



Univerza v Ljubljani  
Fakulteta za strojništvo



Intelligent Energy Europe

# Sončna energija in stavbe Ogrevanje in hlajenje stavb s soncem

**Dr. Sašo Medved, Univerza v Ljubljani, Fakulteta za strojništvo**

**“pasivni  
sistemi”;  
integrirani v  
stavbe**



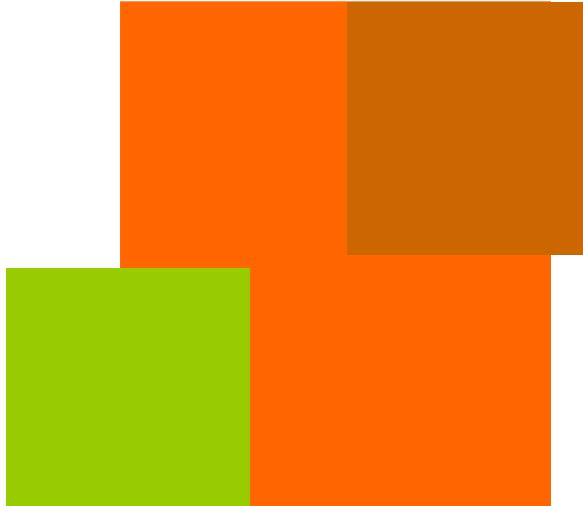
**“aktivni  
sistemi”;  
ogrevalni  
sistemi**



**“visoko  
temperaturni  
sistemi”;  
s koncentratorji**



**25°C**

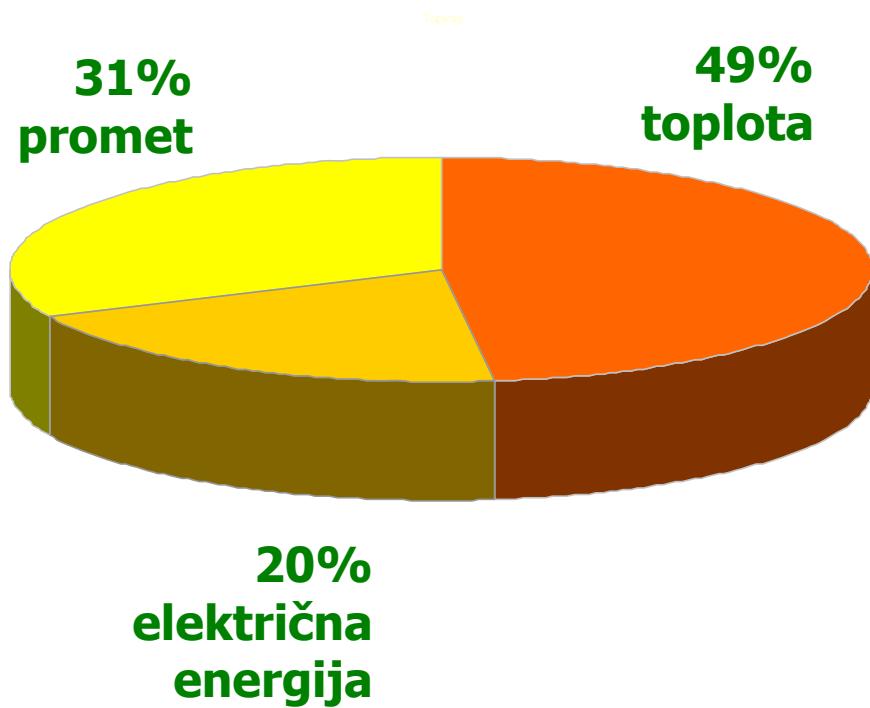


**90°C**



**250°C**

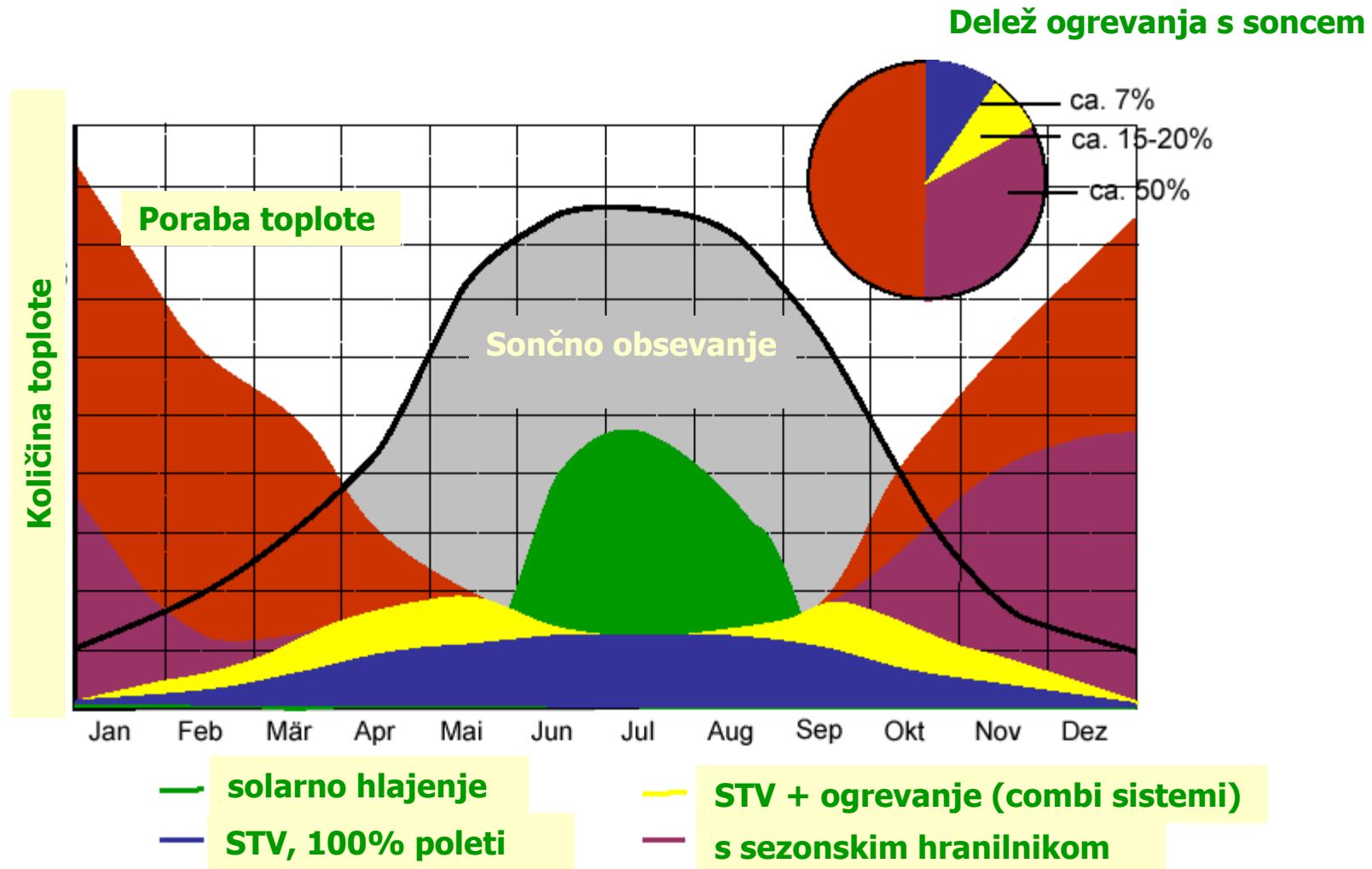
# Raba končne energije v EU

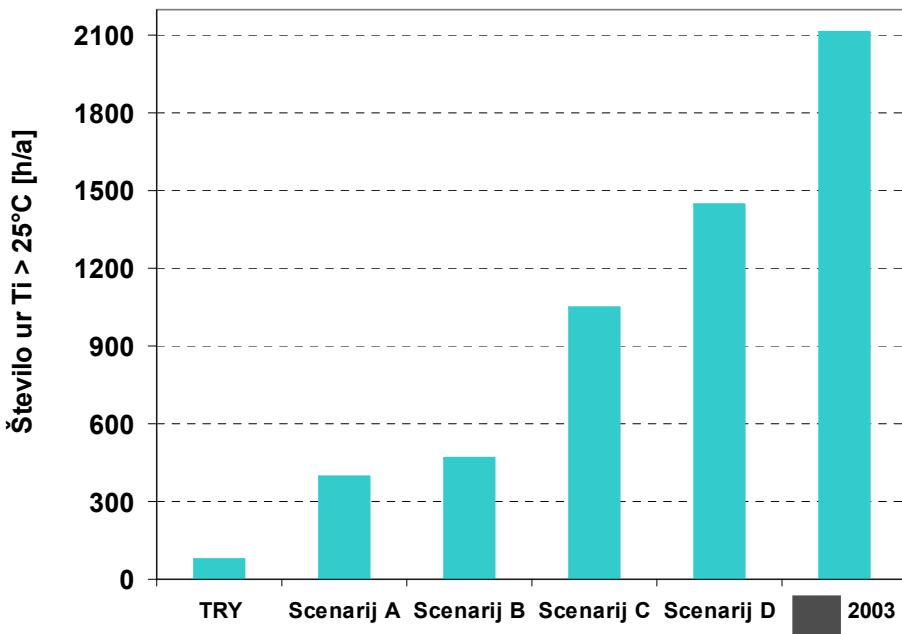
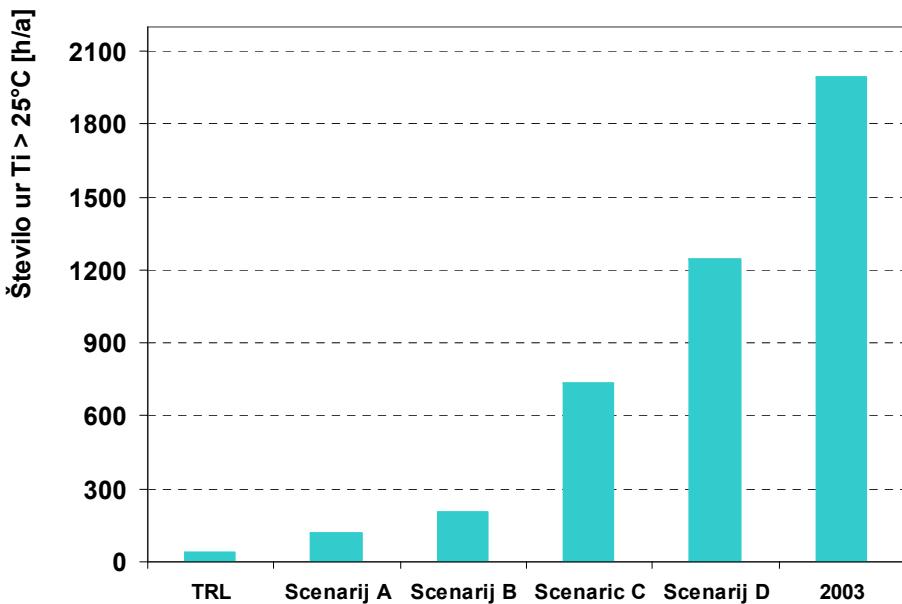
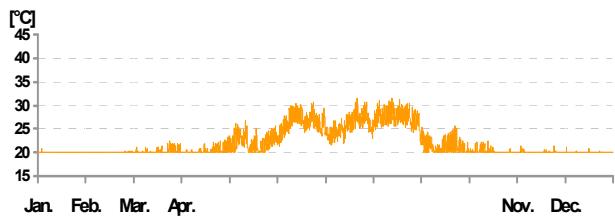


**28% v industriji**

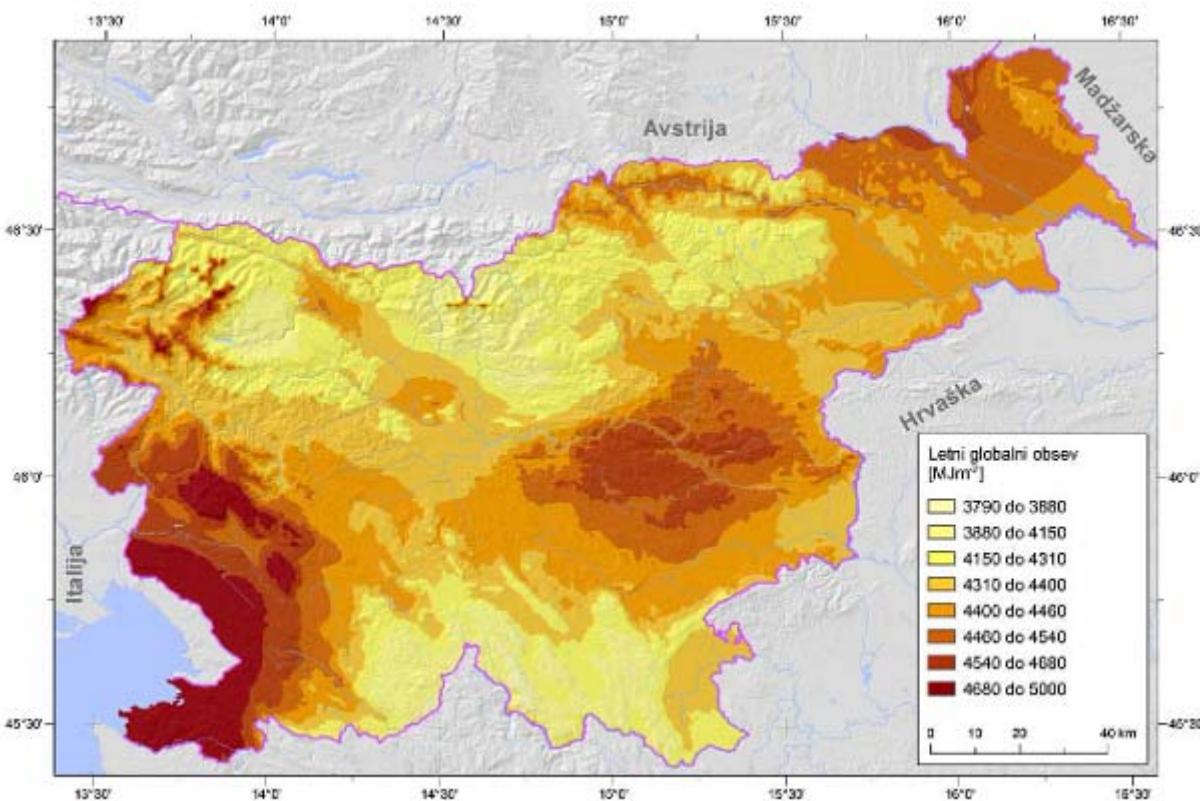
**80% na  
temperaturnem  
nivoju do 250°C**

# Poraba toplote in delež solarnih ogrevalnih sistemov





Sončno obsevanje med 1100 in 1380 kWh/m<sup>2</sup> v letu ali 93.000 PJ na površini SLO. Sedanja poraba primarne energije je okoli 310 PJ. Tehnični potencial je ocenjen na 10.000 in 19.000 PJ na leto.





## Ogrevanje

## Prezračevanje

## Hlajenje

Topla  
voda

Okolje(zrak,  
voda, zemlja)

Sončna  
energija

Biomasa

Geotermalna  
energija

Energija  
veta

25%?

Moči za gretje, prezračevanje, hlajenje in toplo  
pitno vodo moramo v stavbah zagotoviti z  
obnovljivimi viri energije

Prikluček na sistem daljinskega ogrevanja in  
hlajenja iz OVE zunaj stavbe

## Ogrevanje

Prezračevanje

Hlajenje

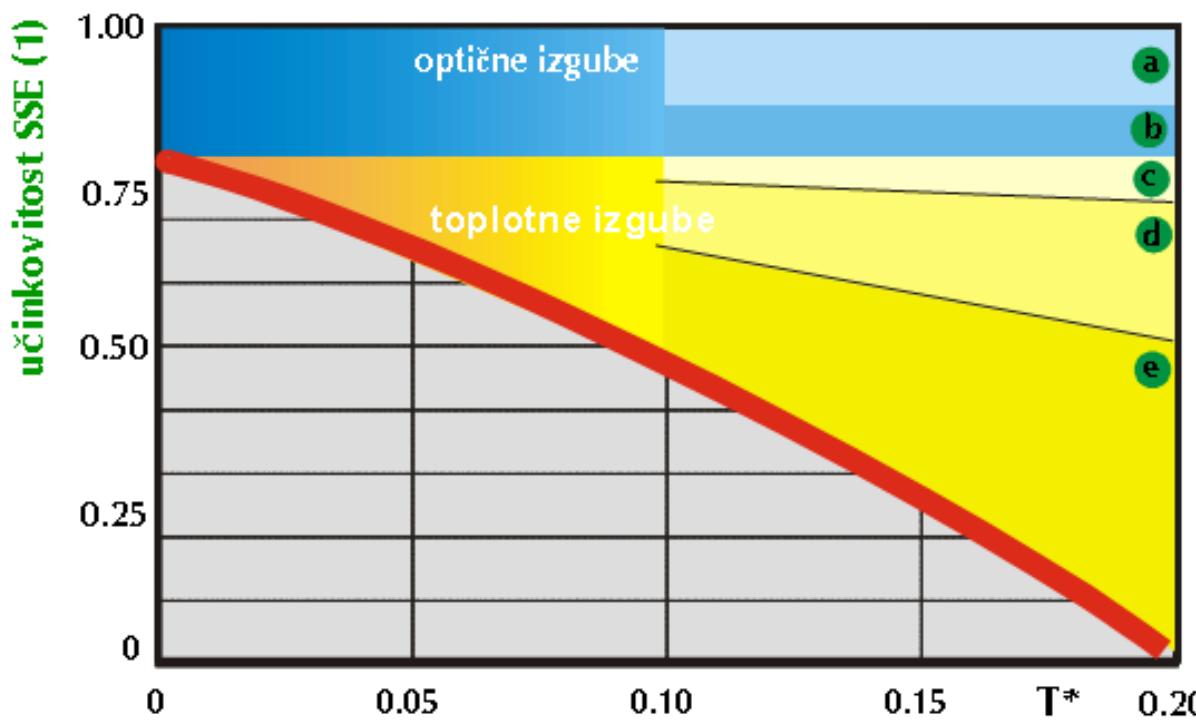
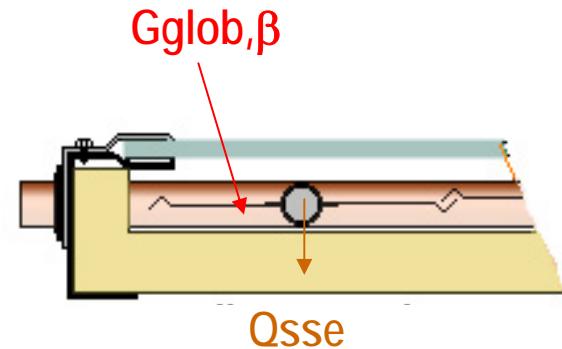
Topla voda

Okolje(zrak,  
voda, zemlja)Sončna  
energijaSSE min( $6m^2$ ; 4+0,02.  $A_{bivalno} \sim 1000m^2 \rightarrow 24 m^2$ )

Biomasa

Geotermalna  
energijaEnergija  
veta

# Vrste in učinkovitost sprejemnikov sončne energije



- a na pokrovu odbito sončno sevanje
- b v pokrovu absorbirano sončno sevanje
- c odvod toplote na bočnih in zadnji strani
- d Izgube toplote s konvekcijo
- e Izgube toplote s sevanjem

**Veliko steklo, visoka  
absorpcija  
sončnega  
sevanja**



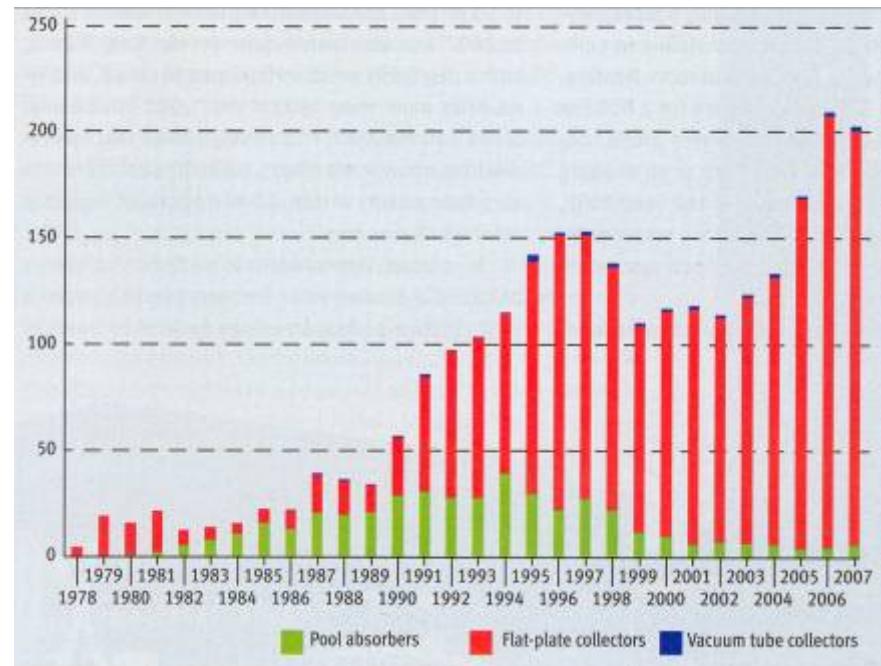
**Sevanje segretega  
absorberja**

**5%**

## Sodobni sprejemniki sončne energije (SSE)

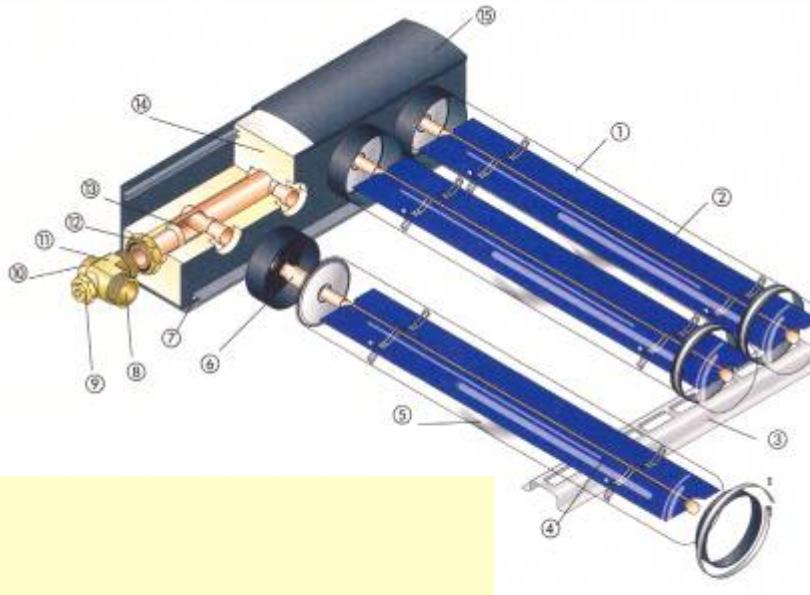
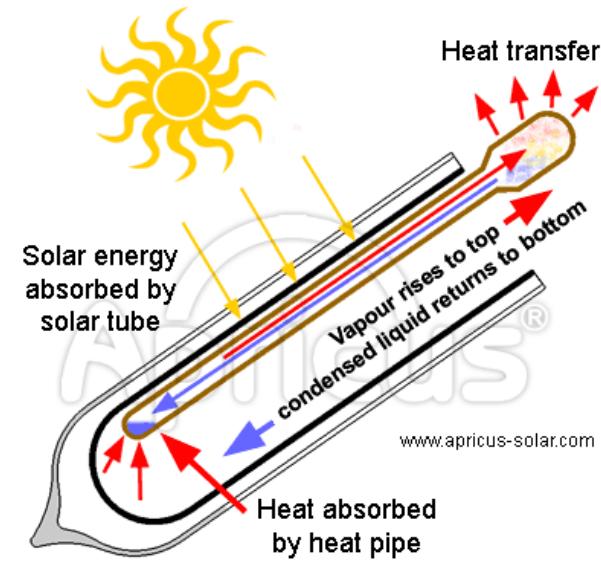
$$S = \frac{\alpha_s}{\epsilon_{IR}}$$

**Selektivnost S:**  
**1- običajna črna barva;**  
**2-4- srednje selektivni**  
**20 - visokoselektivni**





## S toplotno cevjo in cevnim ali ravnim absorberjem



## Z neposrednim obtokom



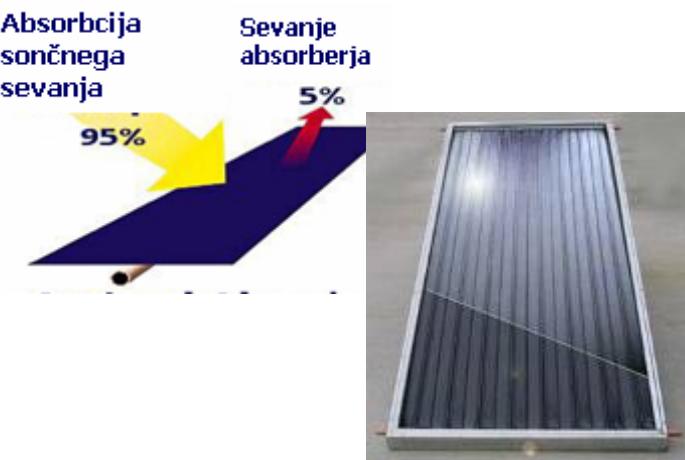
Količina toplote opredeljena glede na tehnologijo spremnikov sončne energije – **moč za selektivne in vakuumski SSE 0,7 kW/m<sup>2</sup>**



**Nezastekleni 250 kWh/m<sup>2</sup>a**



**Neselektivni 350 kWh/m<sup>2</sup>a**

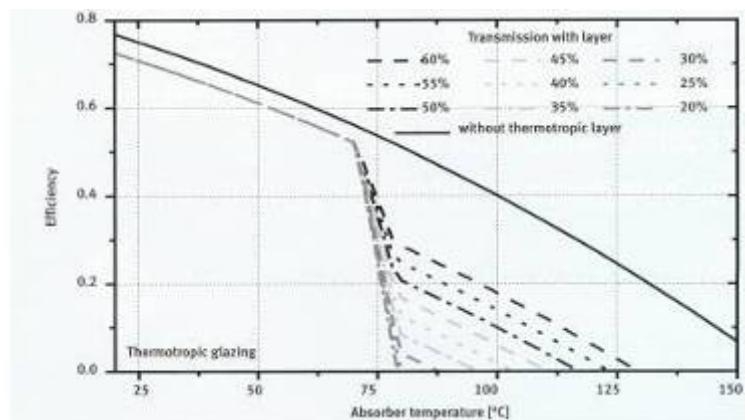


**Selektivni 500 kWh/m<sup>2</sup>a**



**Vakuumski 600 kWh/m<sup>2</sup>a**

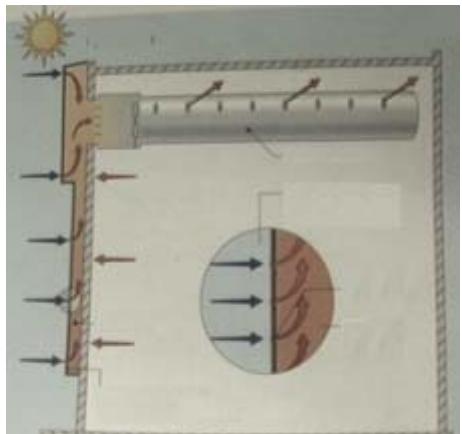
# Nove tehnologije lahko priomorejo k večji tržni uveljavitvi



as 0,626    eIR 0,325  
 as 0,835    eIR 0,368  
 as 0,876    eIR 0,400

Vir: UNI FS, KI, Gorenje Tiki

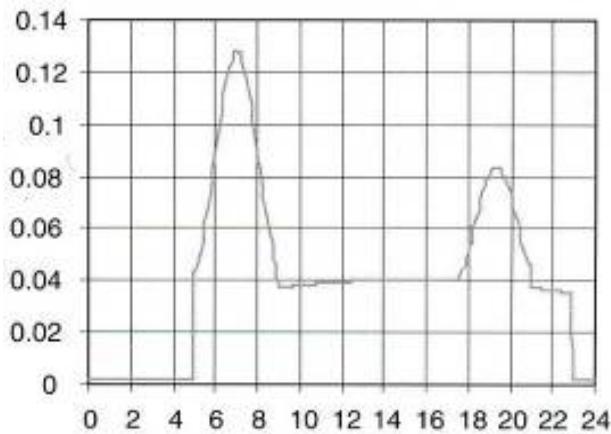
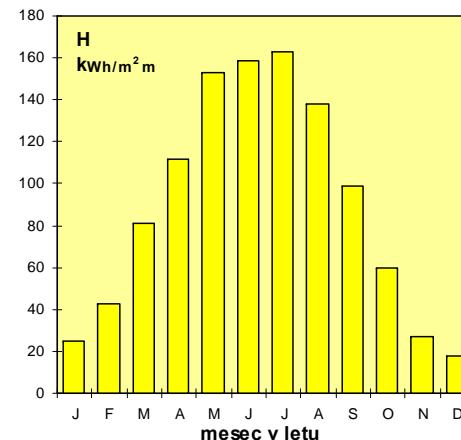
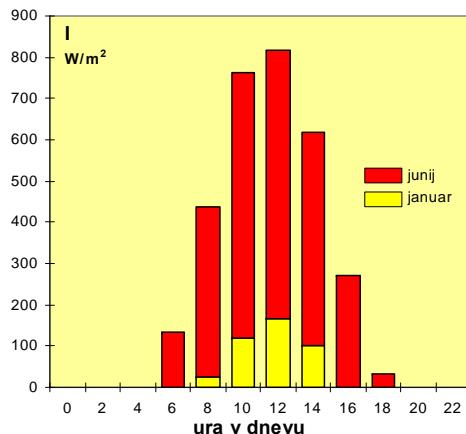
**SolarWall** je perforirana fasadna obloga z rego skozi katero sesamo zunajski zrak za prezračevanje



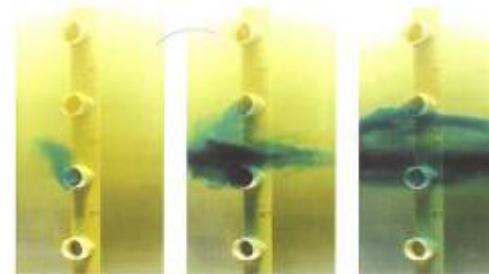
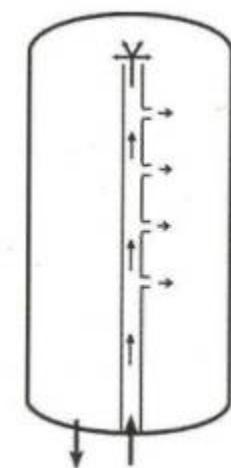
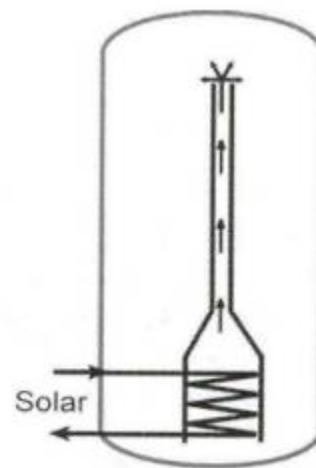
Trimno prezračevani paneli



- Ohraniti eksergijo (temperaturo, ki jo zagotavlja SSE)
- Shraniti čim večjo količino toplote



**Sistemi z variabilnim pretokom - T je konstantna**

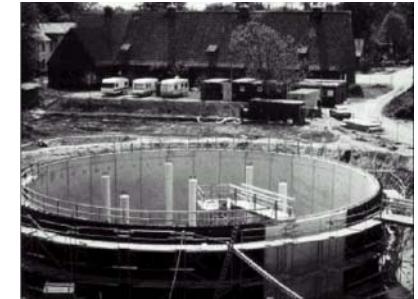
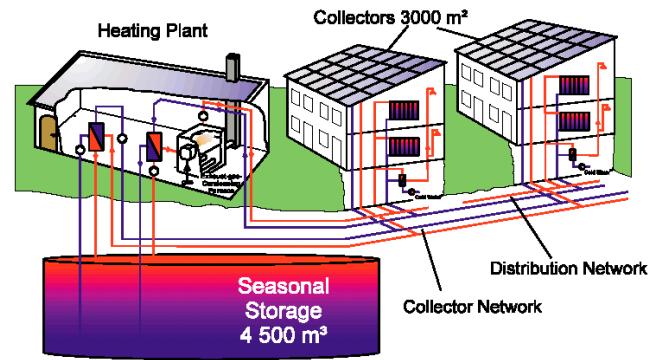


**Sistemi z variabilnim pretokom**

## Z vgrajenim hranilnikom tople sanitarne vode

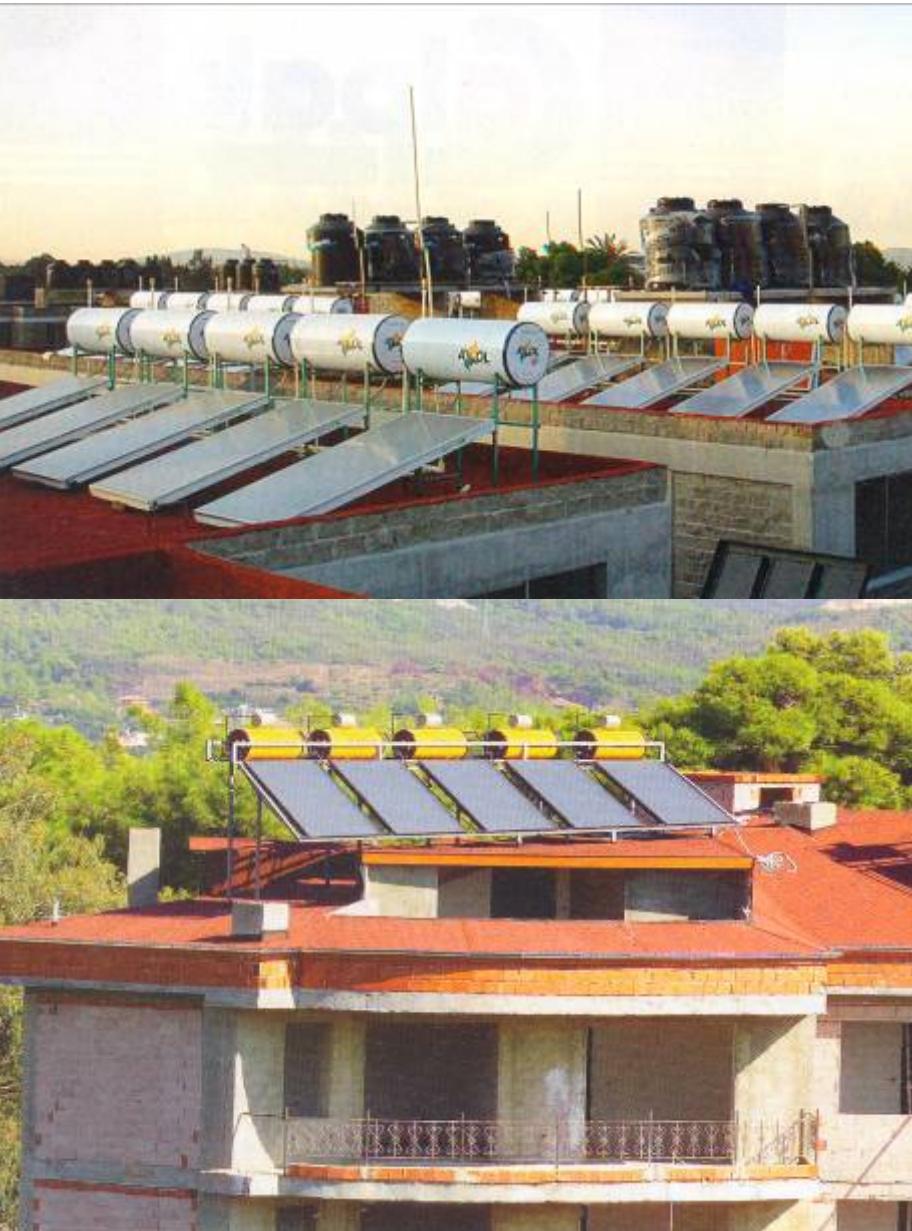
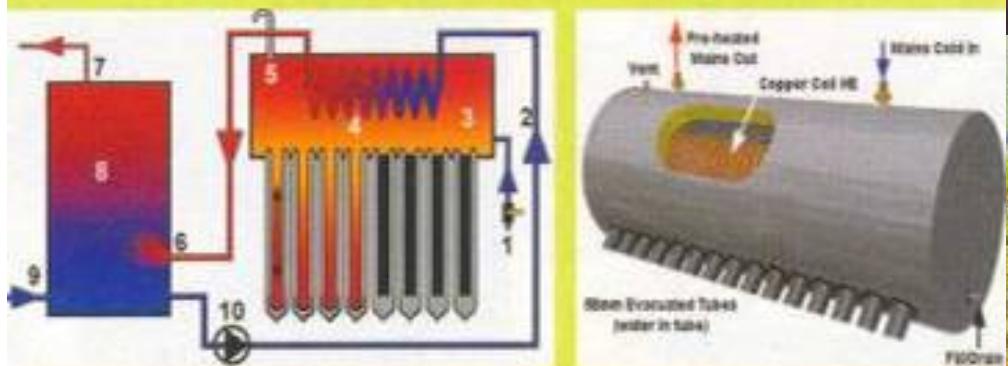


## Sezonski hranilniki toplote (?)



## Hranilniki s temperaturnim razslojevanjem

# Sistemi z naravnim kroženjem - termosifonski sistemi



**Pri sprejemnikih sončne energije uporaba novih materialov, Al in PC**

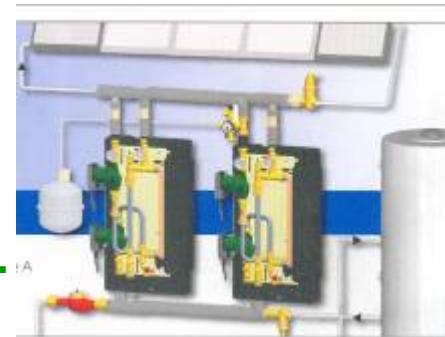
**Hranilniki toplote s temperaturnim razslojevanjem z možnostjo ogrevanja stavb**

**Hidravlične enote z energijsko varčnimi črpalkami in sistemi z izpraznitvijo (drain-back)**

**Sistemi v povezavi s TČ in plinskim ogrevanjem**

**Povečevanje celoletne učinkovitosti sistemov ->733 kWh/m<sup>2</sup>**

**Uveljavljajo se merila kakovosti Solar Keymark, GSR**



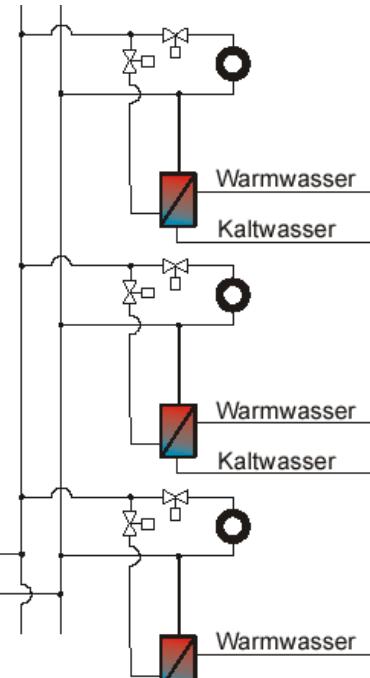
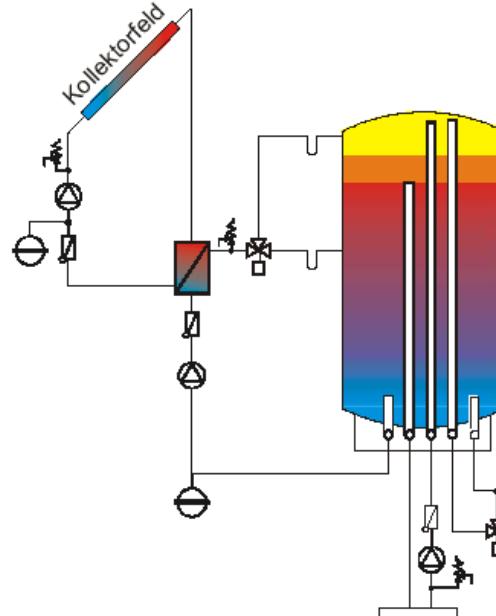


**Tipična poraba topote za pripravo sanitarnih voda v eno družinski stavbi je 18 do 25 kWh/m<sup>2</sup> a**

**S solarnimi ogrevalnimi sistemmi jo lahko zmanjšamo na 4,5 do 6,5 kWh/m<sup>2</sup> a**

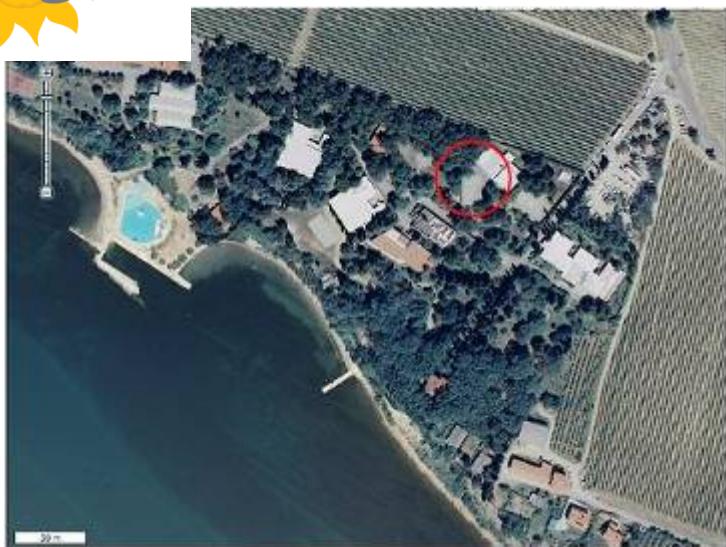
**Podpora ogrevanju stavb**





## “dvocevni” sistem:

- merjenje porabe +
- odstranjen problem legionel.



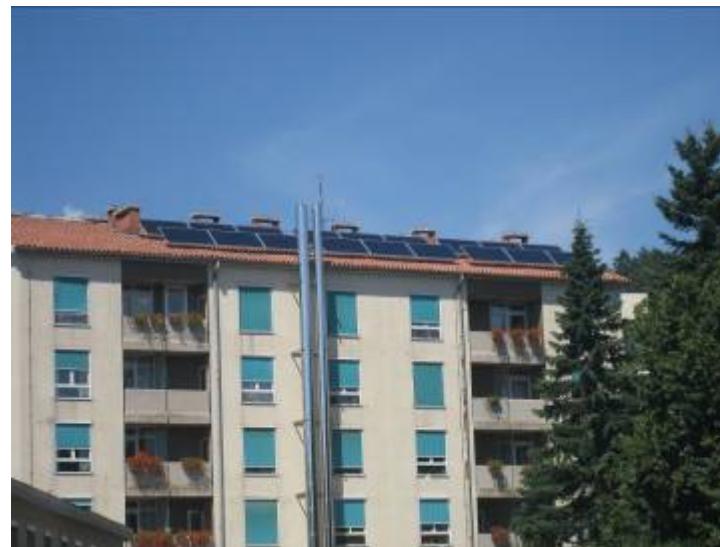
**Debeli rtič, 108 m<sup>2</sup>**



**Impoljca, 90 m<sup>2</sup>**

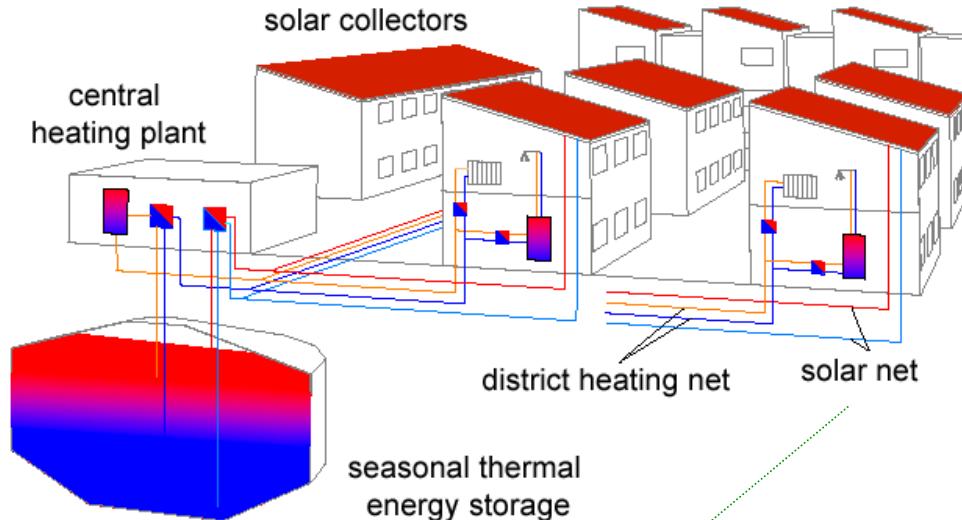


**Gradišče, 90 m<sup>2</sup>**



**Šežana, 2 x 45 m<sup>2</sup>**

# Veliki solarni ogrevalni sistemi – ogrevanje naselij



Example: Central solar heating plant in Hamburg-Bramfeld



Example: Solar village in Gneiss-Moos, Salzburg



# Daljinski sistemi z ogrevanjem na biomaso



# Daljinski sistemi z ogrevanjem na biomaso (SLO)

**Preddvor**



**Vrasko**





# Načrtovanje, primeri dobre prakse velikih SOS

## SOLARGE

Enlarging Solar Thermal Systems in Multi-Family-Houses,  
Hotels, Public and Social Buildings in Europe

**Solarge.org: Dom paraplegikov - Microsoft Internet Explorer**

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Address http://www.solarge.org/index.php?id=1357&no\_cache=1

Specific information by: Country/language

**SOLARGE**  
Enlarging Solar Thermal Systems in Multi-Family-Houses,  
Hotels, Public and Social Buildings in Europe

Home      Novice in dogodki      **Primeri dobre prakse**      Sodelavci projekta      Orodja, izdelki in proizvajalci      Povezave

Primeri dobre prakse

- Dom starejših občanov Tezno
- Dom paraplegikov**
- Dom Tisje
- Dom starejših občanov Preddvor
- Terme Catez / Hotel Zusterma
- Župnijska cerkev Sv. Petra in Sv. Pavla
- Tehnološki center Špan
- Hotel Delfin
- Terme Snovik
- Inn "Pri Bostjanu", Škofja Loka

Evropski primeri dobre prakse

**Dom paraplegikov**  
**Pacug, Slovenija**  
**Hotel, Bolnica, Športni center | sistem velikosti 78 m<sup>2</sup>**

Dom paraplegikov je zgrajen tako, da omogoča bivanje invalidom in jim omogoča zdrave počitnice, športniki invalidi pa ga lahko uporabljajo za priprave na tekmovanja. Dom bo končan leta 2007, solarni sistem pa je že zaključen. Za solarni sistem so se odločili zaradi želje po zmanjšanju vplivov na okolje in znižanju stroškov obratovanja. Solarni sistem je sestavljen iz dveh delov s skupno površino 72 m<sup>2</sup>. Uporablja se za pripravo toplice v predgrevanje bazenske vode. Sanitarna voda se ogreva v hranilniku toplice z vgrajenim prenosnikom toplice. Dom paraplegikov je zaseden celo leto, zato bo tudi solarni sistem deloval vse dni v letu.

Vee informacij



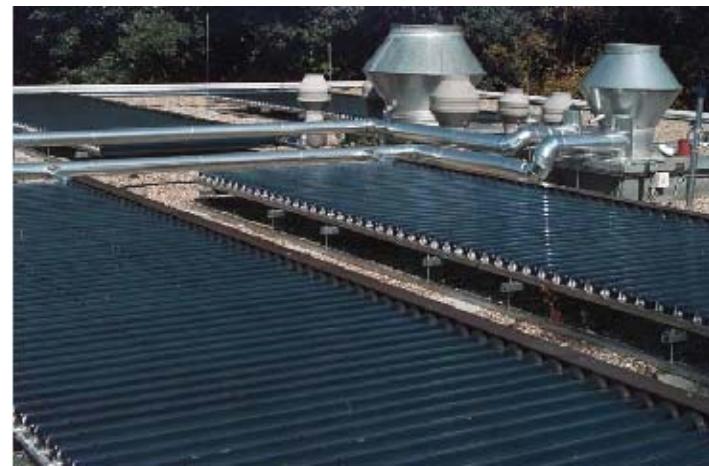
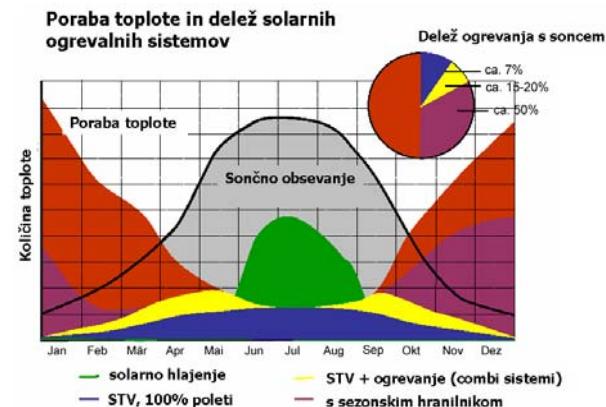

Solarne ogrevalne sisteme lahko uporabimo tudi za **solarno hlajenje**. Dva osnovna principa:

**Absorpcijsko hlajenje; Ohlajena voda s temperaturo 7-12°C, ki jo uporabljam za hlajenje stavb z običajnimi (konvektorskimi) hladilnimi ali klimatizacijskimi sistemi.**

**Potrebna temperatura toplote, ki jo proizvajamo s sprejemniki sončne energije proizvajamo toploto (80-85°C)**

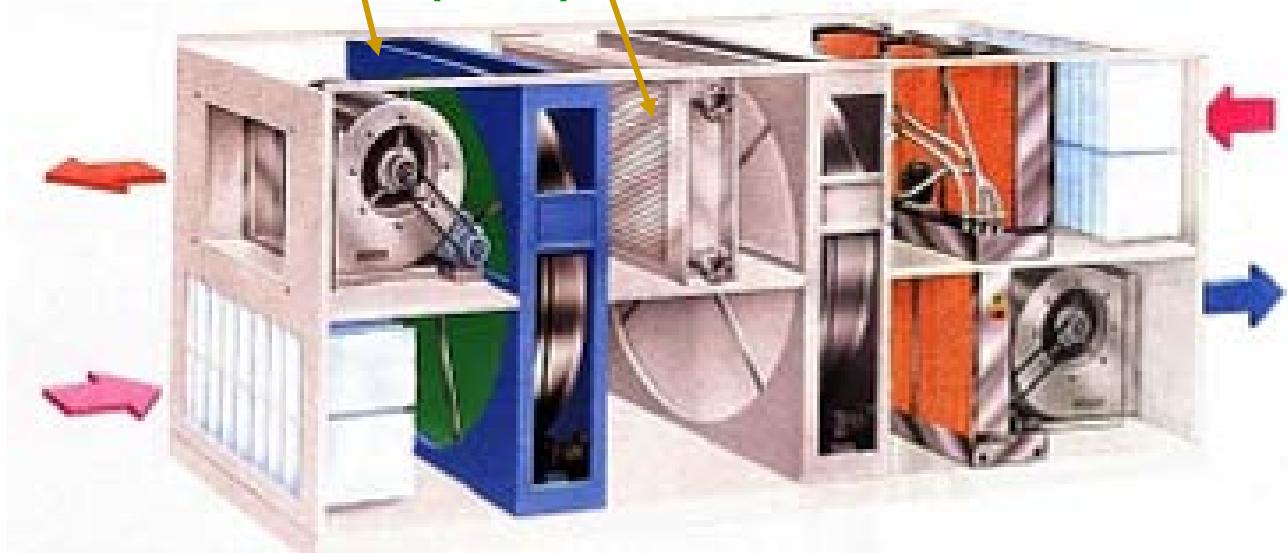


Kompaktni absorpcijski hladilni sistem, hladilna moč 5kW, temperatura hlajene vode 5-7°C



Kot del prezračevalne naprave (klimatske) naprav v kombinaciji **s hlapilnim navlaževanjem svežega zraka.**

Pred navlaževanjem mora biti zrak čim bolj suh, zato ga sušimo s sušilnim kolesom. To je vrteče satovje, ki je prevlečeno z adsorpcijsko (trdno) snovjo, ki vsrka vodno paro, ki jo ponovno razvlažimo s toplim zrakom SSE ( $70^{\circ}\text{C}$ )





# SOLAIR

Increasing the Market Implementation of Solar Air-Conditioning Systems for Small and Medium Applications in Residential and Commercial Buildings

**Technologies - Microsoft Internet Explorer**

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**SOLAIR**  
Increasing the Market Implementation of Solar Air-Conditioning Systems for Small and Medium Applications in Residential and Commercial Buildings

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**Technologies**

To those not acquainted with solar air-conditioning (SAC), the technologies might seem to be a contradiction in terms. In all SAC solar heat is used to drive a cooling process. Generally, SAC can be distinguished into:

**Closed systems:**

Closed systems are thermally driven chillers, which provide chilled water that is either used in air handling units to supply cooled and dehumidified air or that is distributed via a chilled network to decentralized room installations such as fan coils. Available closed systems on the market are [absorption chillers](#), which are most common, and [adsorption chillers](#), which still represent an innovative approach.

**Open systems:**

Open systems allow complete air-conditioning by supplying cooled and dehumidified air. The "refrigerant" is always water, which is brought into direct contact with the atmosphere. The most common open systems are [desiccant cooling systems](#) with a rotating dehumidification wheel and a solid sorbent.



## Europe looks to draw power from Africa

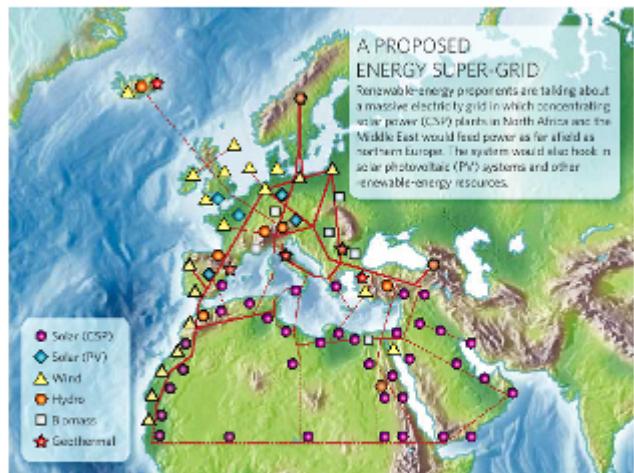
The power needs of Europe, the Middle East and North Africa could be met by an ambitious idea to network renewable energies across the region. The cornerstone of the plan, developed by a group of scientists, economists and businessmen, involves peppering the Sahara Desert with solar thermal power plants, then transmitting the electricity through massive grids.

Prince Hassan bin Talal of Jordan was scheduled to present this green energy idea, dubbed DESERTEC, to members of the European Parliament in Brussels on 28 November.

The vision is ambitious: it would require roughly 1,000 100-megawatt power plants, using mirrors to concentrate energy from the Sun's rays, throughout the Middle East and North Africa to meet the region's projected energy needs. A high-efficiency electricity grid, yet to be built, would then ferry the power around and across the Mediterranean Sea and northern Europe.

"The technology for the DESERTEC concept is available and can offer unlimited, cheap and carbon-dioxide-free energy to Europe," says Gerhard Kries, a retired physicist based in Hamburg, Germany. Kries is co-founder of the Trans-Mediterranean Renewable Energy Cooperation (TREC), which came up with the DESERTEC idea.

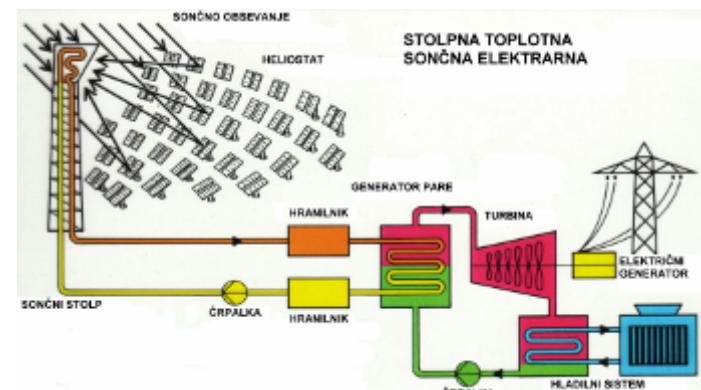
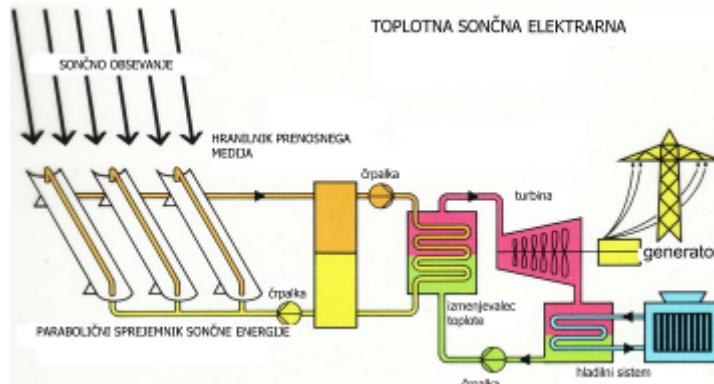
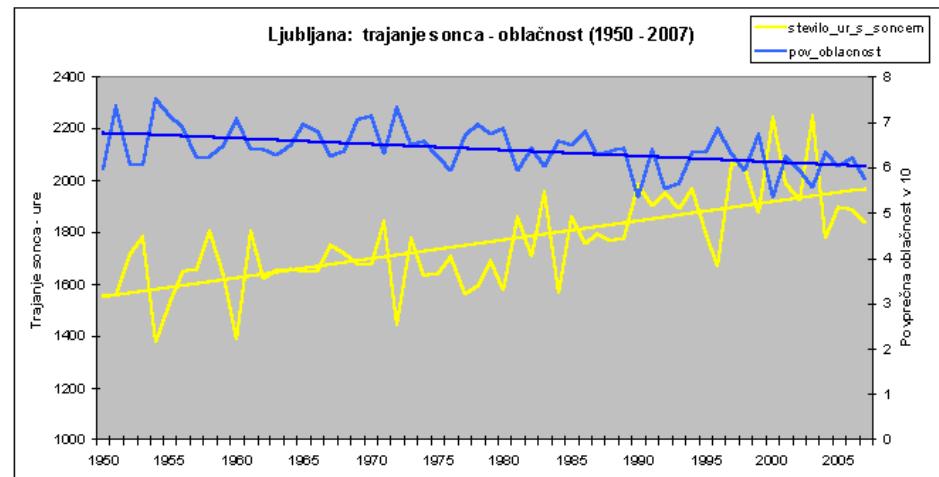
The European Union has a binding target to get 20% of its energy from renewable sources by 2020, so the idea is gaining support in some

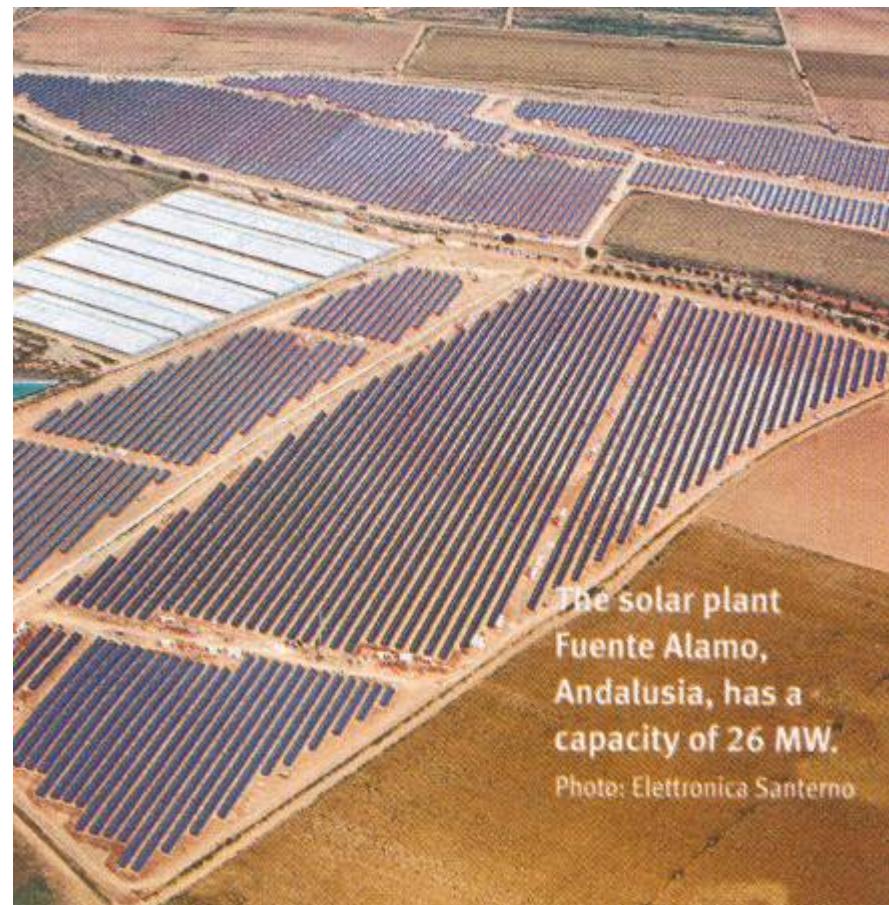


inventor who built a prototype solar thermal plant in Egypt in 1913. But the idea never took off, and today solar power in the region comes from relatively small solar-cell installations on houses and other individual buildings.

and scale could bring that down to less than 10 eurocents per kilowatt-hour, making it more competitive with coal.

Initial solar thermal plants are being planned in Algeria, Egypt and Morocco, with more







## Nemčija

**18 m<sup>2</sup> na 1000 prebivalcev**



## Španija

**8 m<sup>2</sup> na 1000 prebivalcev**



## Avstrija

**41 m<sup>2</sup> na 1000 prebivalcev**



## Francija

**4,3 m<sup>2</sup> na 1000 prebivalcev**





## Kako gospodarno podpiramo solarne ogrevalne sisteme ?

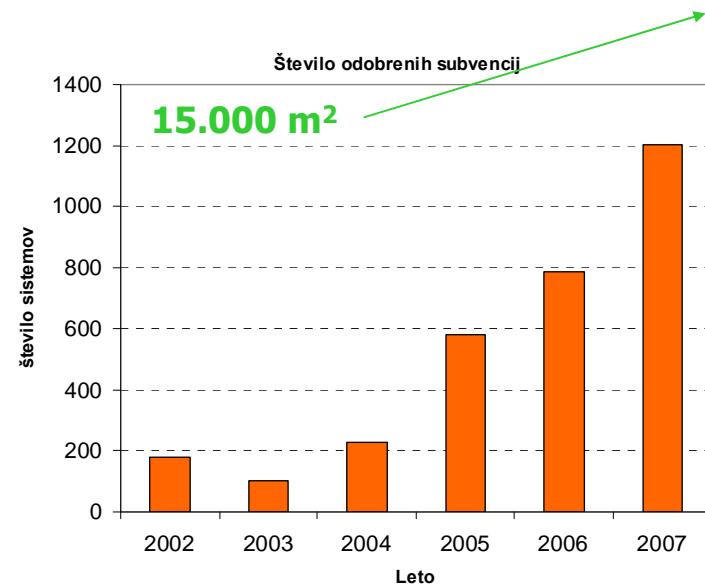
► V 2008 smo vgradili ~ 15.000 m<sup>2</sup> SSE

► Novo instalirana moč -> 10,5 MW,  
v zadnjih 5 letih 33 MW

► Proizvodnja toplice -> 7,5 GWh

► Cena subvencij kWh<sub>(10 let)</sub> -> 0,027 €/kWh

► Cena (za državo) zmanjšanih emisij CO<sub>2</sub> -> 48 € na tono





# Hvala za pozornost



## Solar Thermal Vision 2030

### New buildings

100% solar heated buildings will be the building standard



### Existing building stock

Solar refurbished buildings, > 50% solar heated, will be the most cost effective way to refurbish the building stock



### Industrial and agricultural applications

solar thermal systems will cover process heating and cooling demands



**Overall goal:** Cover 50% of the low temperature need up to 250°C