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REPUBLIKA HRVATSKA
Ministarstvo regionalnoga razvoja
i fondova Europske unije

EIHP
ENERGETSKI INSTITUT
HRVOJE POŽAR

2. radionica PLIGES projekta

Mogućnosti regeneracije geotermalnog bušotinskog polja pohranom Sunčeve energije u tlo - je li solarni BTES isplativ?

PLIGES

Tomislav Kurevija

FSB

ttinzenjering d.o.o.
za projektiranje i građenje

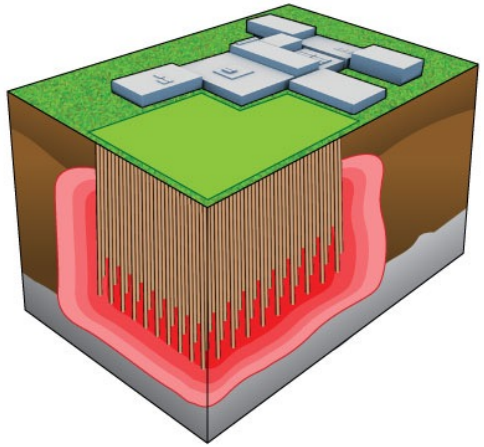
RGNF Zagreb, 22.03.202.

Uvod

- Underground Thermal Energy Storage (UTES) – uravnoteženje potrošnje toplinske energije na godišnjoj razini pohranom u podzemlje

- ATES

- **BTES** - BHE



Metode

- Modelling BHE systems Modeliranje BHE sustava
- Isplativost sustava – utjecaj cijelog niza petrofizikalnih i toplinskih svojstava stijena
- Godišnje potrebna energija za grijanje i hlađenje – ‘trajne’ promjene u temperaturi ležišta u funkciji vremena
- GHX Design Tool, GLD, EED, GLHEPRO… programski paketi za projektiranje plitkih geotermalnih bušotina
- BTES – pohrana toplinske energije u tlo/stijenu putem bušotinskih izmjenjivača

Tehnički i termogeološki parametri

- Primjer modeliranja sustava – Javna zgrada – Institut za medicinska istraživanja i medicinu rada (IMI) Zagreb, RH

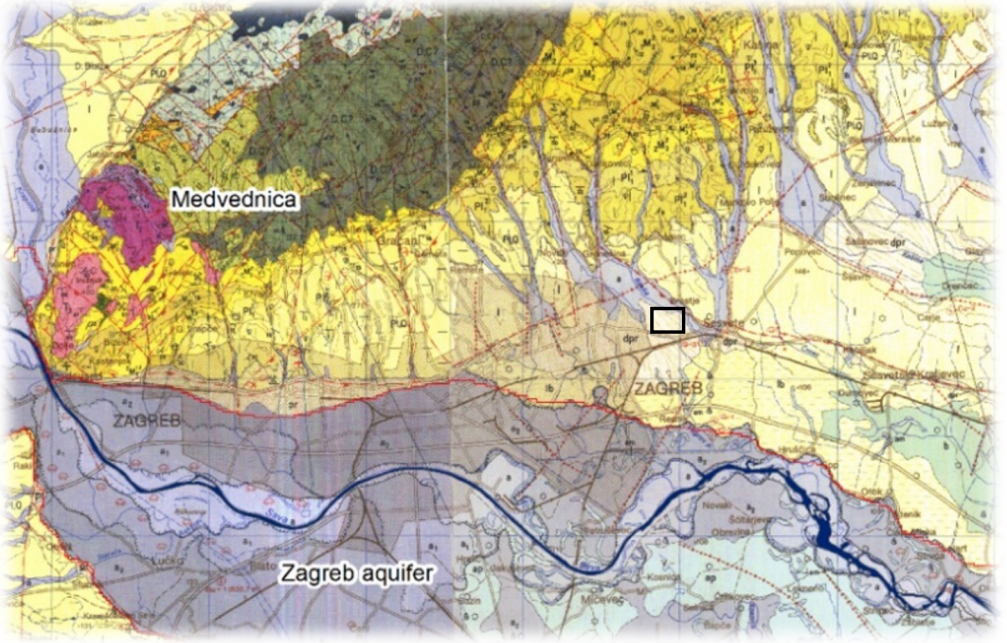
- 5 katova, 5000 m2 površina grijanog prostora, projekt dovršen 2022.

- Grijanje/hlađenje -> GHP

- BTES – opcija razmatranja mogućnosti korištenja

Tehnički i termogeološki parametri

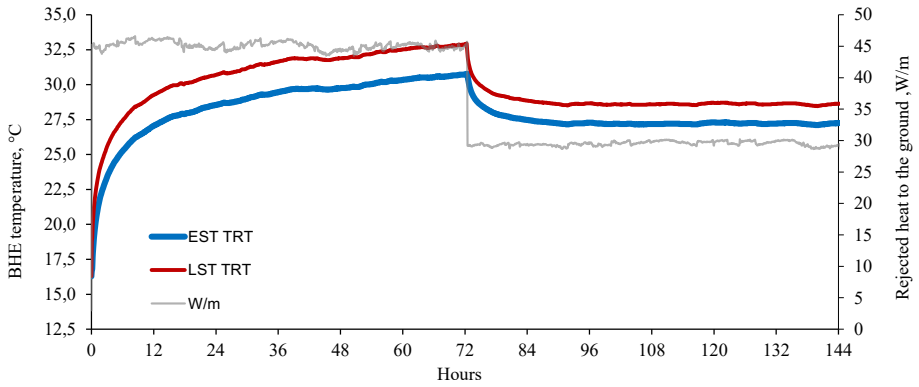
- BHE polje – 53 BHE, 120 m dubina, ukupno 6360 m
- 1U TC45 Turbocollector SDR11
- 2 BHE odvojena polja
- Polje A – 6x4+2 (26 BHE)
- Polje B – 13x2+1 (27 BHE)

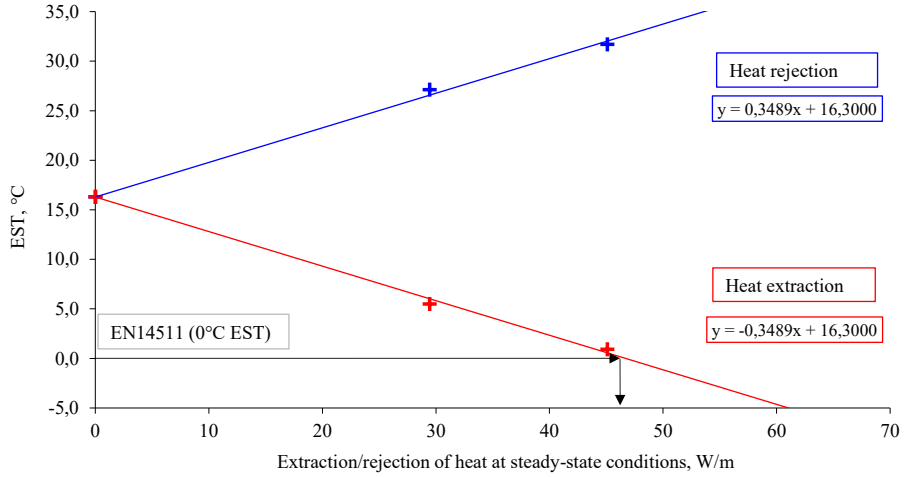


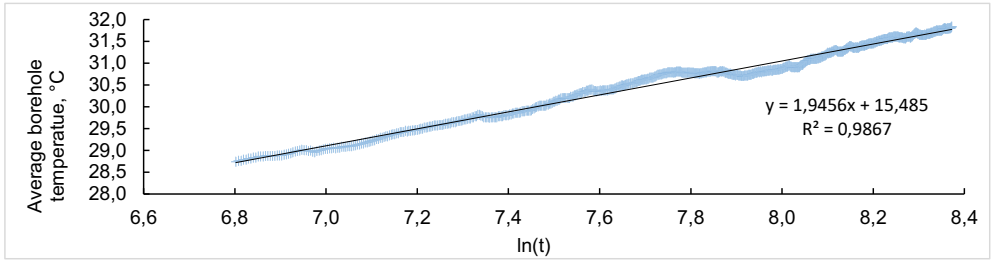
Legend for geology map:
a – aluvium: gravels, sands and clays; a1 – the lowest terrace: gravels, sands and clays to a lesser extent; a2 – middle terrace: gravels and sands; pr – proluvium: gravels, sands and clays; l – clayey silt; lb – marshy loes: silty clays; Pl,Q – gravels, sands and clays; Pl_1^1 – marls, marly clays, sands to a lesser extent, sandstones, gravels and conglomerates (lower pont); Pl_1^2 – upper pont (sands, sandy and clayey marls); $_2M_3^{1,2}$ – lime marls, sands to a lesser extent, sandstones, gravels and conglomerates (upper panon)

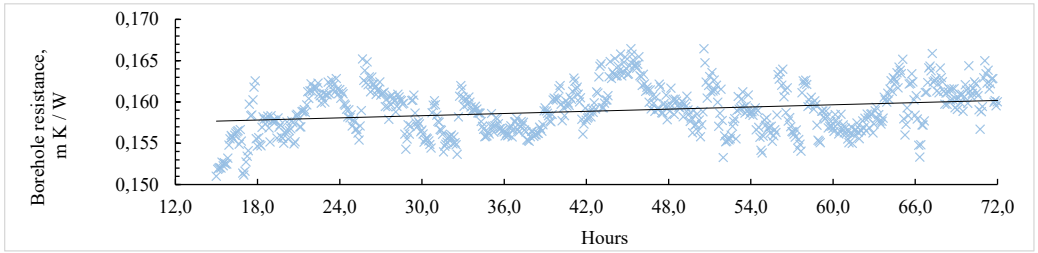
Tehnički i termogeološki parametri

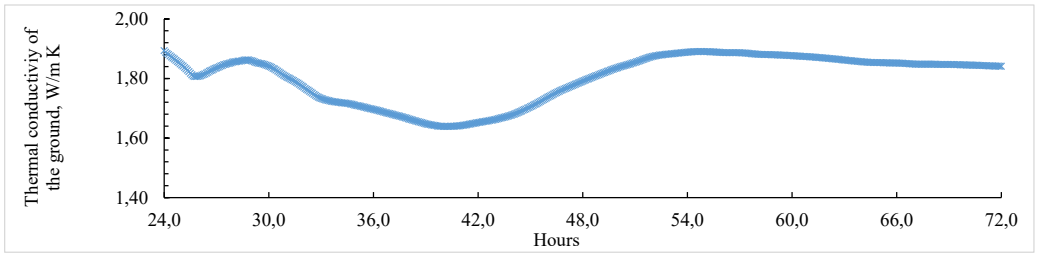
- TRT ispitivanje – termogeološki parametri





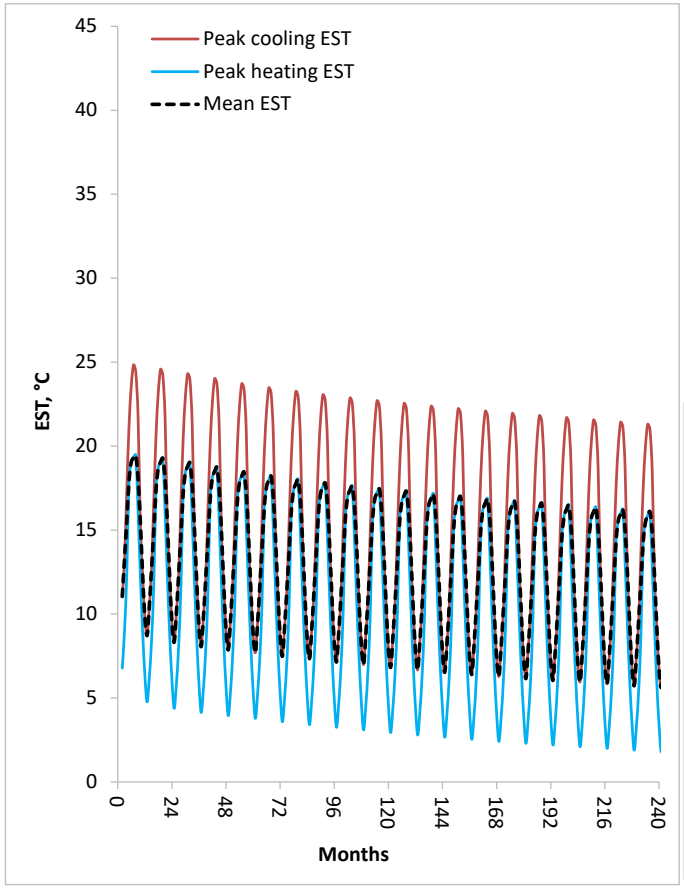




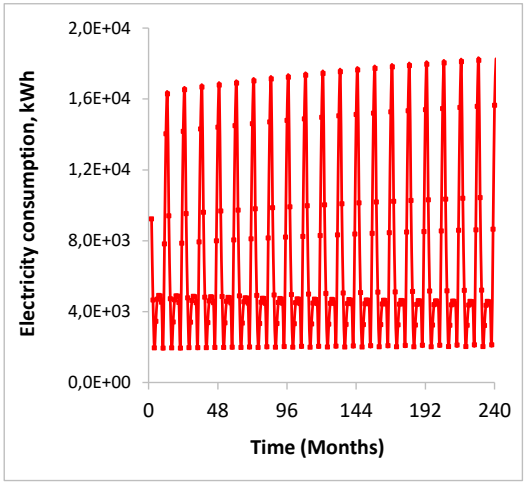


Rezultati

- Tri analizirane varijante mogućeg korištenja
- Varijanta BHE V0 – osnovna varijanta, bez BTES
- Uobičajeno korištenje geotermalnog polja s pridobivanjem toplinke energije zimi i pohrana toplinske energije ljeti



Tot. Heating (kWh)	Tot. Cooling (kWh)	Peak Ht (kW)	Peak Cl (kW)
105.380	0	371	0
64.570	0	339	0
34.890	0	287	0
9.662	6.065	187	82
1.500	25.057	0	164
1.500	33.676	0	227
1.500	35.112	0	266
1.500	34.793	0	243
10.775	24.898	123	182
15.598	0	196	0
57.150	0	271	0
94.250	0	321	0
398.275	159.600	371,0	266,0

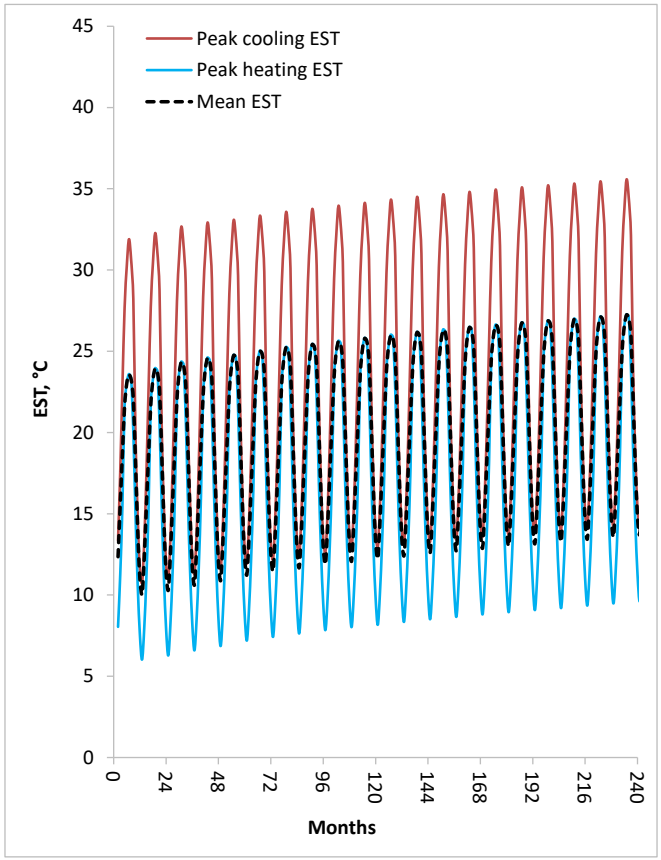


Rezultati

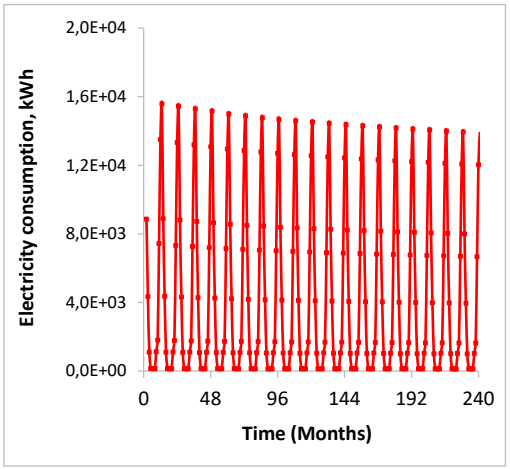
- Varijanta BTES V1

- Solarni BTES implementiran postavljanjem 300 m2 termalnih panela na krov zgrada. Ukupna energija pohranjuje se u 53 bušotine tijekom cijele godine kao jedna hidraulička cjelina

Month	Solar energy to ground, kWhf	Solar energy peak power, kWf
1	10.131	46,9
2	14.925	69,1
3	28.381	131,5
4	36.965	171,2
5	46.168	213,9
6	48.024	222,4
7	51.813	**240,0**
8	44.931	208,1
9	43.523	201,6
10	23.819	110,3
11	11.755	54,4
12	7.501	34,7
Total	**367.937**	

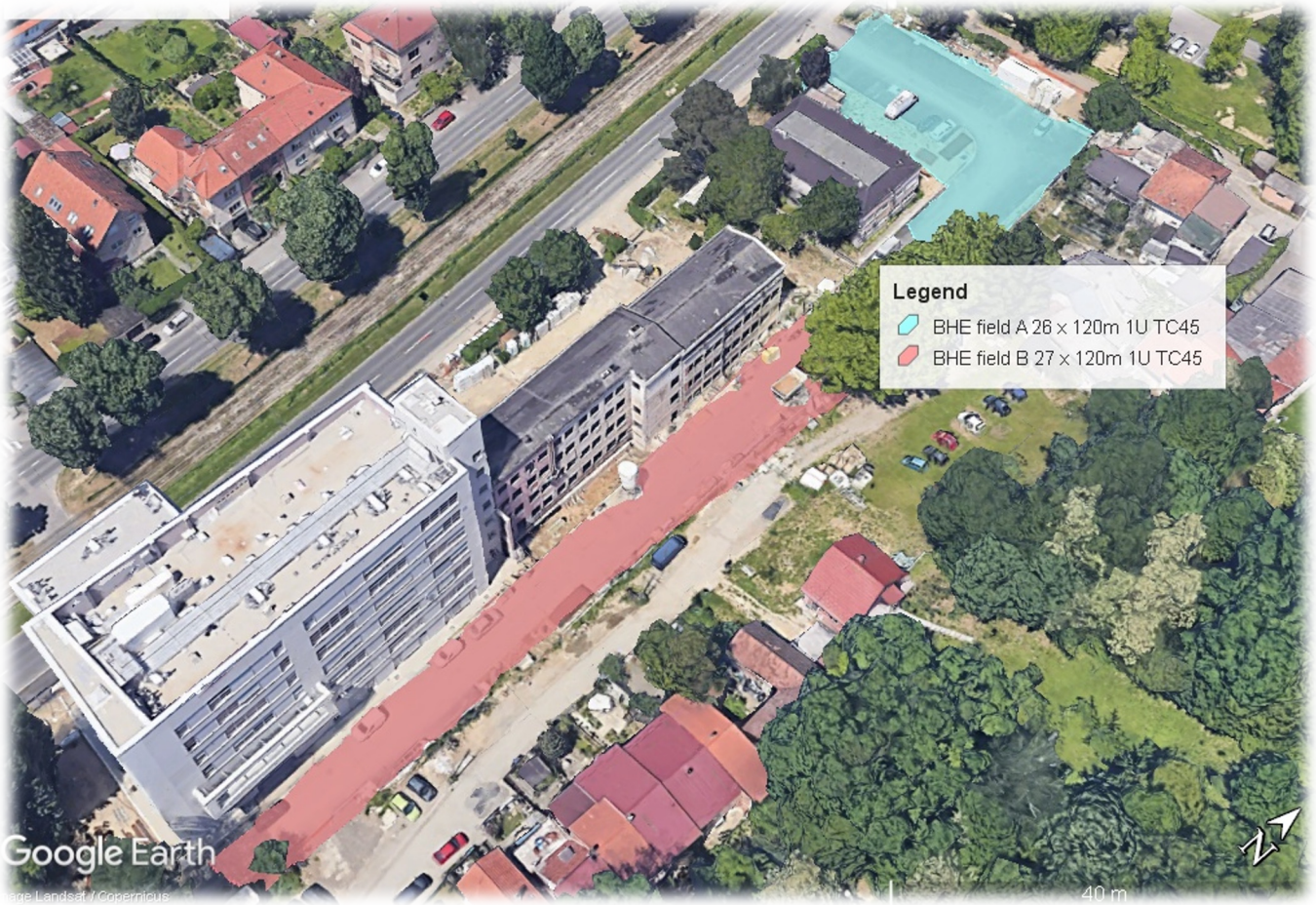


Tot. Heating (kWh)	Tot. Cooling (kWh)	Peak Ht (kW)	Peak Cl (kW)
105.380	10.131	371	47
64.570	14.925	339	69
34.890	28.381	287	131
9.662	43.030	187	253
1.500	71.225	0	378
1.500	81.700	0	450
1.500	86.925	0	506
1.500	79.723	0	451
10.775	68.421	123	383
15.598	23.819	196	110
57.150	11.755	271	54
94.250	7.501	321	35
398.275	527.537	371,0	506,0



Rezultati

Varijanta BTES V2

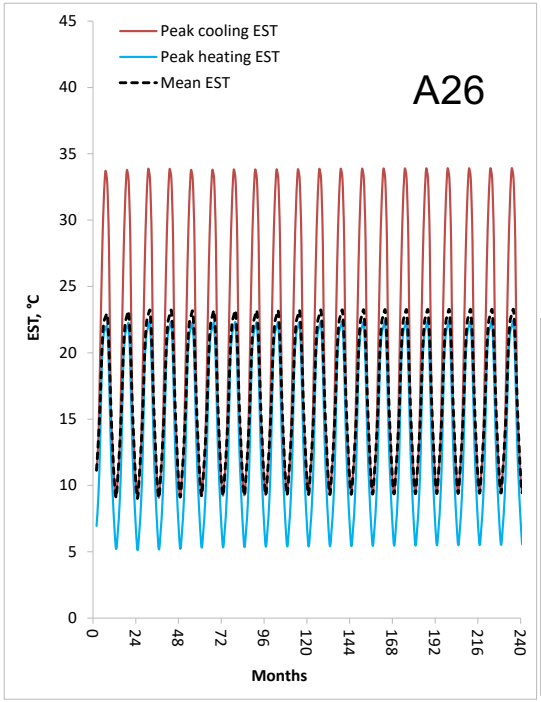


Rezultati

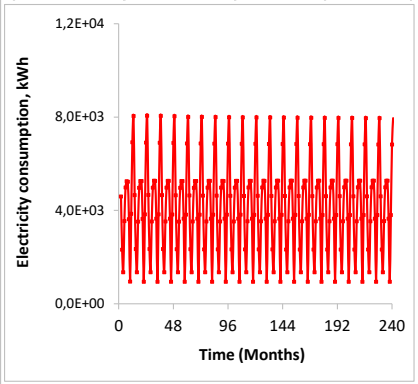
Varijanta BTES V2

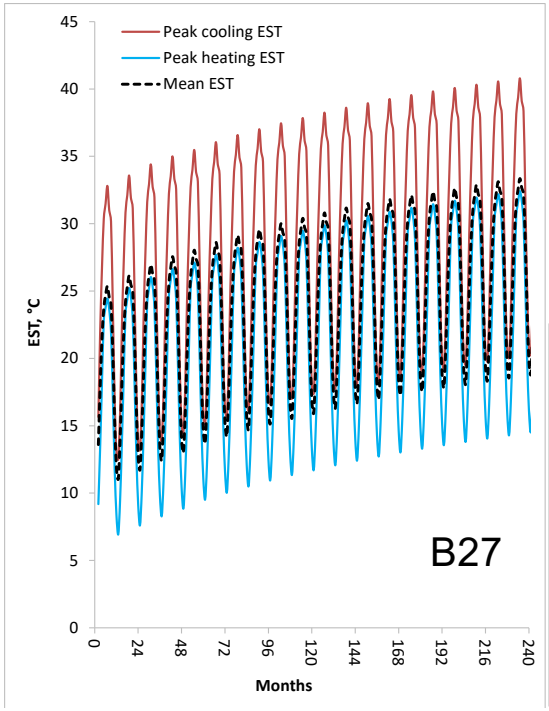
- Solarni BTES implementiran postavljanjem 300 m2 termalnih panela na krov zgrada.
- Polje A26 namijenjeno za 1/2 potreba grijanja i 1/1 pohranu toplinske energije iz rashladnog sustava
- Ukupna sunčeva energija pohranjena u polje B27 uz pridobivanje 1/2 potreba za grijanje. Polje B27 ne sudjeluje u hlađenju zgrade.

Month	Solar energy to ground, kWhf	Solar energy peak power, kWf
1	10.131	46,9
2	14.925	69,1
3	28.381	131,5
4	36.965	171,2
5	46.168	213,9
6	48.024	222,4
7	51.813	**240,0**
8	44.931	208,1
9	43.523	201,6
10	23.819	110,3
11	11.755	54,4
12	7.501	34,7
Total	**367.937**	

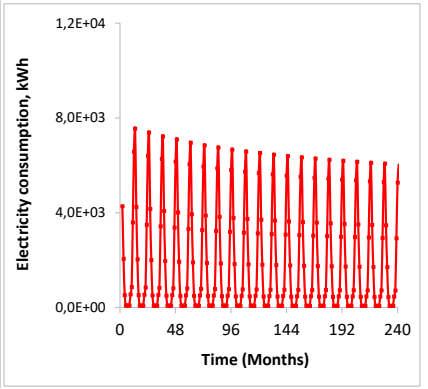


Tot. Heating (kWh)	Tot. Cooling (kWh)	Peak Ht (kW)	Peak Cl (kW)
52.690	0	186	0
32.285	0	170	0
17.445	0	144	0
4.831	6.065	94	82
750	25.057	25	164
750	33.676	25	227
750	35.112	25	266
750	34.793	25	243
5.388	21.865	62	182
7.799	0	98	0
28.575	0	135	0
47.125	0	161	0
199.138	156.568	185,5	266,0





Tot. Heating (kWh)	Tot. Cooling (kWh)	Peak Ht (kW)	Peak Cl (kW)
52.690	10.131	186	47
32.285	14.925	170	69
17.445	28.381	144	131
4.831	36.965	94	171
750	46.168	25	214
750	48.024	25	222
750	51.813	25	240
750	44.931	25	208
5.388	43.523	62	202
7.799	23.819	98	110
28.575	11.755	135	54
47.125	7.501	161	35
199.138	367.937	185,5	240,0



Zaključak

- BTES – viša učinkovitost rada HP tijekom zimskih mjeseci
- Narušavanje SPF HP tijekom rada ljetnih mjeseci
- Najvažniji parametar primjene – klimatski podaci i omjer grijanje/hlađenje zgrade
- Razdvajanje polja ili cjelovit sustav

BTES Variant	Electricity consumption of heat pumps over 20 years, MWh
V0 initial design heating+cooling NO BTES	**1603**
V1 solar BTES whole field	**1006**
V2 A26 1/2 heating+ 1/1 cooling	*1003*
V2 solar BTES B27 1/2 heating + solar storage	*456*
V2 combined solar BTES	**1459**

Q&A

Thank you for your attention!

Additional info:
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