



100 godina Fakulteta
strojarstva i brodogradnje
Sveučilišta u Zagrebu

100 Years of Faculty of
Mechanical Engineering
and Naval Architecture
University of Zagreb



Spremnici topline



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Spremnici topline - podjela

Toplinski spremnici se mogu podijeliti prema više kriterija:

- Razdoblju spremanja – satni, dnevni, višednevni, sezonski... kratkotrajni-dugotrajni
- Mediju pohrane – voda, soli, PCM
- Namjeni – kućanski, industrijski, energetske
- Za proizvodnju el. En. –za grijanje/hlađenje
- Temperaturi medija – topli (visokotemperaturni, niskotemperaturni) – hladni (hladna voda, led)
- Osjetni-latentni
- Termokemijski spremnici

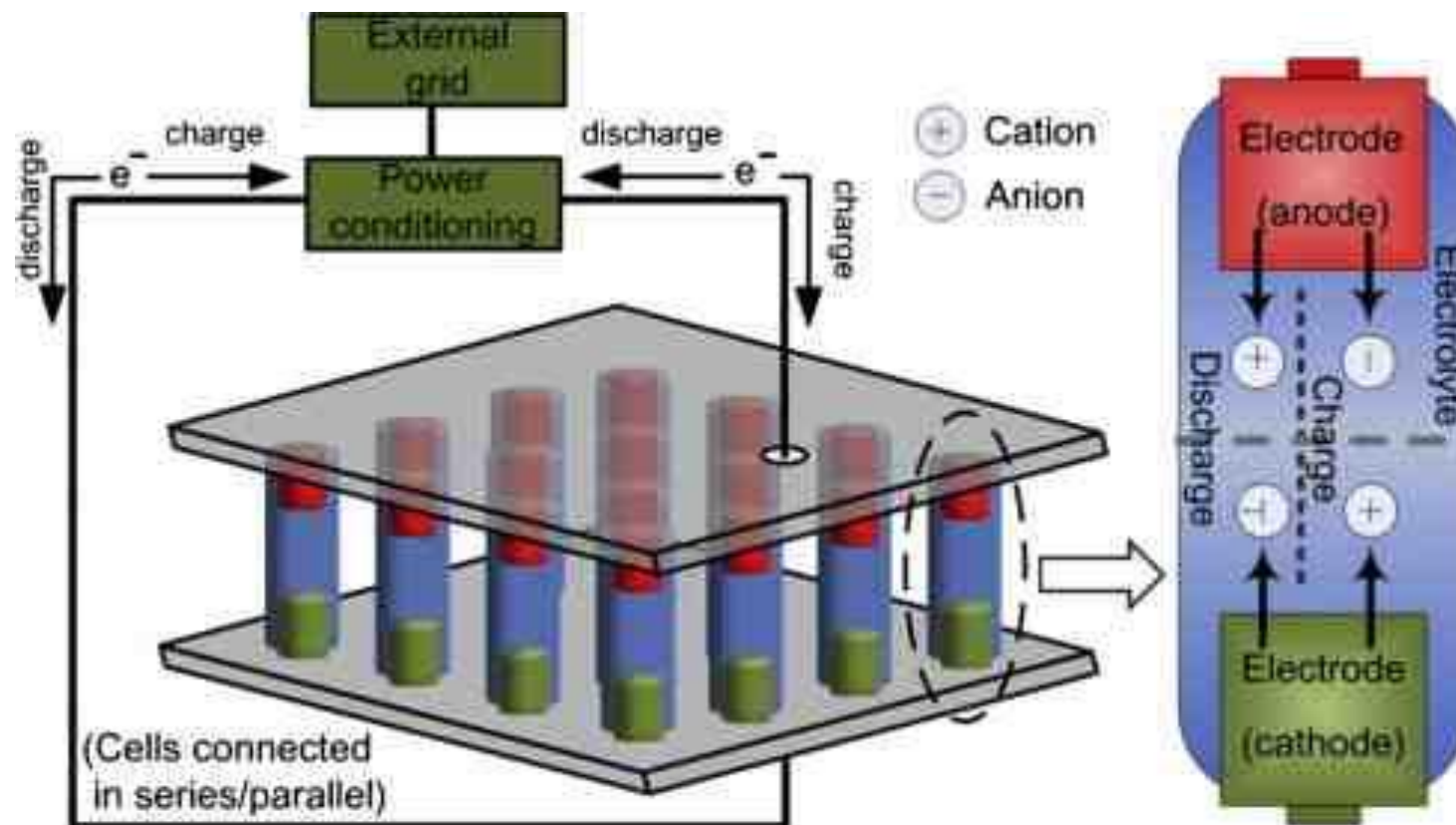


Dobrobit korištenja toplinskih spremnika

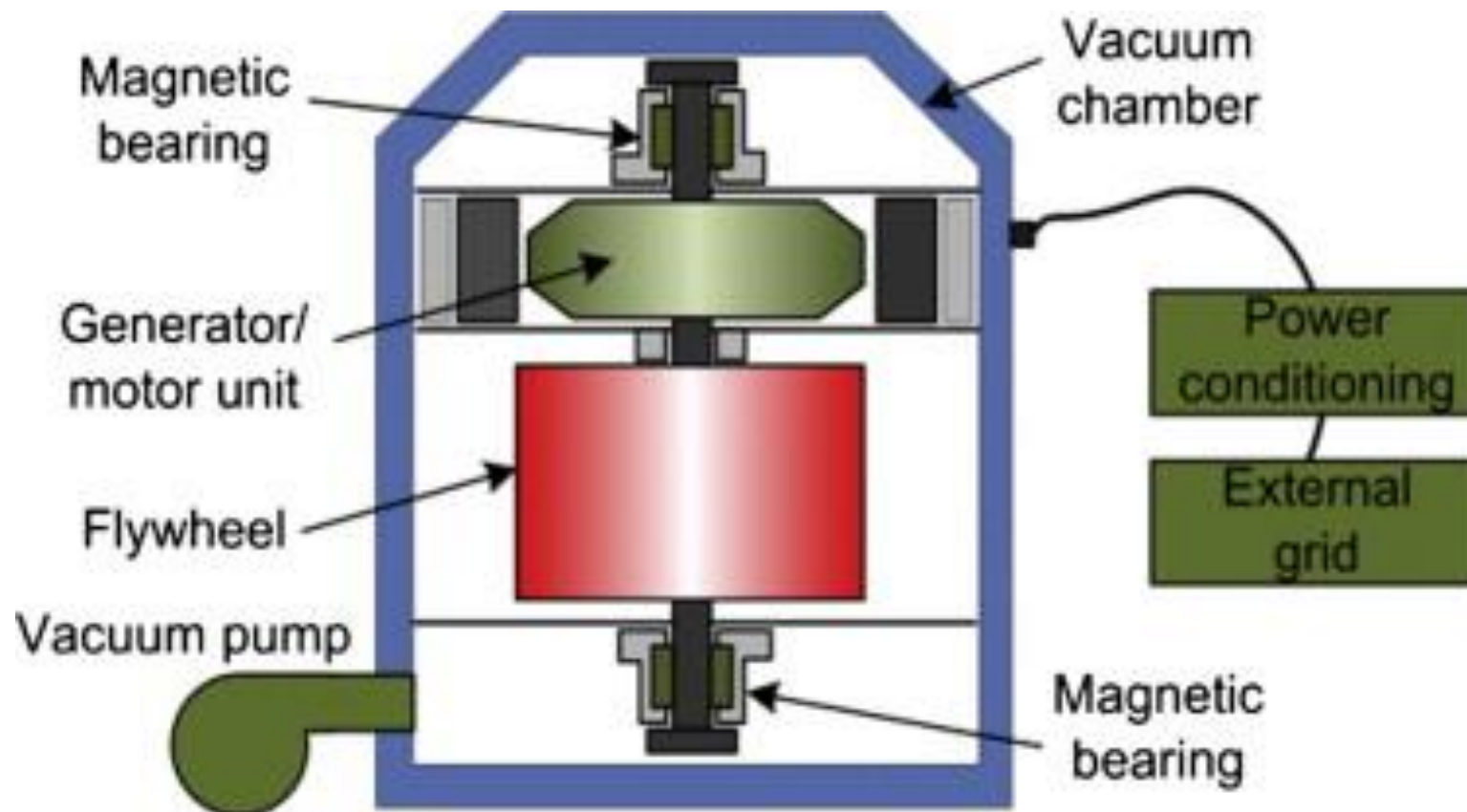
- proizvodnja struje i toplinske en. u kogeneraciji postaje manje međuovisna
- Mogućnost prebacivanja proizvodnje električne energije u pogodnija razdoblja dana
- Mogućnost financijskih ušteda u slučaju promjenjive cijene električne energije
- Ujednačavanje opterećenja postrojenja – izbjegavanje uključivanja manje efikasnih blokova – financijski benefiti i u uvjetima stalne cijene el. en.
- Izbjegavanje izgradnje dodatnih postrojenja radi pokrivanja vršnih opterećenja – povećanje kapaciteta trenutnog postrojenja
- Fleksibilnije postrojenje – brži odziv na promjene konzuma
- Povećanje maksimalne snage plinske turbine u vrućim klimama za vrijeme dana



Energetski spremnici - baterije

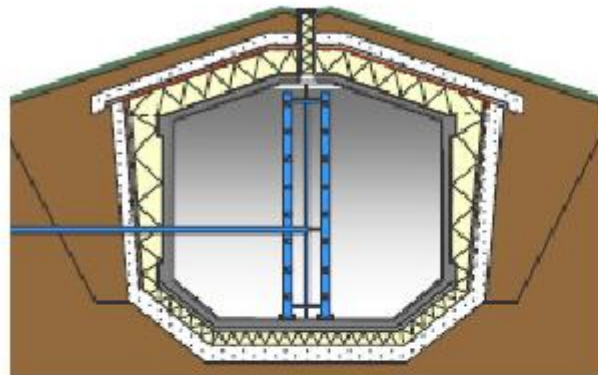


Spremnik mehaničke energije - zamašnjak

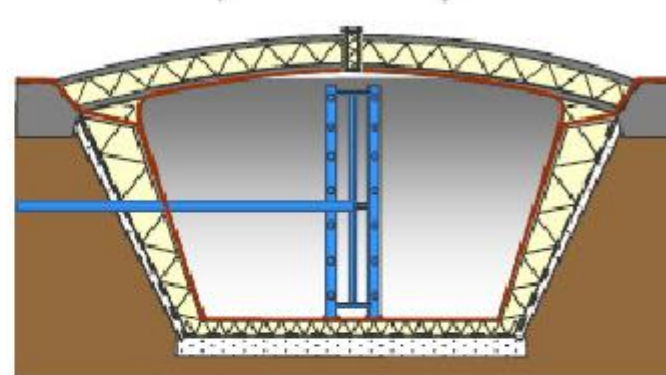


Spremnici u zemlji

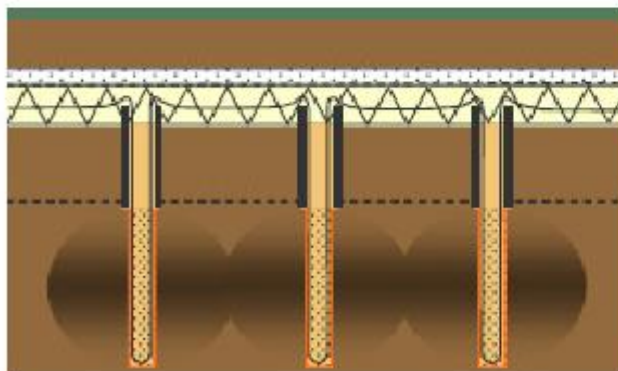
Tank Thermal Energy Storage (TTES)



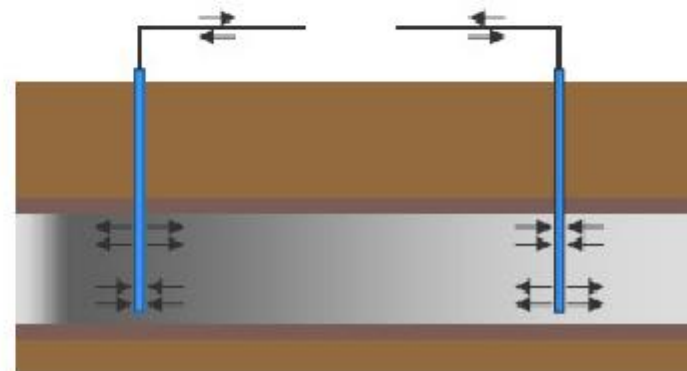
Pit Thermal Energy Storage (PTES)



Borehole Thermal Energy Storages (BTES)

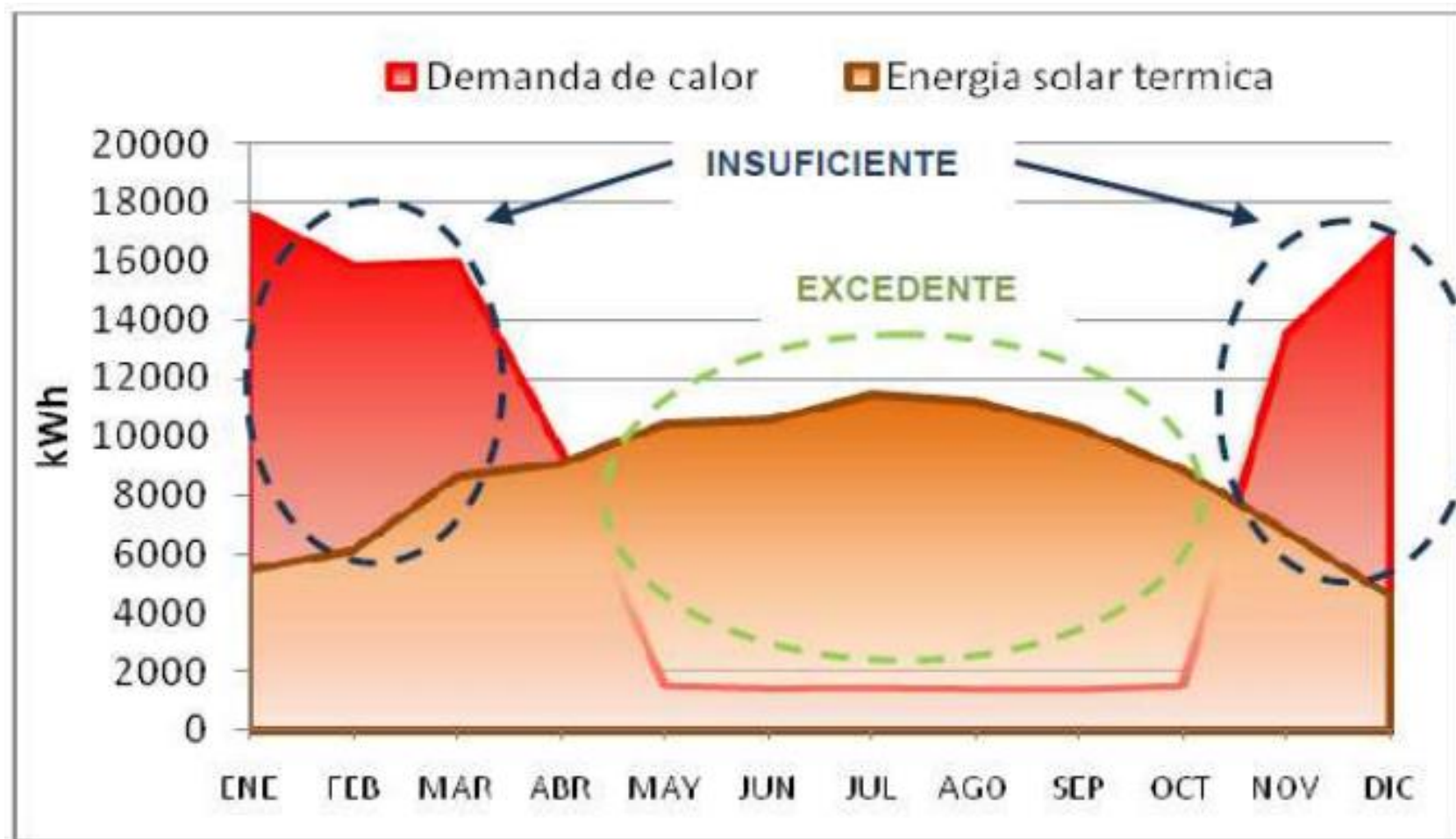


Aquifer Thermal Energy Storages (ATES)





Princip rada sezonskog spremnika



Polje bušotina u zemlji



Applied Hydrogeology
Geothermal Innovation

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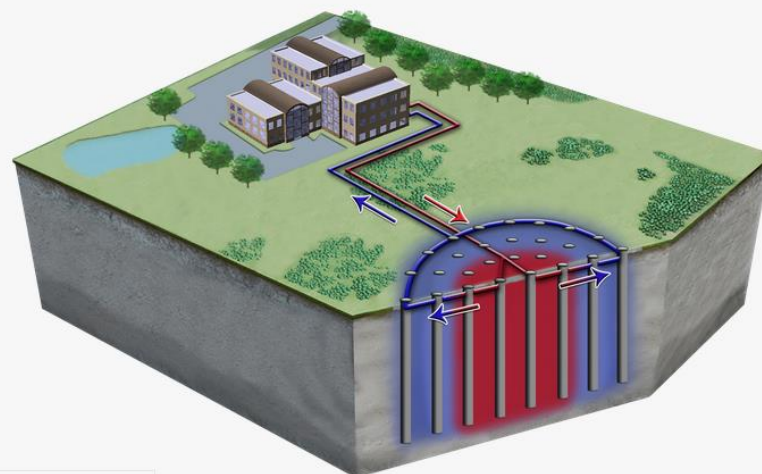
BTES – Borehole Thermal Energy Storage

– What is BTES?

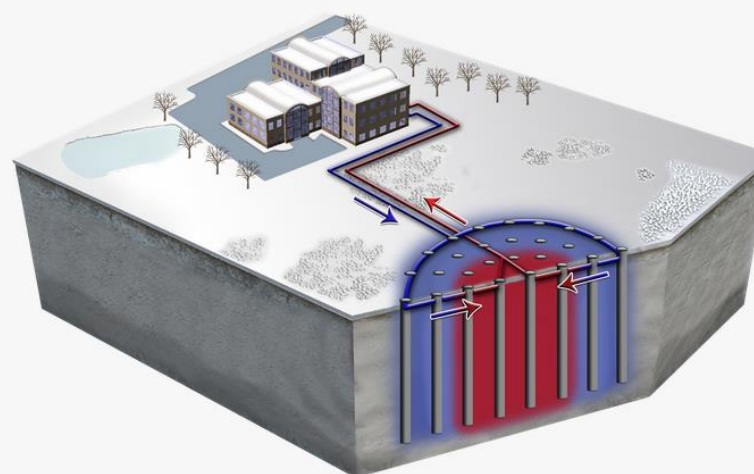
BTES is an improvement on conventional closed-loop ground source heat pump (GSHP) geothermal systems. The ground heat exchanger (GHX) array for a BTES system is designed and operated in a manner such that heat is stored or abstracted seasonally, whereas conventional GSHP systems are designed to simply dissipate heat or cold into the subsurface. BTES essentially uses the Earth as a thermal battery, as opposed to a radiator.

- + How does BTES work?
- + How efficient is BTES?
- + Is BTES expensive? Difficult to permit?

BTES Summer Operation – Cooling

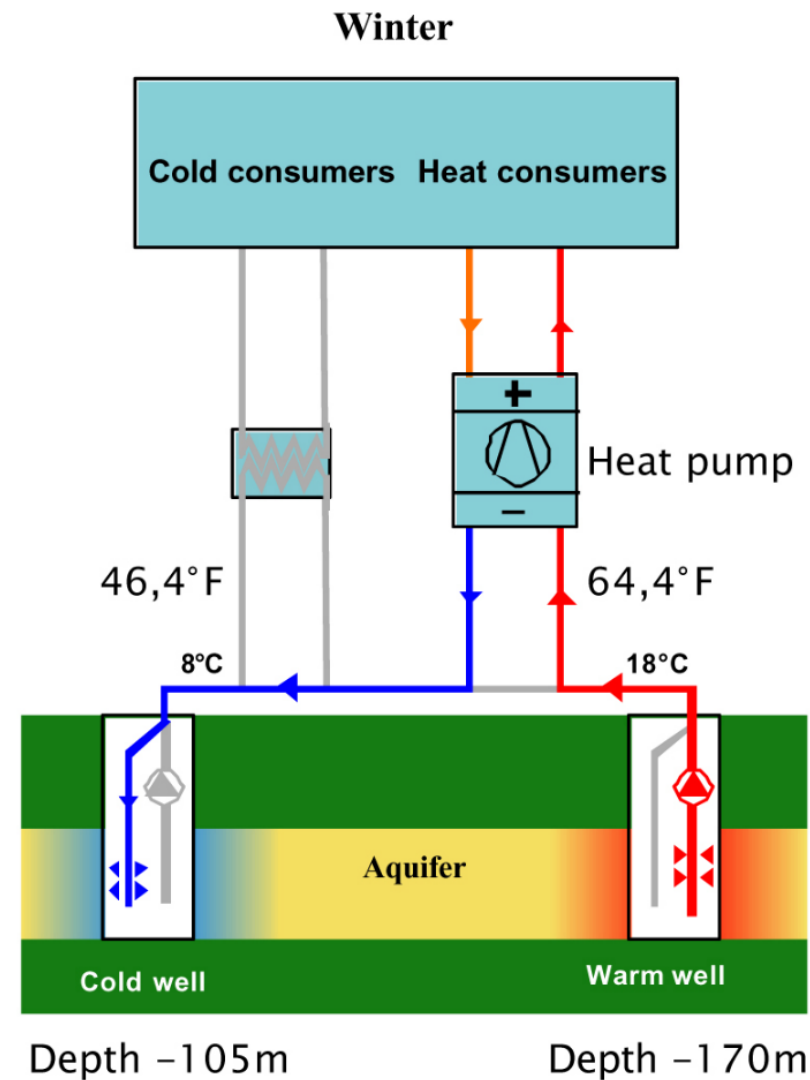
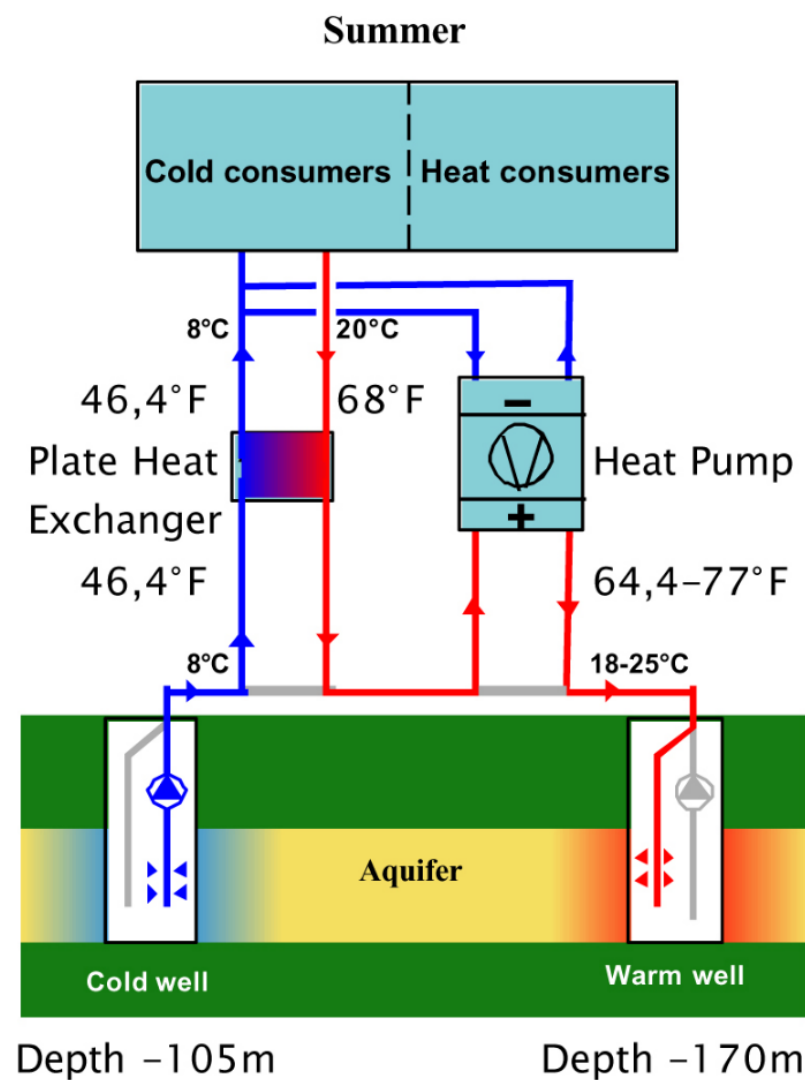


BTES Winter Operation – Heating



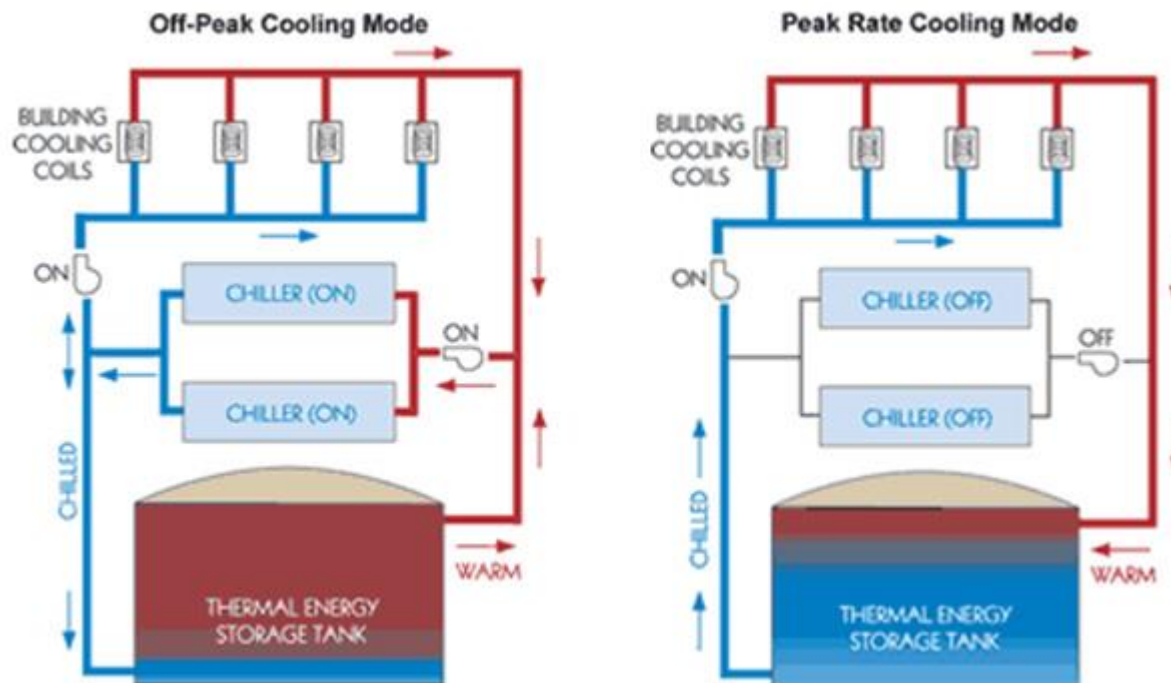


Spremnik u vodonosnom sloju

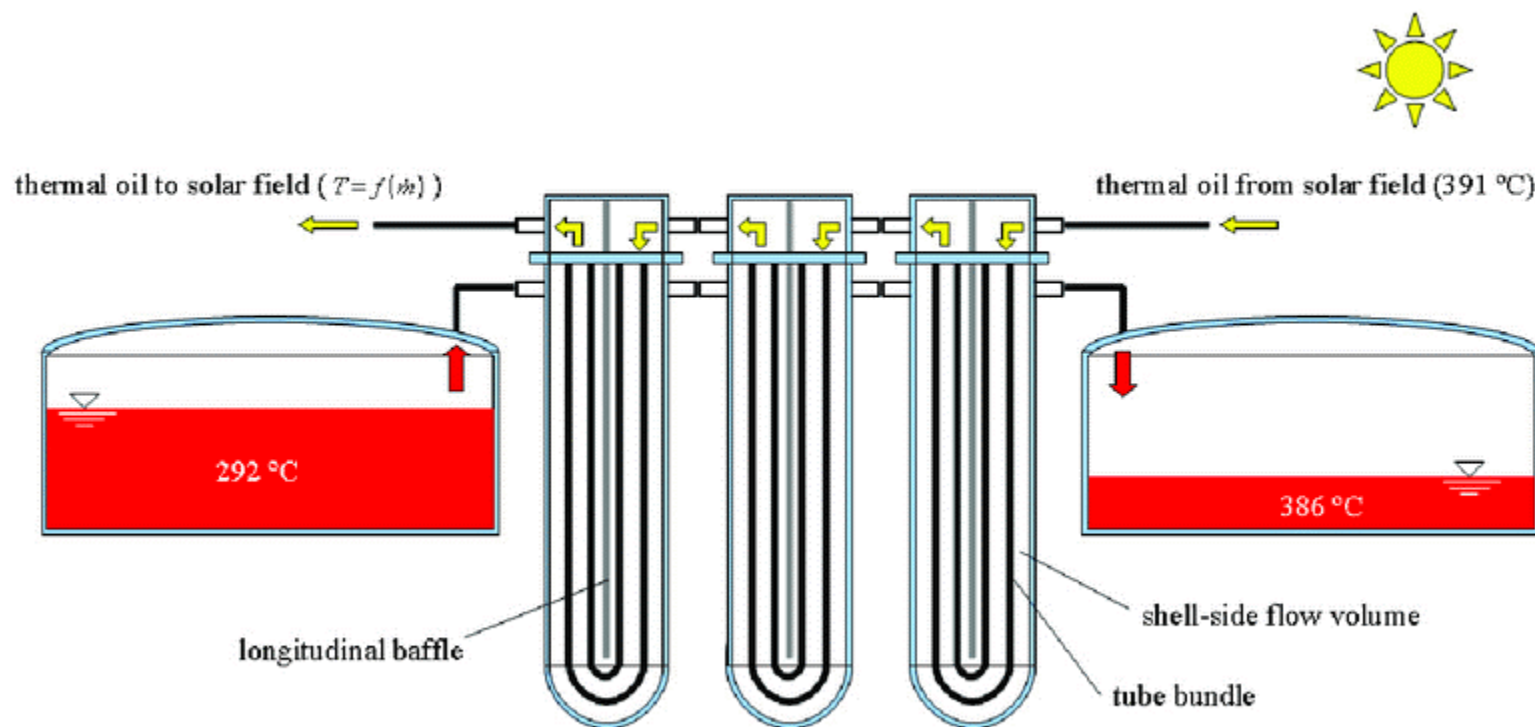




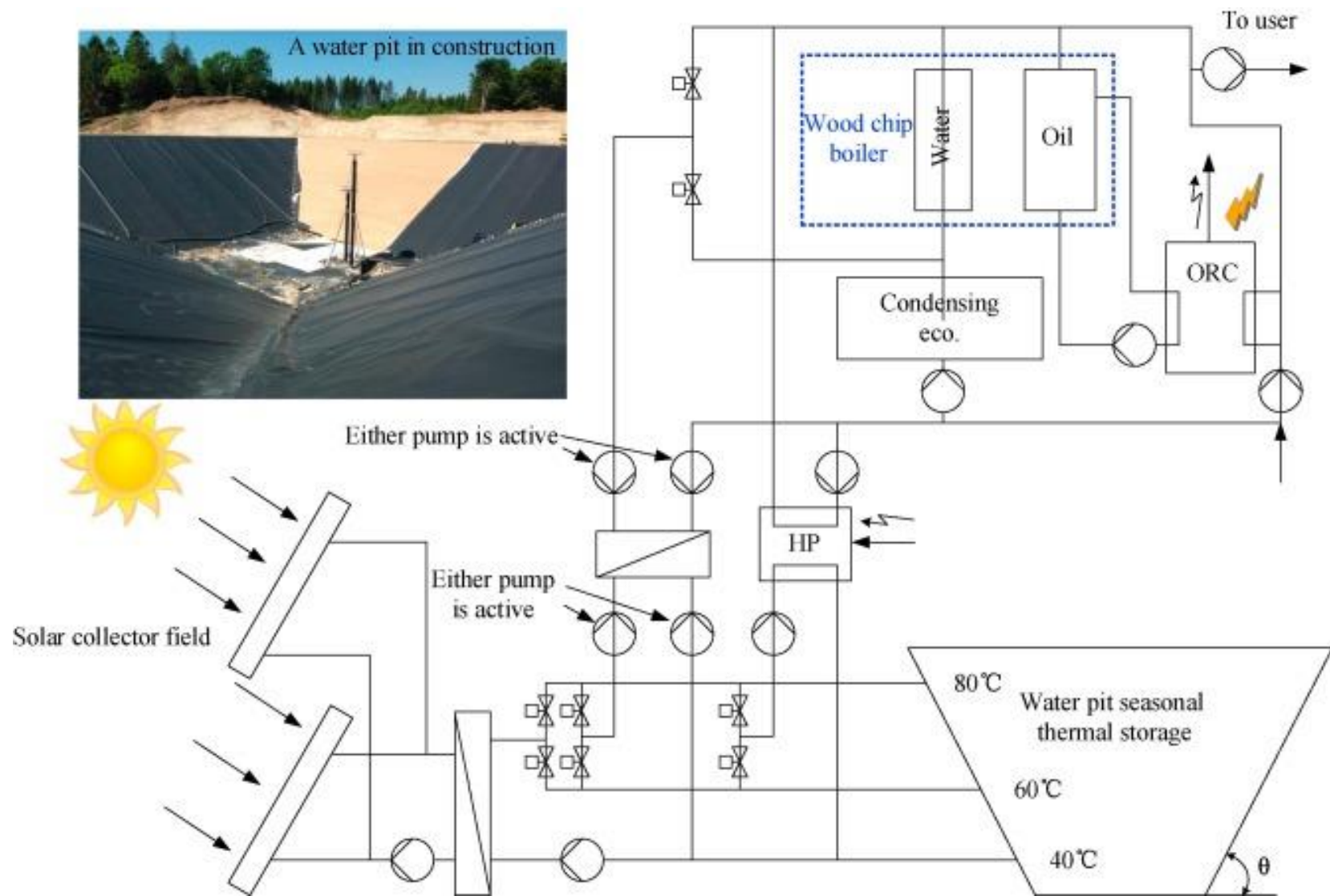
Spremnik hladne vode



Spremnik topline za proizvodnju električne energije



Toplinski spremnik u zemlji - Danska





Daljinsko grijanje - koncept

District heating – kako radi

<https://www.youtube.com/watch?v=9MrfAjTNCyY>

Smart city

<https://www.youtube.com/watch?v=Ww9XOh3Ln1g>

10:47-15

Chicago – district cooling system s bankom leda

<https://www.youtube.com/watch?v=7IZ3PBr7dO4>



Spremnici s vodom

-prikaz sezonskog spremnika u zemlji - Danska -

<https://www.youtube.com/watch?v=sBIXRLVXuG0>

Daljinsko grijanje – Gram Danska

<https://www.youtube.com/watch?v=PdF8e1t7St8>

Aalborg Danska – daljinsko grijanje bez sezonskog spremnika

<https://www.youtube.com/watch?v=SwsWtyrVxfs>

Daytona university betonski spremnik hladne vode

<https://www.youtube.com/watch?v=Pongwl69KKM>



Termokemijski spremnici-bez toplinskih gubitaka

<https://www.youtube.com/watch?v=FZu2qDeOqFQ>

Spremnik komprimiranog zraka

https://www.youtube.com/watch?time_continue=3&v=kvyuzSto0vU

Leverton 10MW battery – reguliranje frekvencije mreže

<https://www.youtube.com/watch?v=8EMCir0atDM>

Reverzibilna hidroelektrana – Hoover dam LA

https://www.youtube.com/watch?v=PRmDm_EusRU



Spremnik mehaničke energije s kranom i betonskim blokovima

<https://www.youtube.com/watch?v=mmrwdTGZxGk>

Spremanje vodika

<https://www.youtube.com/watch?v=4JGMm8qDfxw>