 125,0 | | | |
|---|---|---|---|---|---|
| Vrsta pogona | motorni pog | Pretok [m3/h] | 10.500 | Okvir | Aluminij |
| Št. Osi | 1 | hitrost zraka [m/s] | 2,33 | Lopatice | Aluminij |
| vrtilni moment [Nm] | 4,813 | Padec tlaka [Pa] | 4 | Tip | Arosio 125L |

| Ploščni rekuperator - diagonalni | Dovodni zrak | 2.400,0 mm | 18,12 m2 | 845,00 kg | 228 Pa |
|---|---|---|---|---|---|

proizvajalec PCF-I-180-1381-BR-174-B

| Režim gretja | | | | Hladilni režim | | | |
|---|---|---|---|---|---|---|---|
| Dovod [m3/h] | 10.500 | dP (hum/std) [Pa] | 180/214 | Dovod [m3/h] | 10.500 | dP (hum/std) [Pa] | 228/214 |
| Vstop [gC] | -13,00 | Vlažnost [%] | 90,0 | Vstop [gC] | 33,00 | Vlažnost [%] | 40,0 |
| Izstop [gC] | 14,20 | Vlažnost [%] | 11,0 | Izstop [gC] | 27,40 | Vlažnost [%] | 55,0 |
| odvod [m3/h] | 10.500 | dP (hum/std) [Pa] | 214/214 | odvod [m3/h] | 10.500 | dP (hum/std) [Pa] | 221/214 |
| Vstop [gC] | 20,00 | Vlažnost [%] | 30,0 | Vstop [gC] | 26,00 | Vlažnost [%] | 50,0 |
| Izstop [gC] | -3,40 | Vlažnost [%] | 99,0 | Izstop [gC] | 31,60 | Vlažnost [%] | 36,0 |
| Kondenz [kg/h] | 19,16 | | | izkoristek [%] | 80,4 | | |
| Temp. izkoristek [%] | 82,5 / 80,5 / 80,40 (mokri / suhi / EN308) | | | Moč [kW] | 19,82 | | |
| Moč [kW] | 95,94 | | | Število menjalnikov | 1 | | |
| Energetski razred | H1 | | | Bypass | Bypass | | |
| Energetski izkoristek [%] | 77,50 | (EN 13053 A1) | | Temperatura ledišča [gC] | 0,00 [gC | | |
| Material menjalnika | AL | | | | | EATR [%] | 0 |
| | | | | | | OACF | 1 |

Highest wet pressure is used for Eurovent calculation

| Bana | Tip | flat double pan | Kvaliteta | Aluminij | Odtočna cev | Velikost | 1 1/2" | Side | desno |
|---|---|---|---|---|---|---|---|---|---|

| Regulacijska žaluzija: | | Tip | Bypass-žaluzij | Arosio 125L | |
|---|---|---|---|---|---|
| Width 1 [mm] | 1.311,0 | Višina [mm] | 1.105,0 | Vrsta pogona | motorni pogon |
| Width 2 [mm] | 139,0 | | | vrtilni moment [Nm] | 7,530 |

| | | | |
|---|---|---|---|
| systemair | Naročnik: | Projekt Forma d.o.o. | Številka projekta: |
| | Ulica: | | Pozicija: KN1.1 - |
| | Mesto: | | |
| | Projekt: | OŠ Polzela | |
| | Ulica: | | |
| | Mesto: | | |
| Odgovorni: Maja Čanžek | Oddelek: | | |
| Calc. date: 28.03.2025 | | | |

# Ecodesign information

| Non Residental Unit EU1253 | |
|---|---|
| Ustreza ErP 2018 | Da |
| Pripombe ErP 2018 | - |
| Notranja specifična moč ventilatorja SFPint [W/(m3/s)] | 758 |
| Največja dovoljena SFPint za ErP 2018 [W/(m3/s)] | 1.022 |
| Efektivna vhodna moč [kW] | 6,120 |
| Efektivna vhodna moč krmilja [kW] | |
| Referenčna stopnja pretoka [m3/h] | 10.500 |
| Toplotni izkoristek [%] | 80,40 |
| Tip rekuperacijskega izmenjevalnika toplote | Other HRS |
| Najmanjši toplotni izkoristek za ErP 2018 [%] | 73 |
| Tip motorja in pogona | variable speed |
| Tip enote | BVU |
| Hitrost dotoka [m/s] | 1,95 |
| External leakage rate at +400 Pa (R) [%] | 0,30 |
| External leakage rate at -400 Pa (R) [%] | 0,66 |
| Stopnja notranjega puščanja pri 200 Pa [%] | 1,00 |
| Notranji padec tlaka prezračevalnih elementov [Pa] | 523 |
| eksterni padec tlaka [Pa] | 700 |
| Notranji padec tlaka neprezračevalnih elementov [Pa] | 227 |
| Bonus za učinkovitost E za ErP 2018 [W/(m3/s)] | 222 |
| Korekcija filtra F za ErP2018 [W/(m3/s)] | |
| Izkoristek bazne konfiguracije U1 [%] | 69,82 |
| Notranji padec tlaka prezračevalnih elementov U1 [Pa] | 272 |
| Zunanji padec tlaka U1 [Pa] | 350 |
| Notranji padec tlaka neprezračevalnih elementov U1 [Pa] | 156 |
| Izkoristek bazne konfiguracije U2 [%] | 68,29 |
| Notranji padec tlaka prezračevalnih elementov U2 [Pa] | 251 |
| Zunanji padec tlaka U2 [Pa] | 350 |
| Notranji padec tlaka neprezračevalnih elementov U2 [Pa] | 71 |

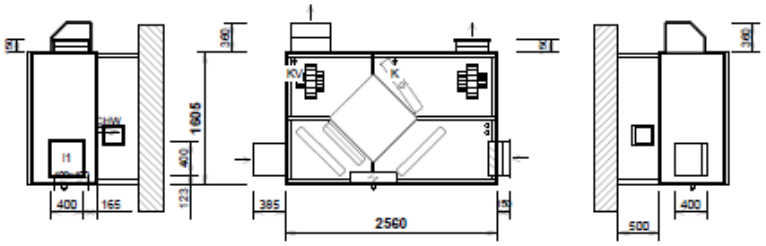
| | | |
|---|---|---|
| | | |
| | | |
| | | |

Naprava **DUPLEX 5400 Basic-N** Specifikacija: DUPLEX 5400 Basic-N / 3/10 - Me.110.EC3 - Mi.110.EC3 - K750.G - Fe.K5 - Fi.K4 - B.LM24A - CHW.3.U - Ke.LM24A - Ki.LM24A - KH-H.400/400.P - He1.KZ - Hi2.KZ - BF.500 - HINGLESS-aM-CL - DPT 2500 - aM-IO12 - aM-XDR - PFe - PFi - SW - CM.i.s - aTouch

**Tip naprave**
- Strešne naprave s križno točnim menjalnikom toplote

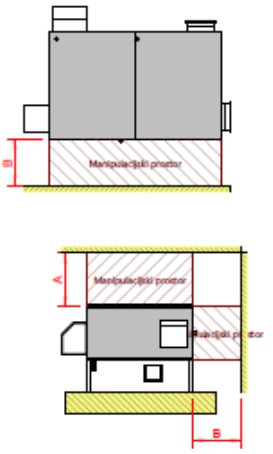
Izvedba: **3/10** strešna izvedba leže pogled od zgoraj (s strani vrat)

**Teža: cca 525 kg, Naprava dobavljena v enem delu**



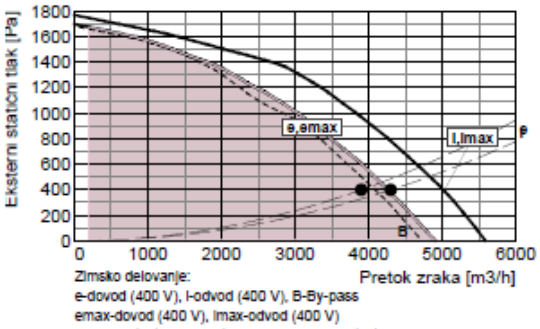

| priključ | tip | dimenzija | dodatna oprema |
|---|---|---|---|
| e1 | e1 - vstop sveži zrak (ODA) | | preobleka, zapiralna loputa, eliminator kapljic |
| e2 | e2 - izstop sveži zrak (SUP) | 400 x 400 mm | fleksibilen priključek |
| I1 | I1 - vstop odpadni zrak (ETA) | 400 x 400 mm | zapiralna loputa, fleksibilen priključek |
| I2 | I2 - izstop odpadni zrak (EHA) | | preobleka |
| K | izstop kondenza | 1 x Ø 32/40 mm | sifon |
| KV | Ogrevano izstop kondenza | 1 x Ø 32/40 mm | sifon |
| CHW | Vodni hladilnik | 1" notranja izvedba | dimenzije priključka - register |

**Manipulacijski prostor**




| | | |
|---|---|---|
| A | posluževalni prostor | min 800 mm |
| B | prednji prostor | min 700 mm |

## Delovna krivulja naprave:




Zimsko delovanje:
e-dovod (400 V), I-odvod (400 V), B-By-pass
emax-dovod (400 V), Imax-odvod (400 V)

Naprava ima ventilatorje z EC tehnologijo. Tem ventilatorjem se lahko zvezno spreminja hitrost v celem označenem področju.

## Akustični parametri:

Zvočna moč LwA (dB)

| Frekvenca [Hz] | Total dB (A) | 63 dB(A) | 125 dB(A) | 250 dB(A) | 500 dB(A) | 1 k dB(A) | 2 k dB(A) | 4 k dB(A) | 8 k dB(A) |
|---|---|---|---|---|---|---|---|---|---|
| priključek e1 proti okolju | 63 | 39 | 47 | 59 | 59 | 53 | 46 | 33 | <25 |
| izstop e2 | 89 | 62 | 70 | 85 | 85 | 82 | 78 | 75 | 70 |
| vstop I1 | 65 | 54 | 55 | 62 | 59 | 56 | 48 | 36 | 30 |
| priključek I2 proti okolju | 86 | 52 | 62 | 79 | 81 | 79 | 77 | 73 | 67 |
| ohišje proti okolju | 72 | 59 | 51 | 64 | 68 | 67 | 62 | 55 | 39 |

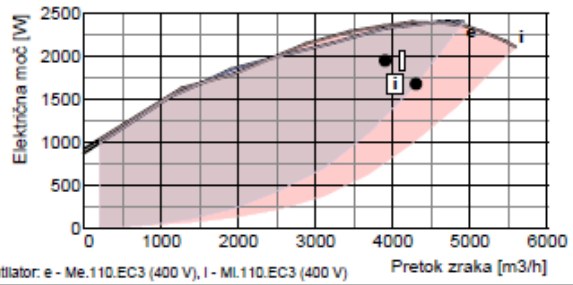
*Zvočna moč je računana za izstočasno obratovanje obeh ventilatorjev in merjena glede na ISO 3744. Zvočna moč na priključkih je merjena glede na ISO 5136.*

Spekter zvočnega tlaka LpA (dB)

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| priključek e1 proti okolju | 42 | <25 | 26 | 38 | 38 | 32 | 25 | <25 | <25 |
| priključek I2 proti okolju | 65 | 31 | 42 | 58 | 60 | 59 | 56 | 52 | 47 |
| ohišje proti okolju | 52 | 38 | 31 | 44 | 47 | 46 | 41 | 35 | <25 |

*Zvočna moč je računana za izstočasno obratovanje obeh ventilatorjev v razdalji 3 m in merjena skladno z ISO 3744.*

| Ventilatorji | | dovod | odvod |
|---|---|---|---|
| Pretok zraka | m3/h | 3900 | 4300 |
| Eksterni statični tlak | Pa | 400 | 400 |
| Napetost (nominalno) | V | 400 | 400 |
| Nazivna moč (v delovni točki) | kW | 1,949 | 1,678 |
| Vrtljaji (v delovni točki) | 1/min | 2791 | 2652 |
| SFP | W/(m3/h) | 0,500 | 0,390 |
| Tip ventilatorja | | Me.110 | Mi.110 |
| Vrste ventilatorjev (z regulacijo hitrosti) | | EC3 | EC3 |
| SFPv | W/(m3/h) | 0,844 | |




Ventilator: e - Me.110.EC3 (400 V), I - Mi.110.EC3 (400 V)

PROVENT

# Tehničen opis

## Nominalne vrednosti

## Ponudba št.:

## Projekt: 24000100_POLZELA OŠ KUHNJA

## Položaj štev.:Naprava 1

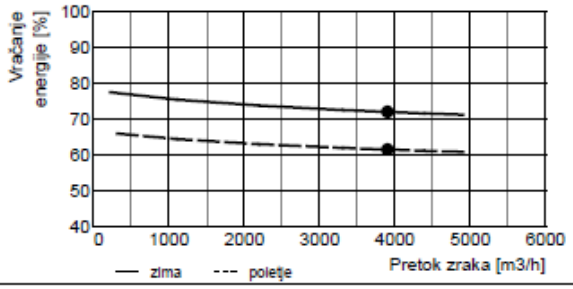


Naprava **DUPLEX 5400 Basic-N** Specifikacija: DUPLEX 5400 Basic-N / 3/10 - Me.110.EC3 - Mi.110.EC3 - K750.G - Fe.K5 - Fi.K4 - B.LM24A - CHW.3.U - Ke.LM24A - Ki.LM24A - KH-H.400/400.P - He1.KZ - Hi2.KZ - BF.500 - HINGLESS-aM-CL - DPT 2500 - aM-IO12 - aM-XDR - PFe - PFi - SW - CM.i.s - aTouch

| Priključni elementi | | dovod | odvod |
|---|---|---|---|
| Dovodna priključka e1, i1 | mm | | 400 x 400 |
| priključek | | eliminator kapljic | fleksibilen |
| Odvodna priključka e2, i2 | mm | 400 x 400 | |
| priključek | | fleksibilen | |
| Odvod kondenza K | mm | 2 x Ø 32/40 mm s sifonom | |

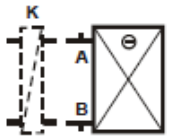
| Regulacija zapiralnih loput | Tip servopogona |
|---|---|
| Zapiralna loputa e1 (del naprave) | LM24A |
| Zapiralna loputa i1 (del naprave) | LM24A |
| By-pass loputa (vgrajena) | LM24A |

| Menjalnik toplote | | dovod | odvod |
|---|---|---|---|
| Pretok zraka | m3/h | 3900 | 4300 |
| Temp. na vstopu | °C | -16 | 20 |
| Temp. na izstopu | °C | 10 | 2 |
| Rel. vlaga vstop | % r.F | 90 | 40 |
| Rel. vlaga izstop | % r.F | 11 | 81 |
| Izkoristek vračanja energije zima (poletje) | % | 72 (62) | |
| Moč menj. toplote zima (poletje) | kW | 35,0 (5,5) | |
| Kondenzacija | l/h | 11,9 | |
| Tip ploščnega menj. toplote | | K750.G rekuperacijski | |



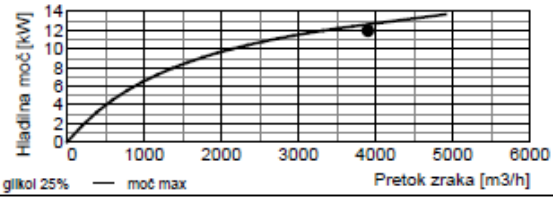

| Vodni hladilnik | | dovod |
|---|---|---|
| Hladilni medij | | etilen glikol 25% |
| Pretok zraka | m3/h | 3900 |
| Temp. na vstopu (za plošč. menj.) | °C | 28 |
| Temp. na izstopu (za hladilnikom) | °C | 21 |
| Rel. vlaga vstop (za plošč. menj.) | % r.F | 57 |
| Rel. vlaga izstop (za hladilnikom) | % r.F | 81 |
| Hladilna moč | kW | 12,0 |
| Kondenzacija | l/h | 4 |
| Padec temp. vode | °C | 9 / 13 |
| Pretok medija (pri max. moči) | l/h | 2550 |
| Padec tlaka medija | kPa | 25,00 |
| Dimenzije priklj. | | 1" notranja izvedba |
| Kapaciteta menjalnika toplote | l | 3,5 |
| Tip hladilnika | | W 5400 3R/ Tip 1 |
| Omejitev | | vgrajeno glej opombo |

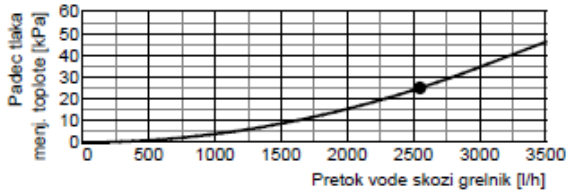
**Dodatna oprema (vključeno v dobavo)**




| | | | |
|---|---|---|---|
| A | odzračevalni ventil | avtomatsko | 2) |
| B | kalužni ventil | čep | 2) |
| **Drugi:** | | | |
| K | register voda/etilen glikol | | 3) |

**2 - vgrajeno in priključeno**
**3 - ni del pošiljke**




| Filtracija | | dovod | odvod |
|---|---|---|---|
| Tip | | kaseta | kaseta |
| Filtracijski razred | | ePM10 50% (M5) | Coarse 90% (G4) |
| Število filtrov | kosov | 2 | 2 |
| Dimenzije kasete | mm | 750x295x96 | 750x295x96 |

**Dodatna oprema (vključeno v dobavo)**

PFe preklop za umazanost filtra na dovodu zraka
PFi preklop za umazanost filtra na odvodu zraka

| | |
|---|---|
| PROKLIMA | ponudba TP<br>last modify 31/03/2025<br>projekt 24000100_POLZELA OŠ KUHINJA<br>pozicija 1000<br>sistem |
| **PRO-KLIMA partner**<br>Gradna 78e<br>HR 10430 SAMOBOR<br>T: F: | Office / Agent PKPall<br>proklima@proklima.hr telefon<br>**www.proklima.hr** |

SAVE THE ENVIRONMENT:Before printing, think about the environment. Thanks!

| | | | |
|---|---|---|---|
| profil | **Modular AHU KG Flex** | | |
| izvedba | **Standard outdoor** | Tip | **KG Flex2520S** |
| izvedba | **L - dovodna izvedba** | | |
| Tension | **3x400 V / 50 Hz** | stopnje pretoka | **100 %** |
| | | količina | **1** kos |

**Casing data**

| | |
|---|---|
| debelina pokrova [mm] | 50.0 |
| mat. pokrova zunaj | **barvana pločevina** RAL 7035 GL S |
| mat. pokrova znotraj | **pocinkana pločevina** |
| mat. pokrova dno | **pocinkana pločevina** |
| profili | **barvani aluminij** |
| Insulation | **Rockwool** |
| Model box | **THOR TB2** |

**Energy efficiency**

| | |
|---|---|
| Eurovent energy efficiency class winter / summer | E 2016 / B ↳ 2020 |
| used lowest tempertature [gC] | 32.00 |
| specific fan power, validation [W/(m3/s)] | 1,092 |
| location | LJUBLJANA BEZIGRAD, Slovenia |
| Mixing ratio | 0 % |

**Mechanical and thermal characteristics**

| | |
|---|---|
| mechanical stability class | D1(M) |
| Casing leaky class at -400 Pa | L1(M),L2R) |
| Casing leaky class at 400 Pa | L1(M),L2(R) |
| Casing leaky class at +700 Pa | L1(M) |
| Filter bypass leakage class | F9 |
| Thermal transmittance | T2 |
| Thermal bridging factor | TB2 |

| | | | |
|---|---|---|---|
| ECODESIGN | Non-residential ventilation unit | **NRVU** | Regulation EU 1253 |
| ErP Ready exclusion | **No Exclusion** | | |

## dovod

| | | | |
|---|---|---|---|
| velikost | **KG Flex 2520** | Velocity class | **V4** |
| pretok [m3/h] | **14,800** | air vel.at unit cr-s [m/s] | **2.01** |
| zun.tlak [Pa] | **450** | specific fan power [W/(m3/s)] | **1,092** |
| Tot. pressure [Pa] | **848** | SFP Class | **SFP3** |
| | | Power class | **P1** |

| pozicija | 1000 | sistem | ponudba | TP |
|---|---|---|---|---|

**Modular AHU KG Flex** **KG Flex 2520S**

**ECODESIGN** Non Residential unit Regulation EU 1253

ErP 2018 Ready

| | | |
|---|---|---|
| Calculation valid | **da** | |
| ErP Ready 2018 | **da**<br>- | |
| Specific fan power internal [W/(m3/s)] | **63** | |
| maximal specific fan power internal 2018 [W/(m3/s)] | **230** | |
| effective electric power input [kW] | **4.966** | |
| Nominal flow rate [m3/h] | **14,800** | **4.11 [m3/s]** |
| Minimum requested Efficiency 2018 [%] | **51.9** | |
| thermal efficiency [%] | | |
| type of heat recovery system | - | |
| Motor and drive type | **variable speed** | |
| directional unit type | **_UVU** | |
| face velocity at design flow rate [m/s] | **2.01** | |
| external leakage +400 Pa [%] | **0.63** | |
| internal pressure drop of ventilation components [Pa] | **41** | |
| eksterni padec tlaka [Pa] | **450** | |
| internal pressure drop of non-ventilation components [Pa] | **249** | |
| Efficiency base configuration U1 [%] | **64.67** | |
| Efficiency base configuration U2 [%] | | |

# Tehnično poročilo o energijski učinkovitosti stavbe
# ELABORAT ENERGETSKIH LASTNOSTIH STAVBE

za PZI

**Splošni podatki o stavbi**

| | |
|---|---|
| Investitor | Občina Polzela, Malteška cesta 28, 3313 Polzela |
| Stavba | Prizidava OŠ Polzela, 1 faza |
| Lokacija stavbe | 3313 Polzela , Šolska ulica 3 |
| Katastrska občina | POLZELA |
| Parcelna številka | *714, 779/4,... |
| Koordinate lokacije stavbe (Y, X) | Y= 506338 X= 126216 |
| Klasifikacija stavbe | 1263001 Stavbe za izobraževanje in znanstvenoraziskovalno delo |
| Etažnost: | P+1N |
| Kondicionirana površina stavbe $A_{use}$ | 629,9 $m^2$ |
| Prostornina stavbe $V_e$ | 2537,0 $m^3$ |
| Neto prostornina stavbe V | 2030,8 $m^3$ |
| Faktor oblike stavbe $f_o$ | 0,49 $m^{-1}$ |

**Vrsta stavbe**

| | |
|---|---|
| Opredelitev stavbe | Energetsko zahtevna stavba |
| Vrsta gradnje | Novogradnja |
| Javna stavba | Da |

**Podatki o izdelovalcu izkaza**

| | |
|---|---|
| Vodja projektiranja | Tadej Renar, m.i.a., ZAPS 2273-PA* |
| Izdelovalec izkaza | Matej Kramar, d.i.s., IZS S-1852 |
| Datum izdelave izkaza | 15. 04. 2025 |
| Podpis izdelovalca izkaza: ..... | |

# IZKAZ O ENERGETSKIH LASTNOSTIH STAVBE

**Toplotna prehodnost gradbenih konstrukcij in gradnikov stavbe**

| Naziv cone | kondicionirana cona | Kondicionirana površina cone $A_{use,zn}$ | 629,9 m² |
|---|---|---|---|

| # | Naziv konstrukcije/gradnika f | A (m²) | U (W/m²K) | $U_{dov}$ (W/m²K) | |
|---|---|---|---|---|---|
| 1 | Zunanja stena | 133 | 0,147 | 0,180 | Ustreza |
| 2 | Zunanja stena | 46 | 0,147 | 0,180 | Ustreza |
| 3 | Zunanja stena | 28 | 0,147 | 0,180 | Ustreza |
| 4 | Zunanja stena - cokl | 24 | 0,134 | 0,180 | Ustreza |
| 5 | Zunanja stena - cokl | 1 | 0,134 | 0,180 | Ustreza |
| 6 | Zunanja stena - cokl | 8 | 0,134 | 0,180 | Ustreza |
| 7 | Previs | 13 | 0,116 | 0,200 | Ustreza |
| 8 | Poševna streha | 347 | 0,100 | 0,150 | Ustreza |
| 9 | Ravna streha | 19 | 0,084 | 0,150 | Ustreza |
| 10 | Tla na terenu, prostori | 453 | 0,088 | 0,350 | Ustreza |
| 11 | Tla na terenu, jašek | 7 | 0,150 | 0,350 | Ustreza |
| 12 | Vkopana stena jaška | 13 | 0,144 | 0,350 | Ustreza |
| 13 | Vrata | 5 | 0,900 | 1,600 | Ustreza |
| 14 | Okna | 105 | 0,620 | 1,000 | Ustreza |
| 15 | Okna | 18 | 0,680 | 1,000 | Ustreza |
| 16 | Strešna okna | 17 | 0,640 | 1,400 | Ustreza |

**Linijske in točkovne toplotne prehodnosti toplotnih mostov**

| Naziv cone | kondicionirana cona | | |
|---|---|---|---|
| Toplotni mostovi ovrednoteni po poenostavljeni metodi | | $\Delta\Psi_{th}$ (W/(m2K)) | 0,04 |

**Preverjanje prehoda vodne pare**

| Naziv cone | kondicionirana cona |
|---|---|

| # | Naziv konstrukcije/gradnika f | Kondenzacija | $M_{c,max}$ (kg/m²) | $f_{rsi}$ (-) | |
|---|---|---|---|---|---|
| 1 | Zunanja stena | Ni kondenzacije | 0,000 | 0,964 | Ustreza |
| 2 | Zunanja stena | Ni kondenzacije | 0,000 | 0,964 | Ustreza |
| 3 | Zunanja stena | Ni kondenzacije | 0,000 | 0,964 | Ustreza |
| 4 | Zunanja stena - cokl | Ni kondenzacije | 0,000 | 0,967 | Ustreza |
| 5 | Zunanja stena - cokl | Ni kondenzacije | 0,000 | 0,967 | Ustreza |
| 6 | Zunanja stena - cokl | Ni kondenzacije | 0,000 | 0,967 | Ustreza |
| 7 | Previs | Ni kondenzacije | 0,000 | 0,971 | Ustreza |
| 8 | Poševna streha | Kondenzat se posuši | 1000000,000 | 0,975 | Ustreza |
| 9 | Ravna streha | Kondenzat se posuši | 1000000,000 | 0,979 | Ustreza |
| 10 | Tla na terenu, prostori | Ni kondenzacije | 0,000 | 0,960 | Ustreza |
| 11 | Tla na terenu, jašek | Ni kondenzacije | 0,000 | 0,960 | Ustreza |
| 12 | Vkopana stena jaška | Ni kondenzacije | 0,000 | 0,963 | Ustreza |

**Toplotne lastnosti transparentnih gradnikov/oken**

| Naziv cone | kondicionirana cona | | | | | |
|---|---|---|---|---|---|---|
| # | Naziv konstrukcije/gradnika f | $A_w$ ($m^2$) | $U_w$ ($W/m^2K$) | $g_{tot,sh}$ (-) | $\tau_{vis}$ (-) | |
| 1 | Vrata | 4,6 | 0,900 | 0,000 | 0,700 | Ustreza |
| 2 | Okna | 105,4 | 0,620 | 0,150 | 0,700 | Ustreza |
| 3 | Okna | 17,5 | 0,680 | 0,250 | 0,700 | Ustreza |
| 4 | Strešna okna | 16,5 | 0,640 | 0,153 | 0,750 | Ustreza |

**Faktor dneven svetlobe**

| Načrtovano | | | |
|---|---|---|---|
| Izračunano | | | |
| # | Naziv cone | FDS (%) | $FDS_{TM}$ (%) |
| 1 | kondicionirana cona | 2,5 | |

**Tesnost ovoja stavbe**

| Načrtovano | | $n_{50}$ ($h^{-1}$) | |
|---|---|---|---|
| Izračunano | | | |
| # | Naziv cone | $n_{50}$ ($h^{-1}$) | $w_{50}$ ($h^{-1}$) |
| 1 | kondicionirana cona | 0,6 | |

**Specifični koeficient transmisijskih toplotnih izgub stavbe/cone**

| $X_{H'tr}$ (-) | $H'_{tr}$ ($W/m^2K$) | $H'_{tr,dov}$ ($W/m^2K$) | |
|---|---|---|---|
| 0,900 | 0,208 | 0,339 | |

| # | Naziv cone | $H'_{tr,zn}$ ($W/m^2K$) |
|---|---|---|
| 1 | kondicionirana cona | 0,208 |

**Koeficient transmisijskih in prezračevalnih toplotnih izgub stavbe/cone**

| $H_{tr}$ (W/K) | $H_{ve}$ (W/K) |
|---|---|
| 257,1 | 108,0 |

| # | Naziv cone | $H_{tr}$ (W/K) | $H_{ve}$ (W/K) |
|---|---|---|---|
| 1 | kondicionirana cona | 257,1 | 108,0 |

**Potrebna toplota/normirana dovedena toplota za ogrevanje in odvedena toplota za hlajenje**

| $Q_{H,nd}$ (kWh/(an)) | $Q_{C,nd}$ (kWh/(an)) | $Q'_{H,nd}$ ($kWh/(m^2an)$) | $Q'_{C,nd}$ ($kWh/(m^2an)$) |
|---|---|---|---|
| 6696 | 2423 | 10,6 | 3,8 |

| # | Naziv cone | $Q'_{H,nd,zn}$ ($kWh/(m^2an)$) | $Q'_{C,nd,zn}$ ($kWh/(m^2an)$) |
|---|---|---|---|
| 1 | kondicionirana cona | 10,6 | 3,8 |

| $H_{nd}$ (-) | $H_{nd,dov}$ (-) | Ustreza | $_{Cnd}$ (-) | $_{Cnd,dov}$ (-) | Ustreza |
|---|---|---|---|---|---|
| 0,37 | 0,80 | DA | 1,54 | 0,80 | Se ne preverja |

**Potrebna toplota/normirana toplota za TSV**

| $Q_{W,nd}$ (kWh/an) | $Q'_{W,nd}$ (kWh/(m²an)) |
|---|---|
| 36036 | 57,2 |

| # | Naziv cone | $Q'_{W,nd,zn}$ (kWh/(m²an)) |
|---|---|---|
| 1 | kondicionirana cona | 57,2 |

**Potrebna energija/normirana energija za navlaževanje in razvlaževanje**

| $Q_{HU,nd}$ (kWh/(an)) | $Q_{DHU,nd}$ (kWh/(an)) | $Q'_{HU,nd}$ (kWh/(m²an)) | $Q'_{DHU,nd}$ (kWh/(m²an)) |
|---|---|---|---|
| 0 | 0 | 0,0 | 0,0 |

| # | Naziv cone | $Q'_{HU,nd,zn}$ (kWh/(m²an)) | $Q'_{DHU,nd,zn}$ (kWh/(m²an)) |
|---|---|---|---|
| 1 | kondicionirana cona | 0,0 | 0,0 |

**Potrebna energija za razsvetljavo***

*Informativna raba električne energije za razsvetljavo

| $Q_L$ (kWh/an) | $Q'_{L,nd}$ (kWh/(m²an)) |
|---|---|
| 3360 | 5,3 |

| # | Naziv cone | $Q'_{L,nd,zn}$ (kWh/(m²an)) |
|---|---|---|
| 1 | kondicionirana cona | 5,3 |

# IZPIS KONSTRUKCIJ V PROJEKTU

Cona: kondicionirana cona

| | | | |
|---|---|---|---|
| Naziv konstrukcije | Zunanja stena | Tip konstrukcije | Zunanje stene |
| Toplotna prehodnost | 0,15 W/m$^2$K | Difuzija vodne pare | |
| | Ustreza | | Ustreza |

| Sloji v konstrukciji | d [cm] | λ [W/mK] | ρ [kg/m$^3$] |
|---|---|---|---|
| Apnena malta | 1 | 0,81 | 1600 |
| Betoni s kamnitimi agregati (2200) | 18 | 1,51 | 2200 |
| lepilna malta za kameno volno | 0,5 | 0,9 | 1450 |
| kamena volna FKD-N Thermal d=50-240 mm | 22 | 0,034 | 90 |
| Pigmentna fasadna malta | 1 | 0,7 | 1850 |

| | | | |
|---|---|---|---|
| Naziv konstrukcije | Zunanja stena | Tip konstrukcije | Zunanje stene |
| Toplotna prehodnost | 0,15 W/m$^2$K | Difuzija vodne pare | |
| | Ustreza | | Ustreza |

| Sloji v konstrukciji | d [cm] | λ [W/mK] | ρ [kg/m$^3$] |
|---|---|---|---|
| Apnena malta | 1 | 0,81 | 1600 |
| Betoni s kamnitimi agregati (2200) | 18 | 1,51 | 2200 |
| lepilna malta za kameno volno | 0,5 | 0,9 | 1450 |
| kamena volna FKD-N Thermal d=50-240 mm | 22 | 0,034 | 90 |
| Pigmentna fasadna malta | 1 | 0,7 | 1850 |

| | | | |
|---|---|---|---|
| Naziv konstrukcije | Zunanja stena | Tip konstrukcije | Zunanje stene |
| Toplotna prehodnost | 0,15 W/m$^2$K | Difuzija vodne pare | |
| | Ustreza | | Ustreza |

| Sloji v konstrukciji | d [cm] | λ [W/mK] | ρ [kg/m$^3$] |
|---|---|---|---|
| Apnena malta | 1 | 0,81 | 1600 |
| Betoni s kamnitimi agregati (2200) | 18 | 1,51 | 2200 |
| lepilna malta za kameno volno | 0,5 | 0,9 | 1450 |
| kamena volna FKD-N Thermal d=50-240 mm | 22 | 0,034 | 90 |
| Pigmentna fasadna malta | 1 | 0,7 | 1850 |

| | | | |
|---|---|---|---|
| Naziv konstrukcije | Zunanja stena - cokl | Tip konstrukcije | Zunanje stene |
| Toplotna prehodnost | 0,13 W/m$^2$K | Difuzija vodne pare | |
| | Ustreza | | Ustreza |

| Sloji v konstrukciji | d [cm] | λ [W/mK] | ρ [kg/m$^3$] |
|---|---|---|---|
| Apnena malta | 1 | 0,81 | 1600 |
| Betoni s kamnitimi agregati (2200) | 18 | 1,51 | 2200 |
| bitumenska hidroizolacija | 0,5 | 0,19 | 1100 |
| Fragmat Neocokl | 22 | 0,031 | 20 |
| Pigmentna fasadna malta | 1 | 0,7 | 1850 |

| Naziv konstrukcije | Zunanja stena - cokl | Tip konstrukcije | Zunanje stene |
|---|---|---|---|
| Toplotna prehodnost | 0,13 W/m$^2$K | Difuzija vodne pare | |
| | Ustreza | | Ustreza |

| Sloji v konstrukciji | d [cm] | λ [W/mK] | ρ [kg/m$^3$] |
|---|---|---|---|
| Apnena malta | 1 | 0,81 | 1600 |
| Betoni s kamnitimi agregati (2200) | 18 | 1,51 | 2200 |
| bitumenska hidroizolacija | 0,5 | 0,19 | 1100 |
| Fragmat Neocokl | 22 | 0,031 | 20 |
| Pigmentna fasadna malta | 1 | 0,7 | 1850 |

| Naziv konstrukcije | Zunanja stena - cokl | Tip konstrukcije | Zunanje stene |
|---|---|---|---|
| Toplotna prehodnost | 0,13 W/m$^2$K | Difuzija vodne pare | |
| | Ustreza | | Ustreza |

| Sloji v konstrukciji | d [cm] | λ [W/mK] | ρ [kg/m$^3$] |
|---|---|---|---|
| Apnena malta | 1 | 0,81 | 1600 |
| Betoni s kamnitimi agregati (2200) | 18 | 1,51 | 2200 |
| bitumenska hidroizolacija | 0,5 | 0,19 | 1100 |
| Fragmat Neocokl | 22 | 0,031 | 20 |
| Pigmentna fasadna malta | 1 | 0,7 | 1850 |

| Naziv konstrukcije | Previs | Tip konstrukcije | Tla s ploskovnim ogrevanjem proti zunanjosti |
|---|---|---|---|
| Toplotna prehodnost | 0,12 W/m$^2$K | Difuzija vodne pare | |
| | Ustreza | | Ustreza |

| Sloji v konstrukciji | d [cm] | λ [W/mK] | ρ [kg/m$^3$] |
|---|---|---|---|
| Keramične ploščice-talne,neglazirane | 1,5 | 1,28 | 2300 |
| Cementni estrih | 9 | 1,4 | 2200 |
| Polietilenske folije | 0,3 | 0,19 | 1000 |
| Fragmat Stirotermal Silent Reflect | 2 | 0,038 | 20 |
| Polietilenske folije | 0,2 | 0,19 | 1000 |
| kamena volna DF | 5 | 0,037 | 100 |
| Betoni s kamnitimi agregati (2200) | 20 | 1,51 | 2200 |
| lepilna malta za kameno volno | 0,5 | 0,9 | 1450 |
| kamena volna FKD-N Thermal d=50-240 mm | 22 | 0,034 | 90 |
| Pigmentna fasadna malta | 1 | 0,7 | 1850 |

| Naziv konstrukcije | Poševna streha | Tip konstrukcije | Ravna in poševne strehe |
|---|---|---|---|
| Toplotna prehodnost | 0,1 W/m$^2$K | Difuzija vodne pare | |
| | Ustreza | | Ustreza |

| Sloji v konstrukciji | d [cm] | λ [W/mK] | ρ [kg/m$^3$] |
|---|---|---|---|
| Mavčno-kartonske plošče-do 15mm | 1,3 | 0,21 | 900 |
| steklena volna AKUSTIK ROLL | 5 | 0,039 | 12,5 |
| HOR. GOR, d=9cm | 9 | 0,563 | 1 |
| Betoni s kamnitimi agregati (2200) | 20 | 1,51 | 2200 |
| parna zapora pvc Sd 1000 | 0,02 | 0,19 | 450 |
| kamena volna SMARTroof Thermal (DDP-RT) d = 60-160 mm | 20 | 0,036 | 115 |
| kamena volna SMARTroof Top (DDP) d > 70 mm | 10 | 0,038 | 135 |
| TPO strešne folije | 0,2 | 0,2 | 1250 |

| Naziv konstrukcije | Ravna streha | Tip konstrukcije | Ravna in poševne strehe |
|---|---|---|---|
| Toplotna prehodnost | 0,08 W/m$^2$K | Difuzija vodne pare | |
| | Ustreza | | Ustreza |

| Sloji v konstrukciji | d [cm] | λ [W/mK] | ρ [kg/m$^3$] |
|---|---|---|---|
| Apnena malta | 1 | 0,81 | 1600 |
| Betoni s kamnitimi agregati (2200) | 20 | 1,51 | 2200 |
| parna zapora pvc Sd 1000 | 0,02 | 0,19 | 450 |
| kamena volna SMARTroof Thermal (DDP-RT) d = 60-160 mm | 20 | 0,036 | 115 |
| kamena volna SMARTroof Top (DDP) d > 70 mm | 10 | 0,038 | 135 |
| kamena volna SMARTroof Top CTF1 (DDP-G) | 13,5 | 0,04 | 145 |
| TPO strešne folije | 0,2 | 0,2 | 1250 |

| Naziv konstrukcije | Tla na terenu, prostori | Tip konstrukcije | Tla na terenu |
|---|---|---|---|
| Toplotna prehodnost | 0,09 W/m$^2$K | Difuzija vodne pare | |
| | Ustreza | | Ustreza |

| Sloji v konstrukciji | d [cm] | λ [W/mK] | ρ [kg/m$^3$] |
|---|---|---|---|
| Keramične ploščice-talne,neglazirane | 1,5 | 1,28 | 2300 |
| Cementni estrih | 9 | 1,4 | 2200 |
| Polietilenske folije | 0,2 | 0,19 | 1000 |
| Fragmat Stirotermal Silent Reflect | 2 | 0,04 | 20 |
| Polietilenske folije | 0,1 | 0,19 | 1000 |
| kamena volna DF | 12 | 0,04 | 100 |
| Fragmat Neo Super 100 | 6 | 0,03 | 40 |
| bitumenska hidroizolacija | 0,5 | 0,19 | 1100 |
| Betoni s kamnitimi agregati (2200) | 10 | 1,51 | 2200 |

| Naziv konstrukcije | Tla na terenu, jašek | Tip konstrukcije | Tla v vkopani kleti |
|---|---|---|---|
| Toplotna prehodnost | 0,15 W/m$^2$K | Difuzija vodne pare | |
| | Ustreza | | Ustreza |

| Sloji v konstrukciji | d [cm] | λ [W/mK] | ρ [kg/m$^3$] |
|---|---|---|---|
| Betoni s kamnitimi agregati (2200) | 20 | 1,51 | 2200 |
| Polietilenske folije | 0,25 | 0,19 | 1000 |
| FIBRAN XPS 300L | 20 | 0,04 | 50 |
| bitumenska hidroizolacija | 0,5 | 0,19 | 1100 |
| Betoni s kamnitimi agregati (2200) | 10 | 1,51 | 2200 |

| Naziv konstrukcije | Vkopana stena jaška | Tip konstrukcije | Stene vkopane kleti |
|---|---|---|---|
| Toplotna prehodnost | 0,14 W/m$^2$K | Difuzija vodne pare | |
| | Ustreza | | Ustreza |

| Sloji v konstrukciji | d [cm] | λ [W/mK] | ρ [kg/m$^3$] |
|---|---|---|---|
| Apnena malta | 1 | 0,81 | 1600 |
| Betoni s kamnitimi agregati (2200) | 18 | 1,51 | 2200 |
| bitumenska hidroizolacija | 0,5 | 0,19 | 1100 |
| FIBRAN XPS 300L | 22 | 0,04 | 50 |

# Izkaz o energetskih lastnostih energetsko zahtevne stavbe za področje Tehničnih stavbnih sistemov

**Vgrajeni tehnični stavbni sistemi**

| | Sistem | Energent | OVE |
|---|---|---|---|
| x | Ogrevanje | elektrika | toplota okolja |
| x | Hlajenje | elektrika | toplota okolja |
| x | Prezračevanje | elektrika | odpadna toplota |
| x | Priprava TSV | elektrika | toplota okolja |
| | Klimatizacija | | |
| x | Razsvetljava | elektrika | |
| x | Avtomatizacija in nadzor | elektrika | |
| | E-mobilnost | | |
| x | Proizvodnja toplote in električne energije | elektrika | toplota okolja, sonce |
| x | Transportni sistemi v stavbi | elektrika | |

**Potrebna toplota/normirana dovedena toplota za ogrevanje in odvedena toplota za hlajenje**

| $Q_{H,nd}$ (kWh/(an)) | $Q_{C,nd}$ (kWh/(an)) | $Q'_{H,nd}$ (kWh/($m^2$an)) | $Q'_{C,nd}$ (kWh/($m^2$an)) |
|---|---|---|---|
| 6696 | 2423 | 10,6 | 3,8 |

| # | Naziv cone | $Q'_{H,nd,zn}$ (kWh/($m^2$an)) | $Q'_{C,nd,zn}$ (kWh/($m^2$an)) |
|---|---|---|---|
| 1 | kondicionirana cona | 10,6 | 3,8 |

| $X_{H,nd}$ (-) | $Q'_{nd,dov,an}$ (KWh/($m^2$an)) | $Q'_{H,nd,dov,kor}$ (kWh/($m^2$an)) | $Q'_{H,nd}$ (kWh/($m^2$an)) | | $Y_{H,nd}$ (-) |
|---|---|---|---|---|---|
| 0,90 | 22,5 | 20,3 | 10,6 | Ustreza | |

**Potrebna toplota/normirana toplota za TSV**

| $Q_{W,nd}$ (kWh/an) | $Q'_{W,nd}$ (kWh/($m^2$an)) |
|---|---|
| 36036 | 57,2 |

| # | Naziv cone | $Q'_{W,nd,zn}$ (kWh/($m^2$an)) |
|---|---|---|
| 1 | kondicionirana cona | 57,2 |

**Potrebna energija/normirana energija za navlaževanje in razvlaževanje**

| $Q_{HU,nd}$ (kWh/(an)) | $Q_{DHU,nd}$ (kWh/(an)) | $Q'_{HU,nd}$ (kWh/($m^2$an)) | $Q'_{DHU,nd}$ (kWh/($m^2$an)) |
|---|---|---|---|
| 0 | 0 | 0,0 | 0,0 |

| # | Naziv cone | $Q'_{HU,nd,zn}$ (kWh/($m^2$an)) | $Q'_{DHU,nd,zn}$ (kWh/($m^2$an)) |
|---|---|---|---|
| 1 | kondicionirana cona | 0,0 | 0,0 |

**Potrebna energija za razsvetljavo***

*Informativna raba električne energije za razsvetljavo

| $Q_L$ (kWh/an) | $Q'_{L,nd}$ (kWh/($m^2$an)) |
|---|---|
| 3360 | 5,3 |

| # | Naziv cone | $Q'_{L,nd,zn}$ (kWh/($m^2$an)) |
|---|---|---|
| 1 | kondicionirana cona | 5,3 |

## Dovedena energija za delovanje tehničnih stavbnih sistemov

**Dovedena energija za gretje $E_{H,del,an}$**

| # | Energent | Dovedena energija (kWh/an) |
|---|---|---|
| 1 | Toplota okolja | 4972 |
| 2 | Elektrika | 1323 |

| # | Naziv sistema | Energent 1 | Energent 2 | Energent 3 |
|---|---|---|---|---|
| 1 | Ogrevanje prostorov | Toplota okolja<br>4972 kWh/an | Elektrika<br>1323 kWh/an | |

**Dovedena energija za hlajenje $E_{C,del,an}$**

| # | Energent | Dovedena energija (kWh/an) |
|---|---|---|
| 1 | Elektrika | 518 |

| # | Naziv sistema | Energent 1 | Energent 2 | Energent 3 |
|---|---|---|---|---|
| 1 | Hlajenje prostorov | Elektrika<br>518 kWh/an | | |

**Dovedena energija za segrevanje TSV $E_{W,del,an}$**

| # | Energent | Dovedena energija (kWh/an) |
|---|---|---|
| 1 | Toplota okolja | 28242 |
| 2 | Elektrika | 15550 |

| # | Naziv sistema | Energent 1 | Energent 2 | Energent 3 |
|---|---|---|---|---|
| 1 | Priprava tople vode | Toplota okolja<br>28242 kWh/an | Elektrika<br>15550 kWh/an | |

**Dovedena energija za prezračevanje $E_{V,del,an}$**

| # | Energent | Dovedena energija (kWh/an) |
|---|---|---|
| 1 | Elektrika | 2121 |

| # | Naziv sistema | Energent 1 | Energent 2 | Energent 3 |
|---|---|---|---|---|
| 1 | Prezračevanje prostorov | Elektrika<br>2121 kWh/an | | |

**Dovedena energija za razsvetljavo $E_{L,del,an}$**

| # | Energent | Dovedena energija (kWh/an) |
|---|---|---|
| 1 | Elektrika | 3360 |

| # | Naziv sistema | Energent 1 | Energent 2 | Energent 3 |
|---|---|---|---|---|
| 1 | kondicionirana cona | Elektrika<br>3360 kWh/an | | |

**Dovedena energija (drugi sistemi)**

| # | Energent | Dovedena energija (kWh/an) |
|---|---|---|
| | | |

| # | Naziv sistema | Energent 1 | Energent 2 | Energent 3 |
|---|---|---|---|---|
| | | | | |

**V/na/ob stavbi proizveden energent in energent oddan v omrežje**

| | Količina (kWh/an) |
|---|---|
| Proizvedena toplota $Q_{pr,an}$ | |
| Proizvedena toplota porabljena na stavbi $Q_{pr,used,an}$ | |
| Oddana toplota iz stavbe $Q_{exp,an}$ | |
| | |
| Faktor ujemanja na stavbi proizvedene in porabljene toplote $f_{match,avg,an}$ | |
| Kontrolni faktor oddane toplote $k_{exp}$ | |
| | |
| Proizvedena električna energija $E_{PV,pr,an}$ | 15242 |
| Proizvedena električna energija porabljena na stavbi $E_{PV,used,an}$ | 13038 |
| Oddana električna energija iz stavbe $E_{PV,exp,an}$ | 2204 |
| | |
| Faktor ujemanja na stavbi proizvedene in porabljene električne energije $f_{match,avg,an}$ | 1,0 |
| Kontrolni faktor oddane električne energije $k_{exp}$ | 1 |

**Učinkovitost sistema za oskrbo s toploto $\eta_{H/W/C,avg,an}$**

| # | Naziv sistema | Učinkovitost | Ustreza |
|---|---|---|---|
| 1 | Skupaj hH/W/C,avg,an | 57 | |

**Delež ogrevanja s solarnim sistemom ali OVE brez izpustov PM esol**

| # | Naziv sistema | Učinkovitost | Ustreza |
|---|---|---|---|
| 1 | Ni podatka | | |

## Kazalniki energijske učinkovitosti stavbe

| | Količina (kWh/an) |
|---|---|
| Neutežena dovedena energija za delovanje TSS $E_{del,an}$ | 56085 |
| Utežena dovedena energija za delovanje TSS $E_{w,del,an}$ | 90392 |
| Obnovljiva primarna energija dovedene energije $E_{Pren,an}$ | 58289 |
| Neobnovljiva primarna energija dovedene energije $E_{Pnren,an}$ | 14749 |
| Skupna primarna energija $E_{Ptot,an}$ | 67529 |
| Skupna primarna energija oddane energije iz stavbe $E_{Ptot,exp,an}$ | -5509 |

| | Vrednost (%) |
|---|---|
| Razmernik obnovljivih virov energije ROVE | 86 |
| Minimalni zahtevani razmernik $ROV_{Emin}$ | 55 |
| Ustreza minimalni zahtevi | Ustreza |

| | Vrednost (-) |
|---|---|
| Korekcijski faktor razmernika ROVE $X_{OVE}$ | 1,1 |
| Kompenzacijski faktor razmernika ROVE $Y_{ROVE}$ | 0,8 |
| | |
| Korekcijski faktor dovoljene skupne primarne energije glede na vrsto stavbe Xs | 0,9 |
| Korekcijski faktor dovoljene skupne primarne energije glede na leto uveljavitve Xp | 0,9 |
| Kompenzacijski faktor potrebne toplote za ogrevanje $Y_{H,nd}$ | 1,0 |

| | Količina (kWh/($m^2$an)) |
|---|---|
| Specifična potrebna skupna primarna energija $E'_{Ptot,an}$ | 107,2 |
| Korigirana specifična potrebna primarna energija $E'_{Ptot,kor,an}$ | 85,8 |
| Specifična potrebna skupna primarna energija referenčne stavbe $E'_{Ptot,ref,an}$ | 230,8 |
| Korigirana specifična potrebna primarna energija refrenčne stavbe $E'_{Ptot,ref,kor,an}$ | 187,0 |
| Ustreza minimalni zahtevi | Ustreza |

| | Vrednost (kg/an) |
|---|---|
| Izpusti ogljikovega dioksida $M_{CO2,an}$ | 3204,32 |

# ENERGIJSKI KAZALNIKI

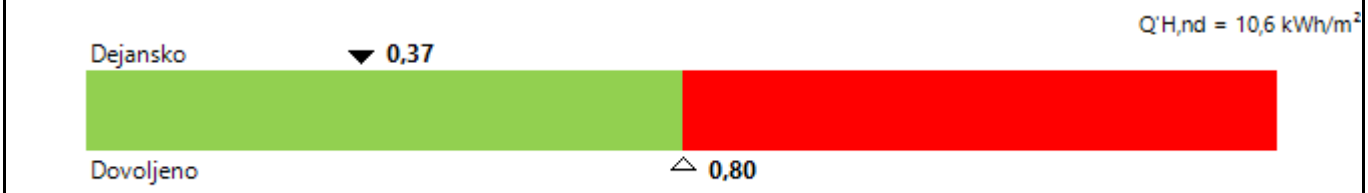
**Splošni podatki o stavbi**

| | |
|---|---|
| Investitor | Občina Polzela, Malteška cesta 28, 3313 Polzela |
| Stavba | Prizidava OŠ Polzela, 1 faza |
| Lokacija stavbe | 3313 Polzela , Šolska ulica 3 |
| Katastrska občina | POLZELA |
| Parcelna številka | *714, 779/4,... |
| Koordinate lokacije stavbe (Y, X) | Y= 506338 X= 126216 |
| Klasifikacija stavbe | 1263001 Stavbe za izobraževanje in znanstvenoraziskovalno delo |
| Etažnost: | P+1N |
| Kondicionirana površina stavbe $A_{use}$ | 629,9 $m^2$ |
| Prostornina stavbe $V_e$ | 2537,0 $m^3$ |
| Neto prostornina stavbe V | 2030,8 $m^3$ |
| Faktor oblike stavbe $f_o$ | 0,49 $m^{-1}$ |

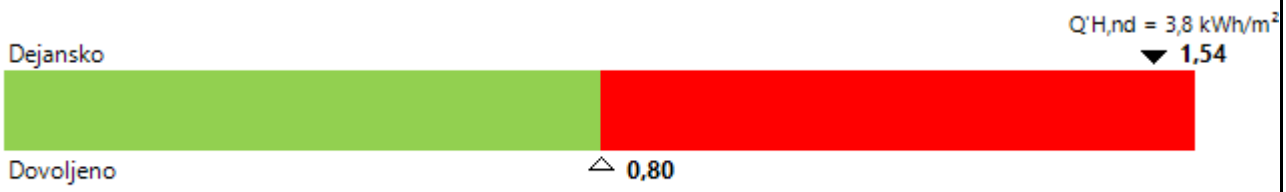
**Vrsta stavbe**

| | |
|---|---|
| Opredelitev stavbe | Energetsko zahtevna stavba |
| Vrsta gradnje | Novogradnja |
| Javna stavba | Da |

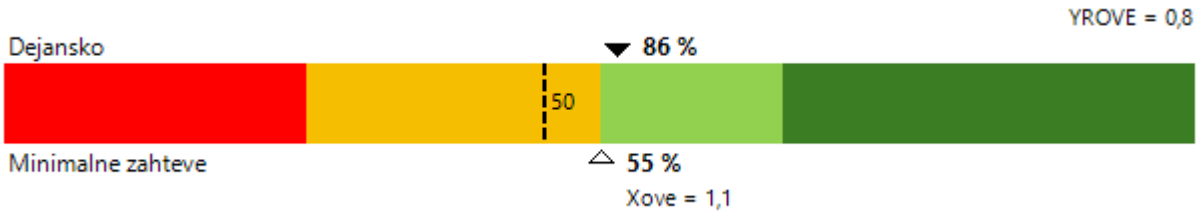
| **Razmernik potrebne toplote za ogrevanje $H_{nd}$** | **Ustreza** |
|---|---|



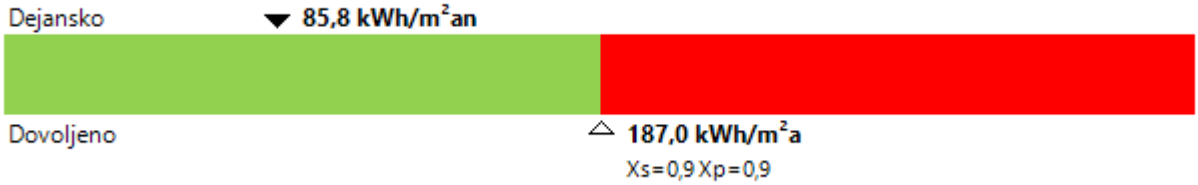
| Razmernik potrebne toplote za ogrevanje $C_{nd}$ | Ustreza |
|---|---|



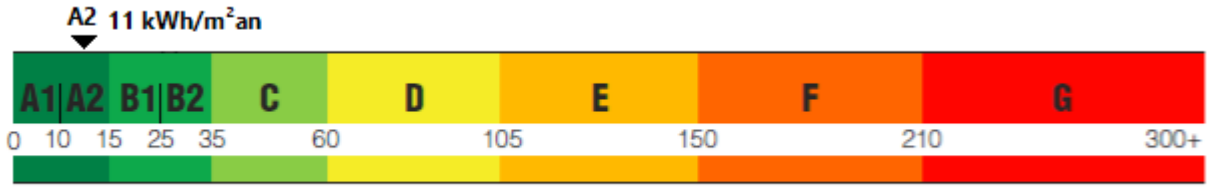

| ROVE | Ustreza |
|---|---|

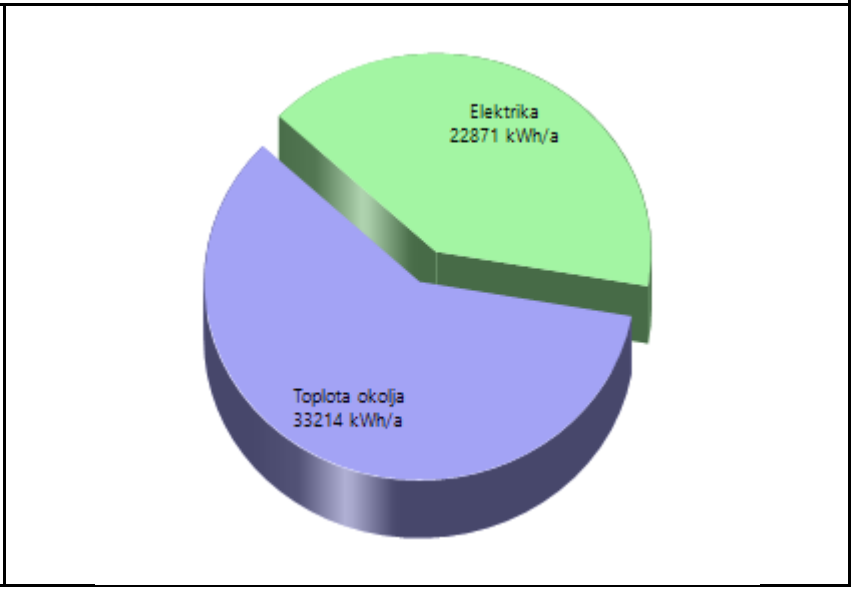



| Korigirana specifična potrebna skupna primarna energija $E'_{Ptot,kor,an}$ | Ustreza |
|---|---|




| Specifična potrebna toplota za ogrevanje $Q_{H,nd,an}$ (Razred) |
|---|



| **Struktura rabe celotne energije za delovanje stavbe po virih energije in energentih** | |
|---|---|
| Dovedena energija za delovanje stavbe:<br>56085 kWh/an |  |

| | |
|---|---|
| **Izpusti ogljikovega dioksoda $MCO_{2,an}$** | **3204 kg/an** |

# Tehnično poročilo o energijski učinkovitosti stavbe
# ELABORAT ENERGETSKIH LASTNOSTIH STAVBE

za PZI

**Splošni podatki o stavbi**

| | |
|---|---|
| Investitor | Občina Polzela, Malteška cesta 28, 3313 Polzela |
| Stavba | Prizidava OŠ Polzela, 2. faza |
| Lokacija stavbe | 3313 Polzela , Šolska ulica 3 |
| Katastrska občina | POLZELA |
| Parcelna številka | *714, 779/4,... |
| Koordinate lokacije stavbe (Y, X) | Y= 506348 X= 126202 |
| Klasifikacija stavbe | 1263001 Stavbe za izobraževanje in znanstvenoraziskovalno delo |
| Etažnost: | P+1N |
| Kondicionirana površina stavbe $A_{use}$ | 407,6 $m^2$ |
| Prostornina stavbe $V_e$ | 1478,0 $m^3$ |
| Neto prostornina stavbe V | 1237,9 $m^3$ |
| Faktor oblike stavbe $f_o$ | 0,58 $m^{-1}$ |

**Vrsta stavbe**

| | |
|---|---|
| Opredelitev stavbe | Energetsko zahtevna stavba |
| Vrsta gradnje | Novogradnja |
| Javna stavba | Da |

**Podatki o izdelovalcu izkaza**

| | |
|---|---|
| Vodja projektiranja | Tadej Renar, m.i.a., ZAPS 2273-PA* |
| Izdelovalec izkaza | Matej Kramar, d.i.s., IZS S-1852 |
| Datum izdelave izkaza | 15. 04. 2025 |
| Podpis izdelovalca izkaza: ..... | |

# IZKAZ O ENERGETSKIH LASTNOSTIH STAVBE

**Toplotna prehodnost gradbenih konstrukcij in gradnikov stavbe**

| Naziv cone | kondicionirana cona | Kondicionirana površina cone $A_{use,zn}$ | 407,6 m² |
|---|---|---|---|

| # | Naziv konstrukcije/gradnika f | A (m²) | U (W/m²K) | $U_{dov}$ (W/m²K) | |
|---|---|---|---|---|---|
| 1 | Zunanja stena | 51 | 0,147 | 0,180 | Ustreza |
| 2 | Zunanja stena | 80 | 0,147 | 0,180 | Ustreza |
| 3 | Zunanja stena | 21 | 0,147 | 0,180 | Ustreza |
| 4 | Zunanja stena | 37 | 0,147 | 0,180 | Ustreza |
| 5 | Zunanja stena - cokl | 6 | 0,134 | 0,180 | Ustreza |
| 6 | Zunanja stena - cokl | 10 | 0,134 | 0,180 | Ustreza |
| 7 | Zunanja stena - cokl | 2 | 0,134 | 0,180 | Ustreza |
| 8 | Zunanja stena - cokl | 9 | 0,134 | 0,180 | Ustreza |
| 9 | Previs | 10 | 0,116 | 0,200 | Ustreza |
| 10 | Poševna streha | 284 | 0,100 | 0,150 | Ustreza |
| 11 | Tla na terenu, kuhinja | 282 | 0,083 | 0,350 | Ustreza |
| 12 | Vrata | 5 | 0,900 | 1,600 | Ustreza |
| 13 | Vrata | 3 | 0,900 | 1,600 | Ustreza |
| 14 | Okna | 32 | 0,620 | 1,000 | Ustreza |
| 15 | Okna | 22 | 0,620 | 1,000 | Ustreza |
| 16 | Strešna okna | 7 | 0,640 | 1,400 | Ustreza |

**Linijske in točkovne toplotne prehodnosti toplotnih mostov**

| Naziv cone | kondicionirana cona | | |
|---|---|---|---|
| Toplotni mostovi ovrednoteni po poenostavljeni metodi | | $\Delta\Psi_{th}$ (W/(m2K)) | 0,04 |

**Preverjanje prehoda vodne pare**

| Naziv cone | kondicionirana cona | | | | |
|---|---|---|---|---|---|
| # | Naziv konstrukcije/gradnika f | Kondenzacija | $M_{c,max}$ (kg/m²) | $f_{rsi}$ (-) | |
| 1 | Zunanja stena | Ni kondenzacije | 0,000 | 0,964 | Ustreza |
| 2 | Zunanja stena | Ni kondenzacije | 0,000 | 0,964 | Ustreza |
| 3 | Zunanja stena | Ni kondenzacije | 0,000 | 0,964 | Ustreza |
| 4 | Zunanja stena | Ni kondenzacije | 0,000 | 0,964 | Ustreza |
| 5 | Zunanja stena - cokl | Ni kondenzacije | 0,000 | 0,967 | Ustreza |
| 6 | Zunanja stena - cokl | Ni kondenzacije | 0,000 | 0,967 | Ustreza |
| 7 | Zunanja stena - cokl | Ni kondenzacije | 0,000 | 0,967 | Ustreza |
| 8 | Zunanja stena - cokl | Ni kondenzacije | 0,000 | 0,967 | Ustreza |
| 9 | Previs | Ni kondenzacije | 0,000 | 0,971 | Ustreza |
| 10 | Poševna streha | Kondenzat se posuši | 1000000,000 | 0,975 | Ustreza |
| 11 | Tla na terenu, kuhinja | Ni kondenzacije | 0,000 | 0,965 | Ustreza |

**Toplotne lastnosti transparentnih gradnikov/oken**

| Naziv cone | kondicionirana cona | | | | | |
|---|---|---|---|---|---|---|
| # | Naziv konstrukcije/gradnika f | $A_w$ ($m^2$) | $U_w$ ($W/m^2K$) | $g_{tot,sh}$ (-) | $\tau_{vis}$ (-) | |
| 1 | Vrata | 4,8 | 0,900 | 0,000 | 0,700 | Ustreza |
| 2 | Vrata | 2,8 | 0,900 | 0,000 | 0,700 | Ustreza |
| 3 | Okna | 31,9 | 0,620 | 0,150 | 0,700 | Ustreza |
| 4 | Okna | 21,9 | 0,620 | 0,150 | 0,700 | Ustreza |
| 5 | Strešna okna | 6,8 | 0,640 | 0,150 | 0,750 | Ustreza |

**Faktor dneven svetlobe**

| Načrtovano | | | |
|---|---|---|---|
| Izračunano | | | |
| # | Naziv cone | FDS (%) | $FDS_{TM}$ (%) |
| 1 | kondicionirana cona | 2,5 | |

**Tesnost ovoja stavbe**

| Načrtovano | | $n_{50}$ ($h^{-1}$) | |
|---|---|---|---|
| Izračunano | | | |
| # | Naziv cone | $n_{50}$ ($h^{-1}$) | $w_{50}$ ($h^{-1}$) |
| 1 | kondicionirana cona | 0,6 | |

**Specifični koeficient transmisijskih toplotnih izgub stavbe/cone**

| $X_{H'tr}$ (-) | $H'_{tr}$ ($W/m^2K$) | $H'_{tr,dov}$ ($W/m^2K$) | |
|---|---|---|---|
| 0,900 | 0,191 | 0,323 | |

| # | Naziv cone | $H'_{tr,zn}$ ($W/m^2K$) |
|---|---|---|
| 1 | kondicionirana cona | 0,191 |

**Koeficient transmisijskih in prezračevalnih toplotnih izgub stavbe/cone**

| $H_{tr}$ (W/K) | $H_{ve}$ (W/K) |
|---|---|
| 164,0 | 56,4 |

| # | Naziv cone | $H_{tr}$ (W/K) | $H_{ve}$ (W/K) |
|---|---|---|---|
| 1 | kondicionirana cona | 164,0 | 56,4 |

**Potrebna toplota/normirana dovedena toplota za ogrevanje in odvedena toplota za hlajenje**

| $Q_{H,nd}$ (kWh/(an)) | $Q_{C,nd}$ (kWh/(an)) | $Q'_{H,nd}$ ($kWh/(m^2an)$) | $Q'_{C,nd}$ ($kWh/(m^2an)$) |
|---|---|---|---|
| 2977 | 1883 | 7,3 | 4,6 |

| # | Naziv cone | $Q'_{H,nd,zn}$ ($kWh/(m^2an)$) | $Q'_{C,nd,zn}$ ($kWh/(m^2an)$) |
|---|---|---|---|
| 1 | kondicionirana cona | 7,3 | 4,6 |

| $H_{nd}$ (-) | $H_{nd,dov}$ (-) | Ustreza | $_{Cnd}$ (-) | $_{Cnd,dov}$ (-) | Ustreza |
|---|---|---|---|---|---|
| 0,41 | 0,80 | DA | 1,40 | 0,80 | Se ne preverja |

**Potrebna toplota/normirana toplota za TSV**

| $Q_{W,nd}$ (kWh/an) | $Q'_{W,nd}$ (kWh/(m²an)) |
|---|---|
| 24362 | 59,8 |

| # | Naziv cone | $Q'_{W,nd,zn}$ (kWh/(m²an)) |
|---|---|---|
| 1 | kondicionirana cona | 59,8 |

**Potrebna energija/normirana energija za navlaževanje in razvlaževanje**

| $Q_{HU,nd}$ (kWh/(an)) | $Q_{DHU,nd}$ (kWh/(an)) | $Q'_{HU,nd}$ (kWh/(m²an)) | $Q'_{DHU,nd}$ (kWh/(m²an)) |
|---|---|---|---|
| 0 | 0 | 0,0 | 0,0 |

| # | Naziv cone | $Q'_{HU,nd,zn}$ (kWh/(m²an)) | $Q'_{DHU,nd,zn}$ (kWh/(m²an)) |
|---|---|---|---|
| 1 | kondicionirana cona | 0,0 | 0,0 |

**Potrebna energija za razsvetljavo***

*Informativna raba električne energije za razsvetljavo

| $Q_L$ (kWh/an) | $Q'_{L,nd}$ (kWh/(m²an)) |
|---|---|
| 2174 | 5,3 |

| # | Naziv cone | $Q'_{L,nd,zn}$ (kWh/(m²an)) |
|---|---|---|
| 1 | kondicionirana cona | 5,3 |

# IZPIS KONSTRUKCIJ V PROJEKTU

Cona: kondicionirana cona

| | | | |
|---|---|---|---|
| Naziv konstrukcije | Zunanja stena | Tip konstrukcije | Zunanje stene |
| Toplotna prehodnost | 0,15 W/m$^2$K | Difuzija vodne pare | |
| | Ustreza | | Ustreza |

| Sloji v konstrukciji | d [cm] | λ [W/mK] | ρ [kg/m$^3$] |
|---|---|---|---|
| Apnena malta | 1 | 0,81 | 1600 |
| Betoni s kamnitimi agregati (2200) | 18 | 1,51 | 2200 |
| lepilna malta za kameno volno | 0,5 | 0,9 | 1450 |
| kamena volna FKD-N Thermal d=50-240 mm | 22 | 0,034 | 90 |
| Pigmentna fasadna malta | 1 | 0,7 | 1850 |

| | | | |
|---|---|---|---|
| Naziv konstrukcije | Zunanja stena | Tip konstrukcije | Zunanje stene |
| Toplotna prehodnost | 0,15 W/m$^2$K | Difuzija vodne pare | |
| | Ustreza | | Ustreza |

| Sloji v konstrukciji | d [cm] | λ [W/mK] | ρ [kg/m$^3$] |
|---|---|---|---|
| Apnena malta | 1 | 0,81 | 1600 |
| Betoni s kamnitimi agregati (2200) | 18 | 1,51 | 2200 |
| lepilna malta za kameno volno | 0,5 | 0,9 | 1450 |
| kamena volna FKD-N Thermal d=50-240 mm | 22 | 0,034 | 90 |
| Pigmentna fasadna malta | 1 | 0,7 | 1850 |

| | | | |
|---|---|---|---|
| Naziv konstrukcije | Zunanja stena | Tip konstrukcije | Zunanje stene |
| Toplotna prehodnost | 0,15 W/m$^2$K | Difuzija vodne pare | |
| | Ustreza | | Ustreza |

| Sloji v konstrukciji | d [cm] | λ [W/mK] | ρ [kg/m$^3$] |
|---|---|---|---|
| Apnena malta | 1 | 0,81 | 1600 |
| Betoni s kamnitimi agregati (2200) | 18 | 1,51 | 2200 |
| lepilna malta za kameno volno | 0,5 | 0,9 | 1450 |
| kamena volna FKD-N Thermal d=50-240 mm | 22 | 0,034 | 90 |
| Pigmentna fasadna malta | 1 | 0,7 | 1850 |

| | | | |
|---|---|---|---|
| Naziv konstrukcije | Zunanja stena | Tip konstrukcije | Zunanje stene |
| Toplotna prehodnost | 0,15 W/m$^2$K | Difuzija vodne pare | |
| | Ustreza | | Ustreza |

| Sloji v konstrukciji | d [cm] | λ [W/mK] | ρ [kg/m$^3$] |
|---|---|---|---|
| Apnena malta | 1 | 0,81 | 1600 |
| Betoni s kamnitimi agregati (2200) | 18 | 1,51 | 2200 |
| lepilna malta za kameno volno | 0,5 | 0,9 | 1450 |
| kamena volna FKD-N Thermal d=50-240 mm | 22 | 0,034 | 90 |
| Pigmentna fasadna malta | 1 | 0,7 | 1850 |

| Naziv konstrukcije | Zunanja stena - cokl | Tip konstrukcije | Zunanje stene |
|---|---|---|---|
| Toplotna prehodnost | 0,13 W/m$^2$K | Difuzija vodne pare | |
| | Ustreza | | Ustreza |

| Sloji v konstrukciji | d [cm] | λ [W/mK] | ρ [kg/m$^3$] |
|---|---|---|---|
| Apnena malta | 1 | 0,81 | 1600 |
| Betoni s kamnitimi agregati (2200) | 18 | 1,51 | 2200 |
| bitumenska hidroizolacija | 0,5 | 0,19 | 1100 |
| Fragmat Neocokl | 22 | 0,031 | 20 |
| Pigmentna fasadna malta | 1 | 0,7 | 1850 |


| Naziv konstrukcije | Zunanja stena - cokl | Tip konstrukcije | Zunanje stene |
|---|---|---|---|
| Toplotna prehodnost | 0,13 W/m$^2$K | Difuzija vodne pare | |
| | Ustreza | | Ustreza |

| Sloji v konstrukciji | d [cm] | λ [W/mK] | ρ [kg/m$^3$] |
|---|---|---|---|
| Apnena malta | 1 | 0,81 | 1600 |
| Betoni s kamnitimi agregati (2200) | 18 | 1,51 | 2200 |
| bitumenska hidroizolacija | 0,5 | 0,19 | 1100 |
| Fragmat Neocokl | 22 | 0,031 | 20 |
| Pigmentna fasadna malta | 1 | 0,7 | 1850 |

| Naziv konstrukcije | Zunanja stena - cokl | Tip konstrukcije | Zunanje stene |
|---|---|---|---|
| Toplotna prehodnost | 0,13 W/m$^2$K | Difuzija vodne pare | |
| | Ustreza | | Ustreza |

| Sloji v konstrukciji | d [cm] | λ [W/mK] | ρ [kg/m$^3$] |
|---|---|---|---|
| Apnena malta | 1 | 0,81 | 1600 |
| Betoni s kamnitimi agregati (2200) | 18 | 1,51 | 2200 |
| bitumenska hidroizolacija | 0,5 | 0,19 | 1100 |
| Fragmat Neocokl | 22 | 0,031 | 20 |
| Pigmentna fasadna malta | 1 | 0,7 | 1850 |

| Naziv konstrukcije | Zunanja stena - cokl | Tip konstrukcije | Zunanje stene |
|---|---|---|---|
| Toplotna prehodnost | 0,13 W/m$^2$K | Difuzija vodne pare | |
| | Ustreza | | Ustreza |

| Sloji v konstrukciji | d [cm] | λ [W/mK] | ρ [kg/m$^3$] |
|---|---|---|---|
| Apnena malta | 1 | 0,81 | 1600 |
| Betoni s kamnitimi agregati (2200) | 18 | 1,51 | 2200 |
| bitumenska hidroizolacija | 0,5 | 0,19 | 1100 |
| Fragmat Neocokl | 22 | 0,031 | 20 |
| Pigmentna fasadna malta | 1 | 0,7 | 1850 |

| Naziv konstrukcije | Previs | Tip konstrukcije | Tla s ploskovnim ogrevanjem proti zunanjosti |
|---|---|---|---|
| Toplotna prehodnost | 0,12 W/m$^2$K | Difuzija vodne pare | |
| | Ustreza | | Ustreza |

| Sloji v konstrukciji | d [cm] | λ [W/mK] | ρ [kg/m$^3$] |
|---|---|---|---|
| Keramične ploščice-talne,neglazirane | 1,5 | 1,28 | 2300 |
| Cementni estrih | 9 | 1,4 | 2200 |
| Polietilenske folije | 0,3 | 0,19 | 1000 |
| Fragmat Stirotermal Silent Reflect | 2 | 0,038 | 20 |
| Polietilenske folije | 0,2 | 0,19 | 1000 |
| kamena volna DF | 5 | 0,037 | 100 |
| Betoni s kamnitimi agregati (2200) | 20 | 1,51 | 2200 |
| lepilna malta za kameno volno | 0,5 | 0,9 | 1450 |
| kamena volna FKD-N Thermal d=50-240 mm | 22 | 0,034 | 90 |
| Pigmentna fasadna malta | 1 | 0,7 | 1850 |

| Naziv konstrukcije | Poševna streha | Tip konstrukcije | Ravna in poševne strehe |
|---|---|---|---|
| Toplotna prehodnost | 0,1 W/m$^2$K | Difuzija vodne pare | |
| | Ustreza | | Ustreza |

| Sloji v konstrukciji | d [cm] | λ [W/mK] | ρ [kg/m$^3$] |
|---|---|---|---|
| Mavčno-kartonske plošče-do 15mm | 1,3 | 0,21 | 900 |
| steklena volna AKUSTIK ROLL | 5 | 0,039 | 12,5 |
| HOR. GOR, d=9cm | 9 | 0,563 | 1 |
| Betoni s kamnitimi agregati (2200) | 20 | 1,51 | 2200 |
| parna zapora pvc Sd 1000 | 0,02 | 0,19 | 450 |
| kamena volna SMARTroof Thermal (DDP-RT) d = 60-160 mm | 20 | 0,036 | 115 |
| kamena volna SMARTroof Top (DDP) d > 70 mm | 10 | 0,038 | 135 |
| TPO strešne folije | 0,2 | 0,2 | 1250 |

| Naziv konstrukcije | Tla na terenu, kuhinja | Tip konstrukcije | Tla na terenu |
|---|---|---|---|
| Toplotna prehodnost | 0,08 W/m$^2$K | Difuzija vodne pare | |
| | Ustreza | | Ustreza |

| Sloji v konstrukciji | d [cm] | λ [W/mK] | ρ [kg/m$^3$] |
|---|---|---|---|
| Keramične ploščice-talne,neglazirane | 1,5 | 1,28 | 2300 |
| Cementni estrih | 10 | 1,4 | 2200 |
| Polietilenske folije | 0,3 | 0,19 | 1000 |
| Fragmat Neo Super 100 | 18 | 0,03 | 40 |
| FIBRAN XPS 300L | 3 | 0,04 | 50 |
| bitumenska hidroizolacija | 0,5 | 0,19 | 1100 |
| Betoni s kamnitimi agregati (2200) | 10 | 1,51 | 2200 |

# Izkaz o energetskih lastnostih energetsko zahtevne stavbe za področje Tehničnih stavbnih sistemov

**Vgrajeni tehnični stavbni sistemi**

| | Sistem | Energent | OVE |
|---|---|---|---|
| x | Ogrevanje | elektrika | toplota okolja |
| x | Hlajenje | elektrika | toplota okolja |
| x | Prezračevanje | elektrika | odpadna toplota |
| x | Priprava TSV | elektrika | toplota okolja |
| | Klimatizacija | | |
| x | Razsvetljava | elektrika | |
| x | Avtomatizacija in nadzor | elektrika | |
| | E-mobilnost | | |
| x | Proizvodnja toplote in električne energije | elektrika | toplota okolja, sonce |
| x | Transportni sistemi v stavbi | elektrika | |

**Potrebna toplota/normirana dovedena toplota za ogrevanje in odvedena toplota za hlajenje**

| $Q_{H,nd}$ (kWh/(an)) | $Q_{C,nd}$ (kWh/(an)) | $Q'_{H,nd}$ (kWh/(m$^2$an)) | $Q'_{C,nd}$ (kWh/(m$^2$an)) |
|---|---|---|---|
| 2977 | 1883 | 7,3 | 4,6 |

| # | Naziv cone | $Q'_{H,nd,zn}$ (kWh/(m$^2$an)) | $Q'_{C,nd,zn}$ (kWh/(m$^2$an)) |
|---|---|---|---|
| 1 | kondicionirana cona | 7,3 | 4,6 |

| $X_{H,nd}$ (-) | $Q'_{nd,dov,an}$ (KWh/(m$^2$an)) | $Q'_{H,nd,dov,kor}$ (kWh/(m$^2$an)) | $Q'_{H,nd}$ (kWh/(m$^2$an)) | | $Y_{H,nd}$ (-) |
|---|---|---|---|---|---|
| 0,90 | 22,5 | 20,3 | 7,3 | Ustreza | |

**Potrebna toplota/normirana toplota za TSV**

| $Q_{W,nd}$ (kWh/an) | $Q'_{W,nd}$ (kWh/(m$^2$an)) |
|---|---|
| 24362 | 59,8 |

| # | Naziv cone | $Q'_{W,nd,zn}$ (kWh/(m$^2$an)) |
|---|---|---|
| 1 | kondicionirana cona | 59,8 |

**Potrebna energija/normirana energija za navlaževanje in razvlaževanje**

| $Q_{HU,nd}$ (kWh/(an)) | $Q_{DHU,nd}$ (kWh/(an)) | $Q'_{HU,nd}$ (kWh/(m$^2$an)) | $Q'_{DHU,nd}$ (kWh/(m$^2$an)) |
|---|---|---|---|
| 0 | 0 | 0,0 | 0,0 |

| # | Naziv cone | $Q'_{HU,nd,zn}$ (kWh/(m$^2$an)) | $Q'_{DHU,nd,zn}$ (kWh/(m$^2$an)) |
|---|---|---|---|
| 1 | kondicionirana cona | 0,0 | 0,0 |

**Potrebna energija za razsvetljavo***

*Informativna raba električne energije za razsvetljavo

| $Q_L$ (kWh/an) | $Q'_{L,nd}$ (kWh/($m^2$an)) |
|---|---|
| 2174 | 5,3 |

| # | Naziv cone | $Q'_{L,nd,zn}$ (kWh/($m^2$an)) |
|---|---|---|
| 1 | kondicionirana cona | 5,3 |

## Dovedena energija za delovanje tehničnih stavbnih sistemov

**Dovedena energija za gretje $E_{H,del,an}$**

| # | Energent | Dovedena energija (kWh/an) |
|---|---|---|
| 1 | Toplota okolja | 2126 |
| 2 | Elektrika | 469 |

| # | Naziv sistema | Energent 1 | Energent 2 | Energent 3 |
|---|---|---|---|---|
| 1 | Ogrevanje prostorov | Toplota okolja<br>2126 kWh/an | Elektrika<br>469 kWh/an | |

**Dovedena energija za hlajenje $E_{C,del,an}$**

| # | Energent | Dovedena energija (kWh/an) |
|---|---|---|
| 1 | Elektrika | 444 |

| # | Naziv sistema | Energent 1 | Energent 2 | Energent 3 |
|---|---|---|---|---|
| 1 | Hlajenje prostorov | Elektrika<br>444 kWh/an | | |

**Dovedena energija za segrevanje TSV $E_{W,del,an}$**

| # | Energent | Dovedena energija (kWh/an) |
|---|---|---|
| 1 | Toplota okolja | 20825 |
| 2 | Elektrika | 9608 |

| # | Naziv sistema | Energent 1 | Energent 2 | Energent 3 |
|---|---|---|---|---|
| 1 | Priprava tople vode | Toplota okolja<br>20825 kWh/an | Elektrika<br>9608 kWh/an | |

**Dovedena energija za prezračevanje $E_{V,del,an}$**

| # | Energent | Dovedena energija (kWh/an) |
|---|---|---|
| 1 | Elektrika | 1325 |

| # | Naziv sistema | Energent 1 | Energent 2 | Energent 3 |
|---|---|---|---|---|
| 1 | Prezračevanje prostorov | Elektrika<br>1325 kWh/an | | |

**Dovedena energija za razsvetljavo $E_{L,del,an}$**

| # | Energent | Dovedena energija (kWh/an) |
|---|---|---|
| 1 | Elektrika | 2174 |

| # | Naziv sistema | Energent 1 | Energent 2 | Energent 3 |
|---|---|---|---|---|
| 1 | kondicionirana cona | Elektrika<br>2174 kWh/an | | |

**Dovedena energija (drugi sistemi)**

| # | Energent | Dovedena energija (kWh/an) |
|---|---|---|
| | | |

| # | Naziv sistema | Energent 1 | Energent 2 | Energent 3 |
|---|---|---|---|---|
| | | | | |

**V/na/ob stavbi proizveden energent in energent oddan v omrežje**

| | Količina (kWh/an) |
|---|---|
| Proizvedena toplota $Q_{pr,an}$ | |
| Proizvedena toplota porabljena na stavbi $Q_{pr,used,an}$ | |
| Oddana toplota iz stavbe $Q_{exp,an}$ | |
| | |
| Faktor ujemanja na stavbi proizvedene in porabljene toplote $f_{match,avg,an}$ | |
| Kontrolni faktor oddane toplote $k_{exp}$ | |
| | |
| Proizvedena električna energija $E_{PV,pr,an}$ | 9526 |
| Proizvedena električna energija porabljena na stavbi $E_{PV,used,an}$ | 8243 |
| Oddana električna energija iz stavbe $E_{PV,exp,an}$ | 1283 |
| | |
| Faktor ujemanja na stavbi proizvedene in porabljene električne energije $f_{match,avg,an}$ | 1,0 |
| Kontrolni faktor oddane električne energije $k_{exp}$ | 1 |

**Učinkovitost sistema za oskrbo s toploto $\eta_{H/W/C,avg,an}$**

| # | Naziv sistema | Učinkovitost | Ustreza |
|---|---|---|---|
| 1 | Skupaj hH/W/C,avg,an | 57 | |

**Delež ogrevanja s solarnim sistemom ali OVE brez izpustov PM esol**

| # | Naziv sistema | Učinkovitost | Ustreza |
|---|---|---|---|
| 1 | Ni podatka | | |

## Kazalniki energijske učinkovitosti stavbe

| | Količina (kWh/an) |
|---|---|
| Neutežena dovedena energija za delovanje TSS $E_{del,an}$ | 36972 |
| Utežena dovedena energija za delovanje TSS $E_{w,del,an}$ | 58004 |
| Obnovljiva primarna energija dovedene energije $E_{Pren,an}$ | 38255 |
| Neobnovljiva primarna energija dovedene energije $E_{Pnren,an}$ | 8667 |
| Skupna primarna energija $E_{Ptot,an}$ | 43715 |
| Skupna primarna energija oddane energije iz stavbe $E_{Ptot,exp,an}$ | -3208 |

| | Vrednost (%) |
|---|---|
| Razmernik obnovljivih virov energije ROVE | 88 |
| Minimalni zahtevani razmernik $ROV_{Emin}$ | 55 |
| Ustreza minimalni zahtevi | Ustreza |

| | Vrednost (-) |
|---|---|
| Korekcijski faktor razmernika ROVE $X_{OVE}$ | 1,1 |
| Kompenzacijski faktor razmernika ROVE $Y_{ROVE}$ | 0,8 |
| | |
| Korekcijski faktor dovoljene skupne primarne energije glede na vrsto stavbe Xs | 0,9 |
| Korekcijski faktor dovoljene skupne primarne energije glede na leto uveljavitve Xp | 0,9 |
| Kompenzacijski faktor potrebne toplote za ogrevanje $Y_{H,nd}$ | 1,0 |

| | Količina (kWh/($m^2$an)) |
|---|---|
| Specifična potrebna skupna primarna energija $E'_{Ptot,an}$ | 107,2 |
| Korigirana specifična potrebna primarna energija $E'_{Ptot,kor,an}$ | 85,8 |
| Specifična potrebna skupna primarna energija referenčne stavbe $E'_{Ptot,ref,an}$ | 222,6 |
| Korigirana specifična potrebna primarna energija refrenčne stavbe $E'_{Ptot,ref,kor,an}$ | 180,3 |
| Ustreza minimalni zahtevi | Ustreza |

| | Vrednost (kg/an) |
|---|---|
| Izpusti ogljikovega dioksida $M_{CO2,an}$ | 1887,86 |

# ENERGIJSKI KAZALNIKI

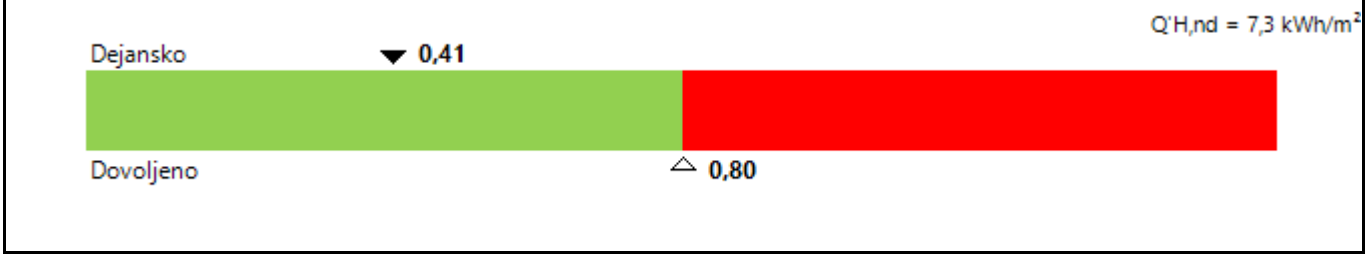
**Splošni podatki o stavbi**

| | |
|---|---|
| Investitor | Občina Polzela, Malteška cesta 28, 3313 Polzela |
| Stavba | Prizidava OŠ Polzela, 2F |
| Lokacija stavbe | 3313 Polzela , Šolska ulica 3 |
| Katastrska občina | POLZELA |
| Parcelna številka | *714, 779/4,... |
| Koordinate lokacije stavbe (Y, X) | Y= 506348 X= 126202 |
| Klasifikacija stavbe | 1263001 Stavbe za izobraževanje in znanstvenoraziskovalno delo |
| Etažnost: | P+1N |
| Kondicionirana površina stavbe $A_{use}$ | 407,6 $m^2$ |
| Prostornina stavbe $V_e$ | 1478,0 $m^3$ |
| Neto prostornina stavbe V | 1237,9 $m^3$ |
| Faktor oblike stavbe $f_o$ | 0,58 $m^{-1}$ |

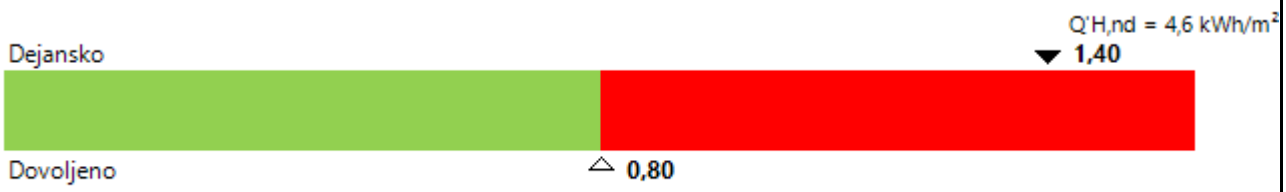
**Vrsta stavbe**

| | |
|---|---|
| Opredelitev stavbe | Energetsko zahtevna stavba |
| Vrsta gradnje | Novogradnja |
| Javna stavba | Da |

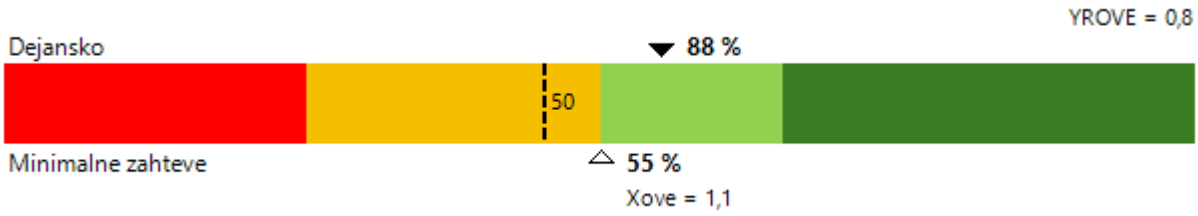
| **Razmernik potrebne toplote za ogrevanje $H_{nd}$** | **Ustreza** |
|---|---|



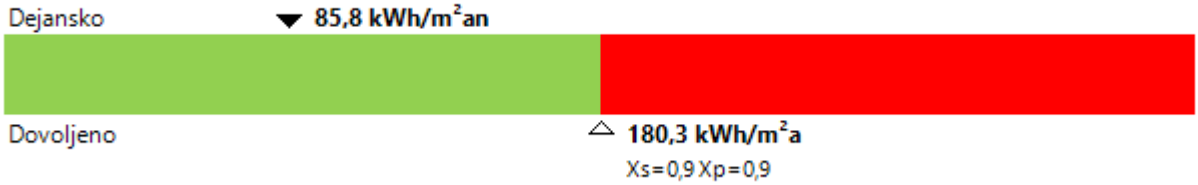
| Razmernik potrebne toplote za ogrevanje $C_{nd}$ | Ustreza |
|---|---|



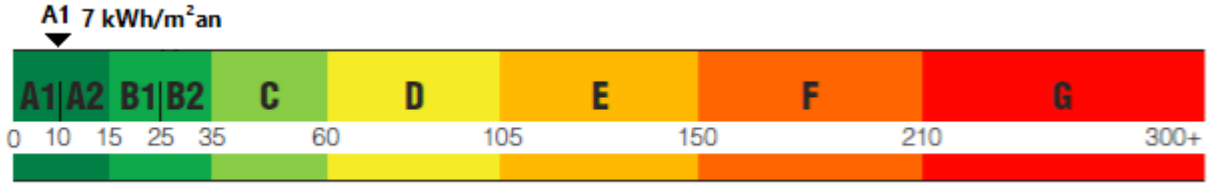

| ROVE | Ustreza |
|---|---|

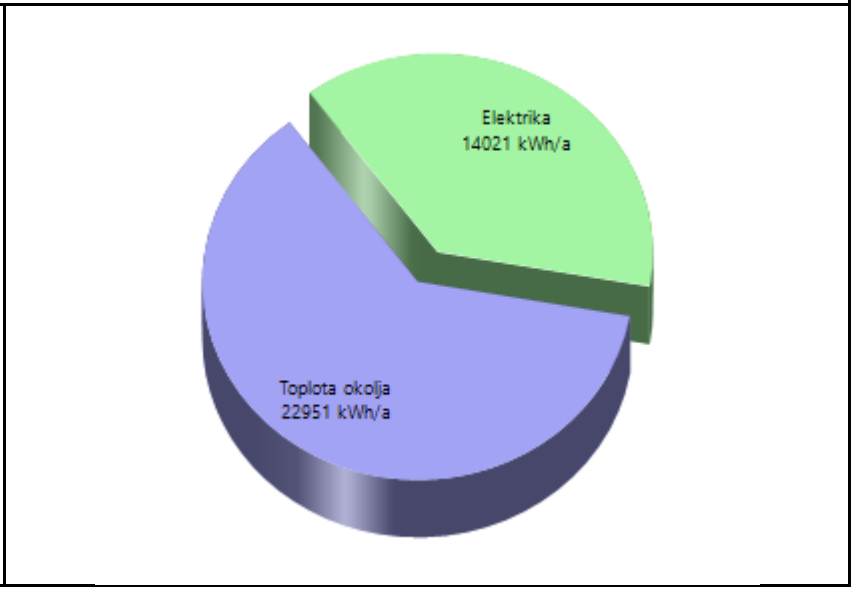



| Korigirana specifična potrebna skupna primarna energija $E'_{Ptot,kor,an}$ | Ustreza |
|---|---|




| Specifična potrebna toplota za ogrevanje $Q_{H,nd,an}$ (Razred) |
|---|



| **Struktura rabe celotne energije za delovanje stavbe po virih energije in energentih** | |
|---|---|
| Dovedena energija za delovanje stavbe:<br>36972 kWh/an |  |

| | |
|---|---|
| **Izpusti ogljikovega dioksoda $MCO_{2,an}$** | **1888 kg/an** |