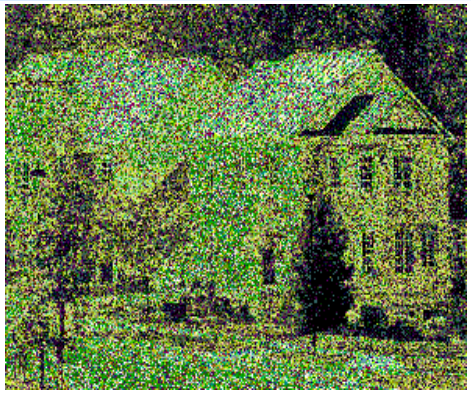
Trendi raziskav v fotovoltaiki

Marko Topič

Laboratorij za fotovoltaiko in optoelektroniko (LPVO)

Univerza v Ljubljani
Fakulteta za elektrotehniko







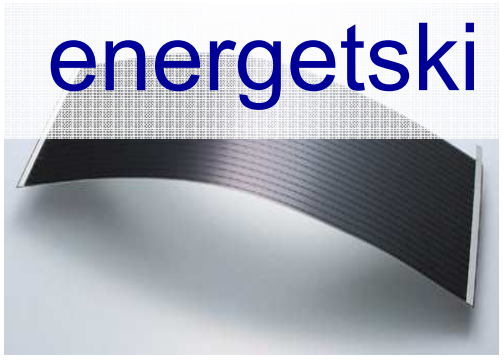

Fotovoltaika



sedanjosti



postaja

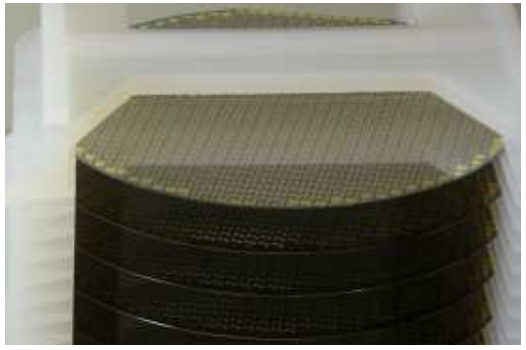
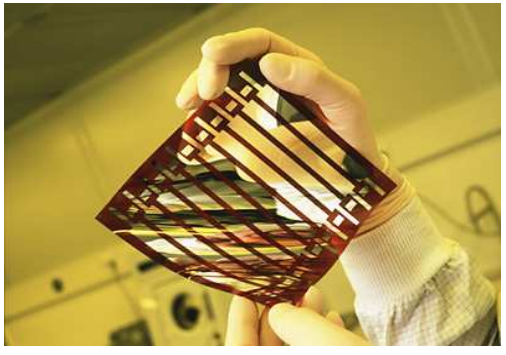
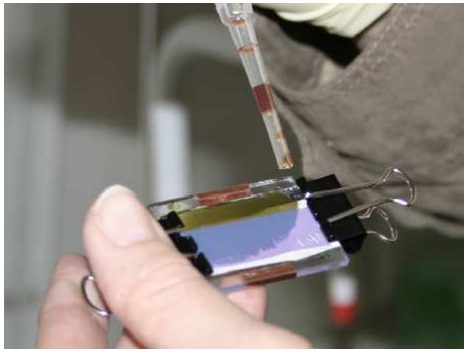


energetski



posel

~~prihodnosti~~

Fotovoltaika in ekonomika

- učinkovitost pretvorbe sončnih celic in PV modulov (%) — raziskovalec
- Cena na enoto naznačene moči (€/kWp) — investitor
- Energijski izplen PVS — proizvajalec
- Življenjska doba PVS
- Cena na enoto proizvedene električne energije (€c/kWh)

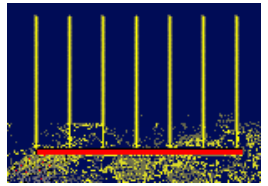
30 let * 1 MWh/leto/kWp / 5.000 €/kWp =

30 MWh / 5.000 € ali 166 € / MWh (z 10 m^2 za 10% PVS)

Tehnologije PV modulov

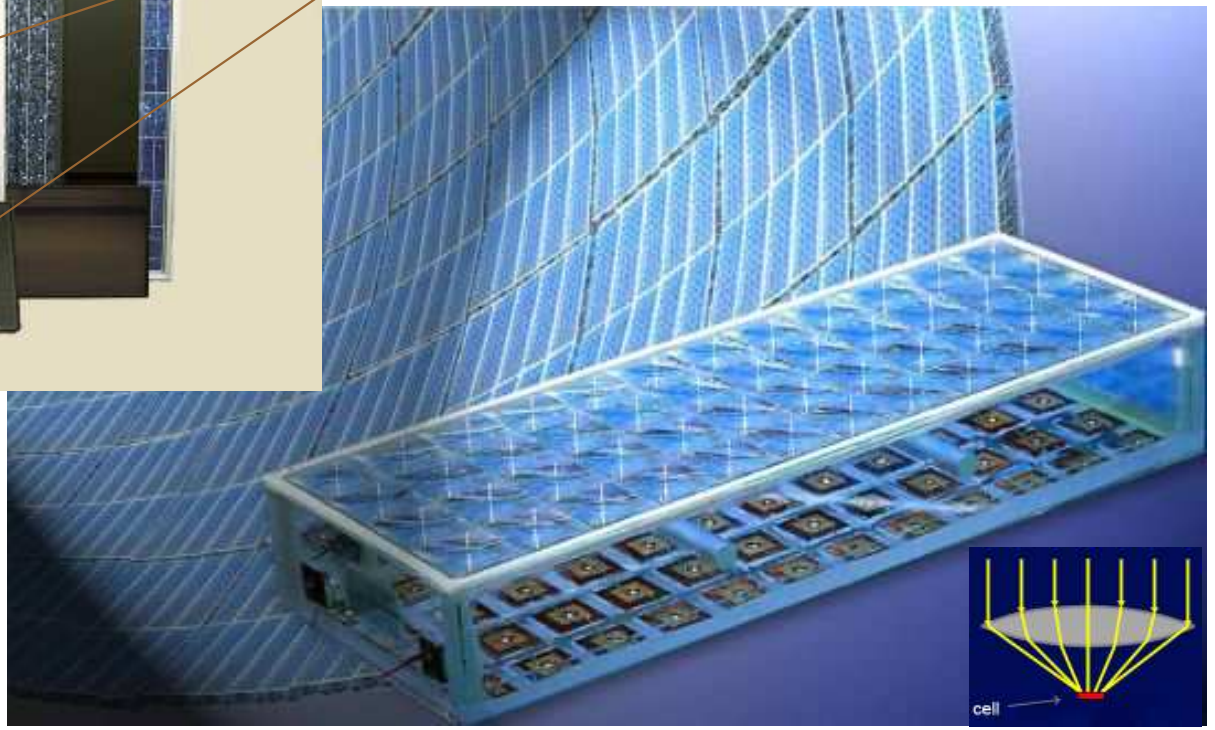


klasični PV moduli



tankoplastni PV moduli

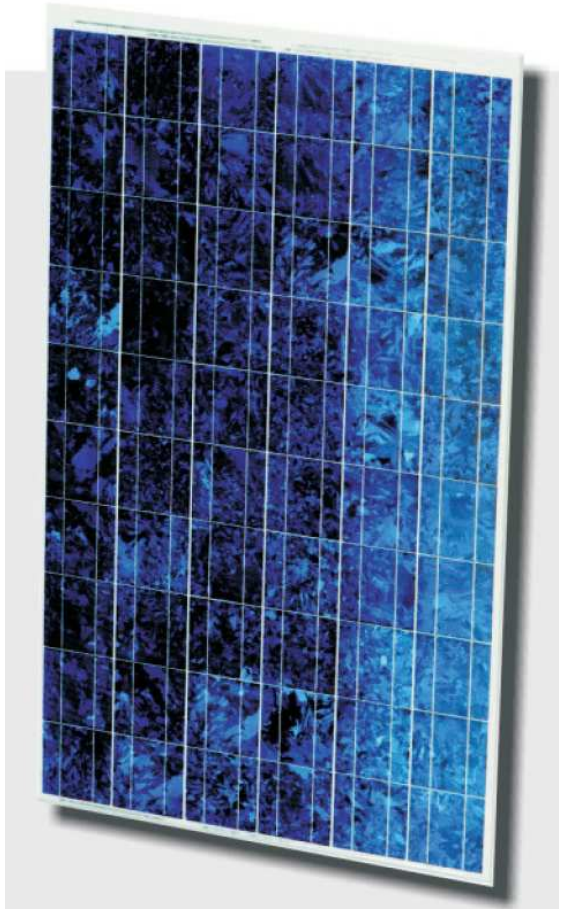
koncentratorski PV moduli



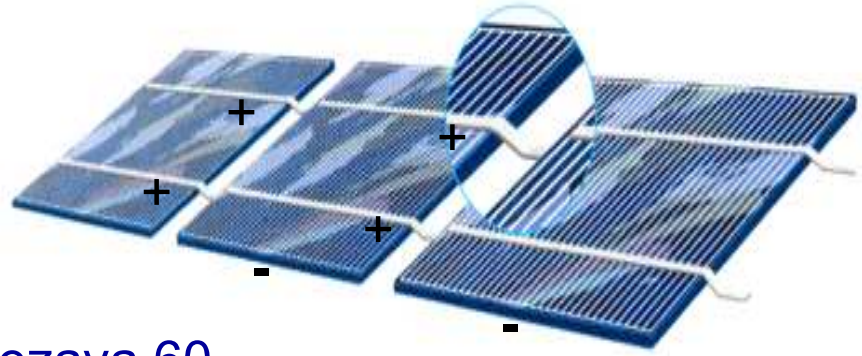
Vir: Concentrix, Germany

Klasični PV moduli (1G)





BMU-215-1/221



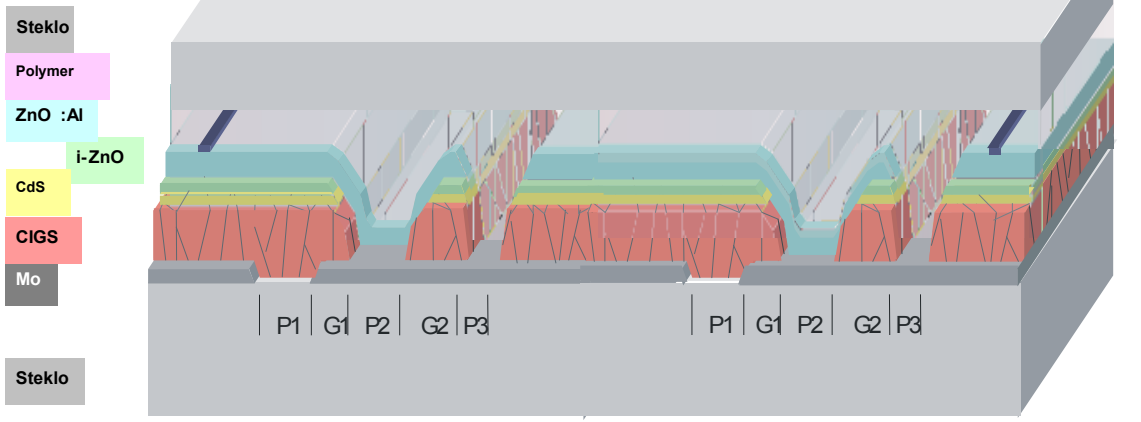
Vir: Solarpraxis AG

- zaporedna vezava 60 multikristalnih Si sončnih celic
- I_{sc} = 8.30 A
- U_{oc}= 36.8 V
- P = 221 Wp

Tankoplastni PV moduli (2G)

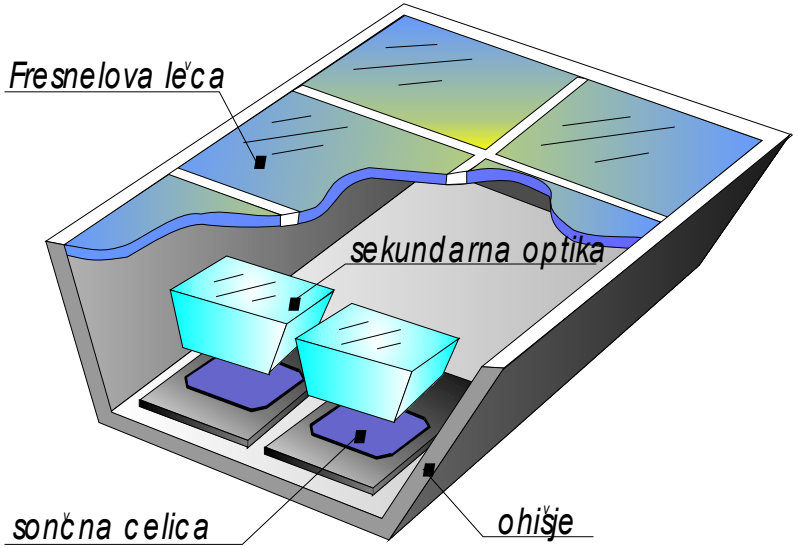


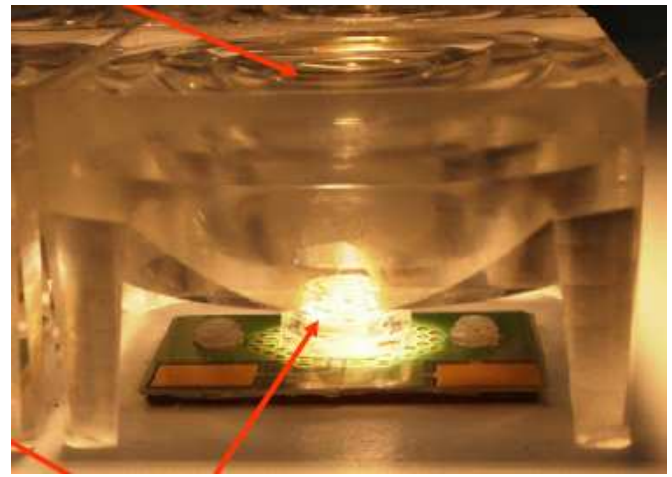
Vir: ZSW, Nemčija

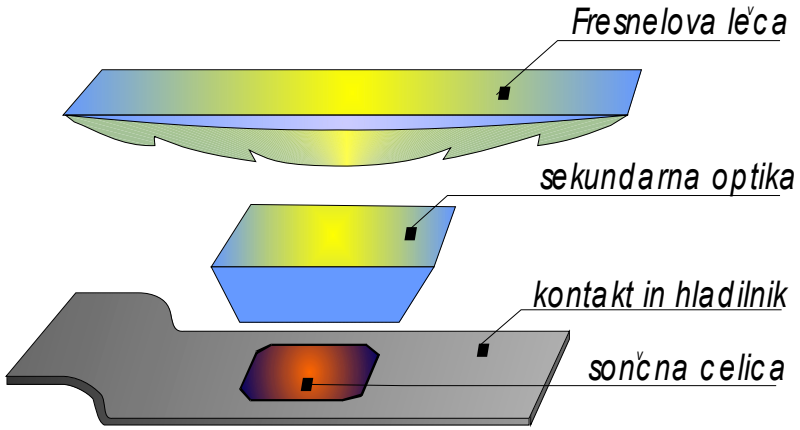




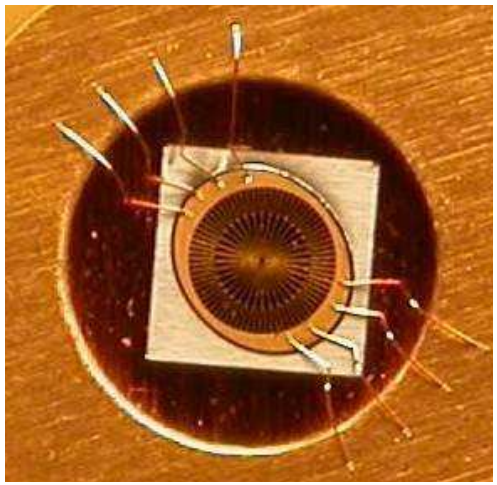
Koncentratorski PV moduli (2G)







Vir: ISOFOTON



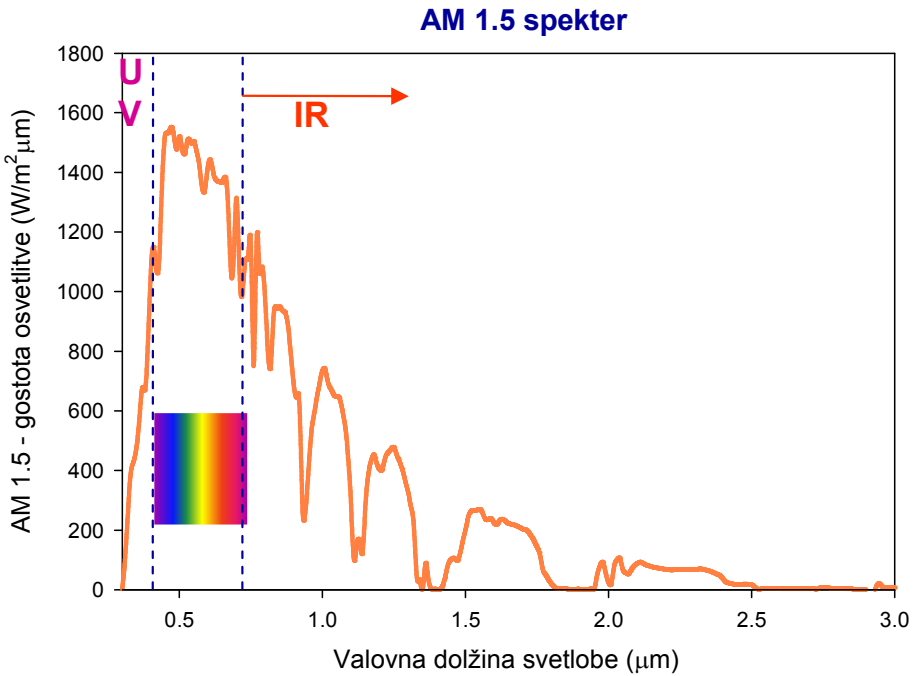
Wp - naznačena moč

Naznačena električna moč $P_{max@STC}$ [enota: **Wp** (vršni vat, angl. “watt-peak”)]

je maksimalna moč PV generatorja pod standardnimi preskusnimi pogoji.

Standardni preskusni pogoji (STC):

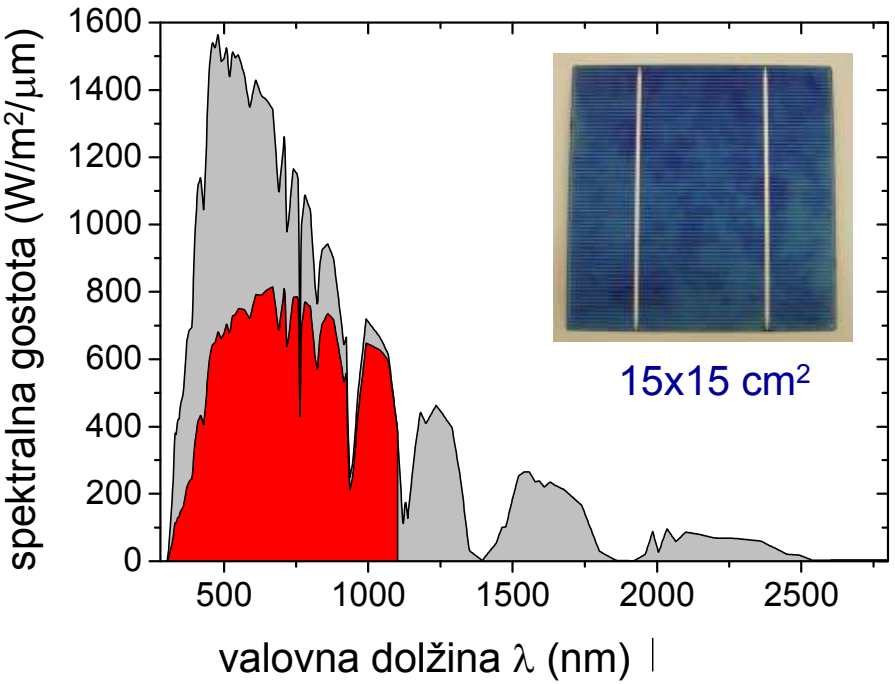
- Standardni spekter: **AM 1.5g**
- Gostota moči osvetlitve: **1000 W/m²** (eno sonce)
- Temperatura sončne celice: **25 °C**
- Hitrost vetra: **1 m/s**

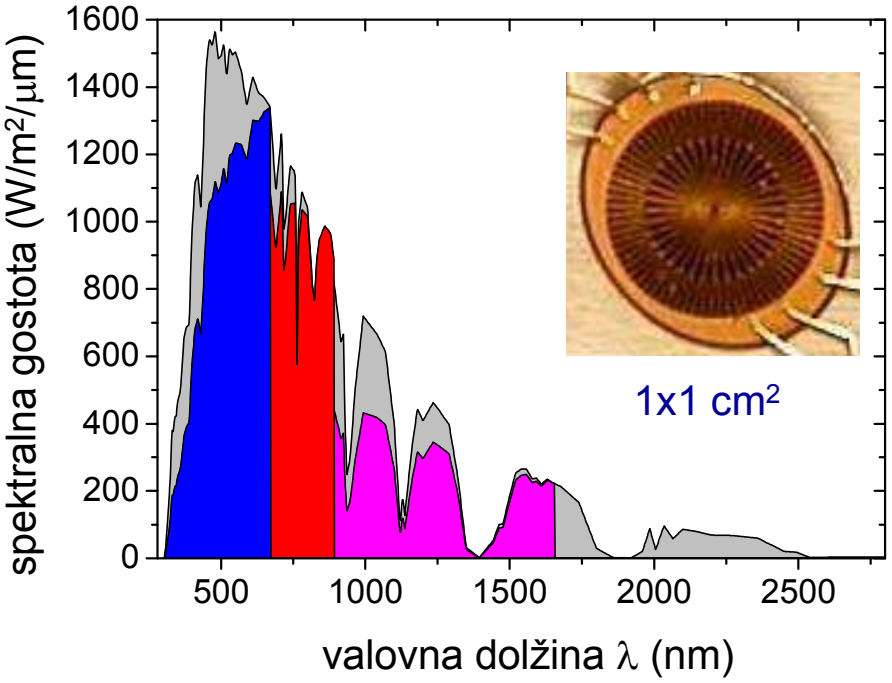


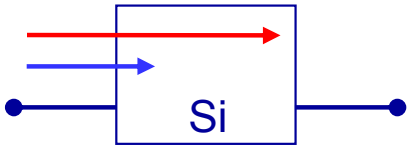
Učinkovitost pretvorbe ali izkoristek (η):

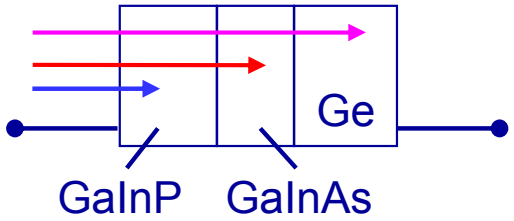
$$\eta = \frac{P_{električna}}{P_{svetlobna}} = \frac{P_{električna}}{G_{svetlobna} \bullet A_{modula}} = \frac{221\ \text{Wp}}{1000\ \text{W/m}^2 \cdot 1.63\ \text{m}^2} = 13.7\ \%$$

Tipi sončnih celic





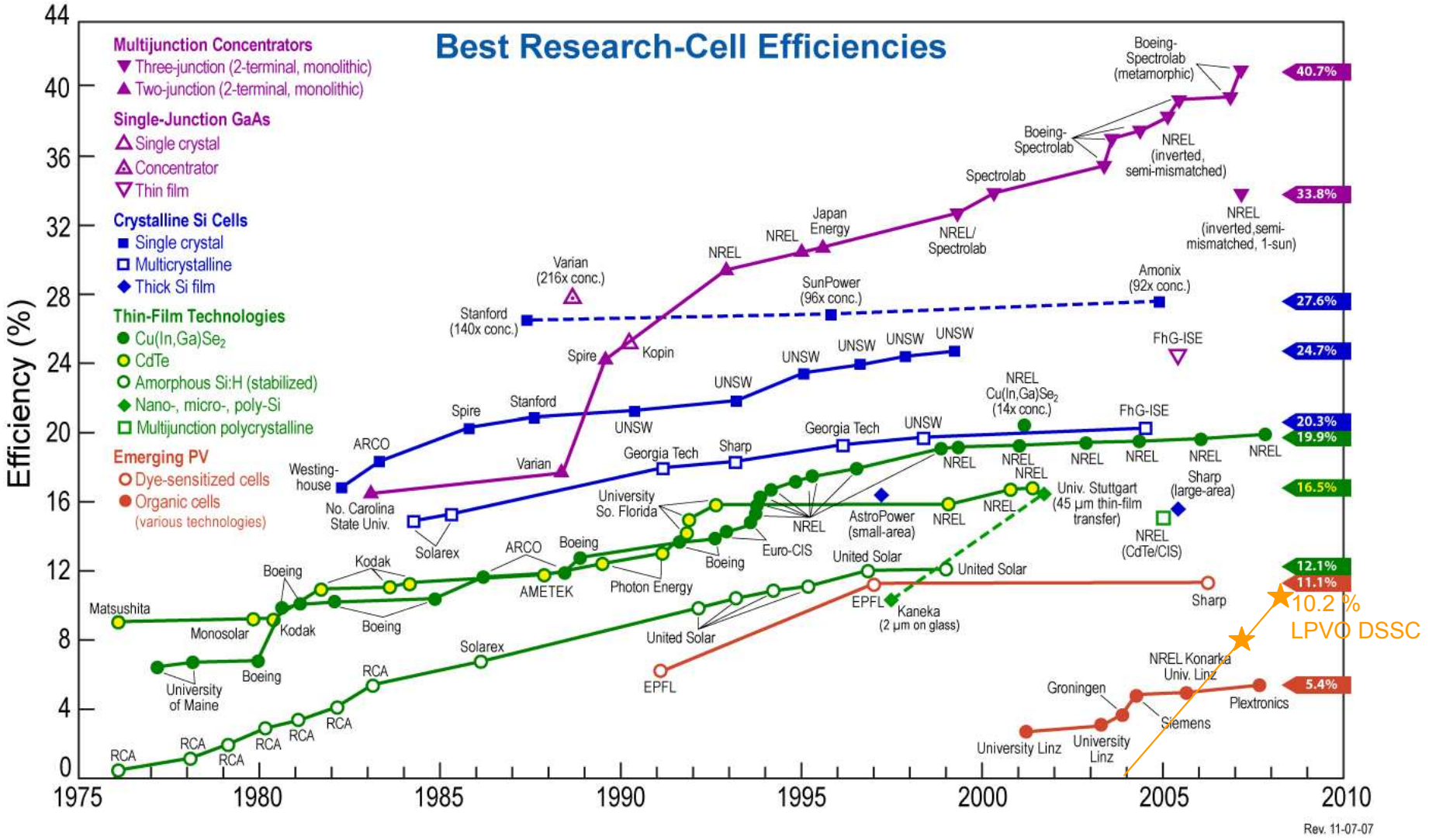




enospojna *np* celica
rekord: 24,7% za Si
25,1% za GaAs

trispojna *np/np/np* celica
rekord: 32,0% pod 1 soncem
40,7% pod 200 sonci

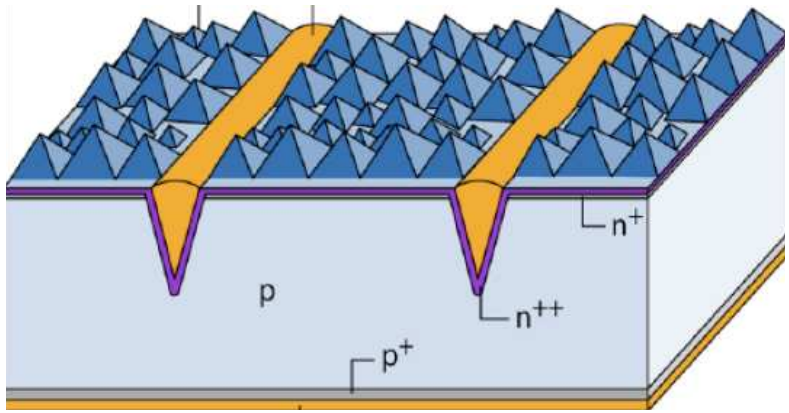
Tehnologije sončnih celic in rekordni izkoristki



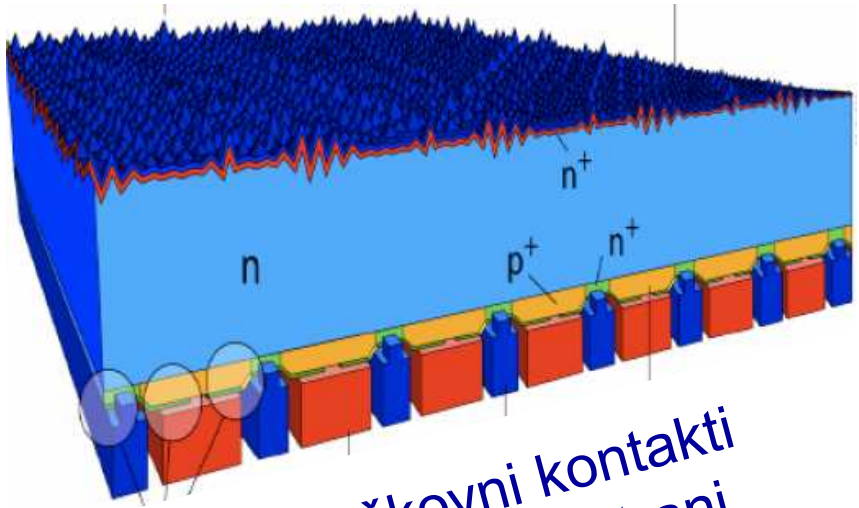
Vir: Lawrence Kazmerski, Don Gwinner, Al Hicks, 11/11/2007, NREL

20% Si sončne celice (1G)

BP Saturn

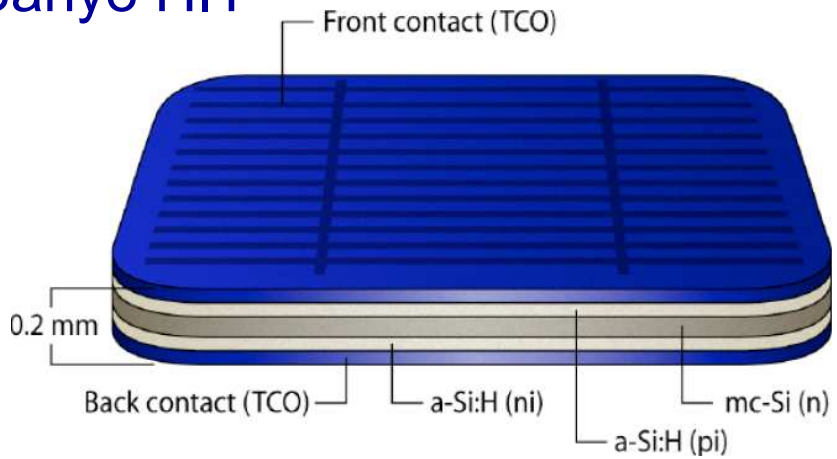


SunPower



točkovni kontakti
na hrbtni strani

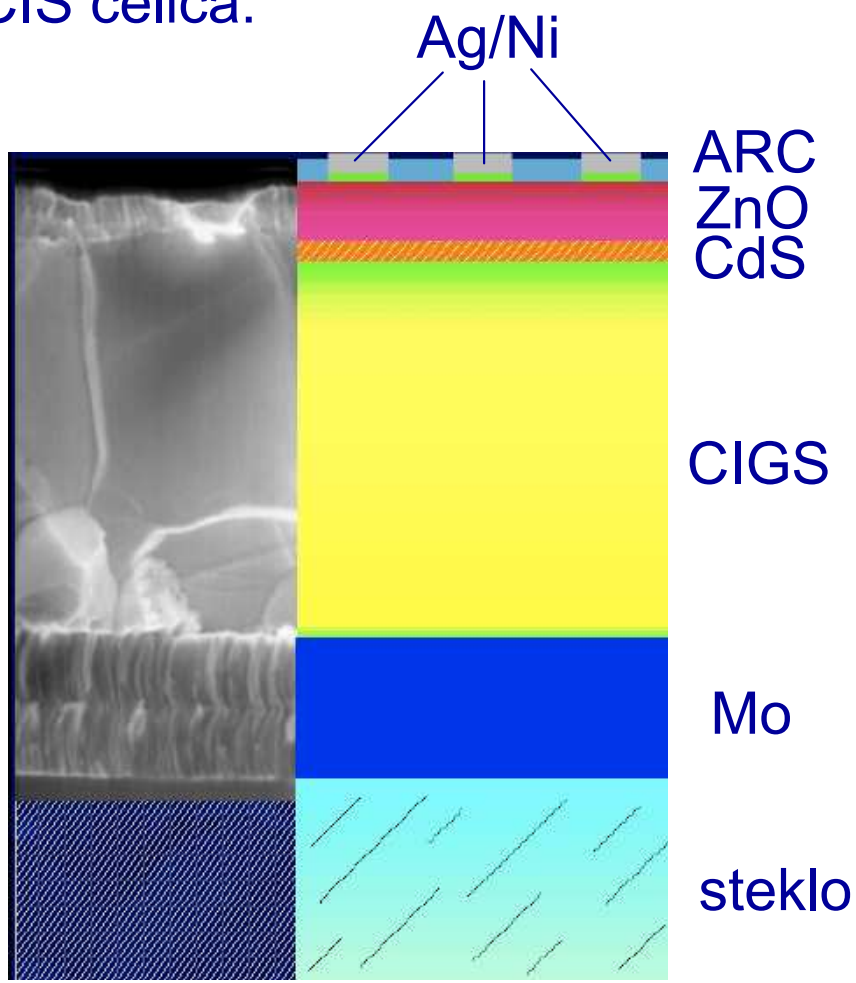
Sanyo HIT

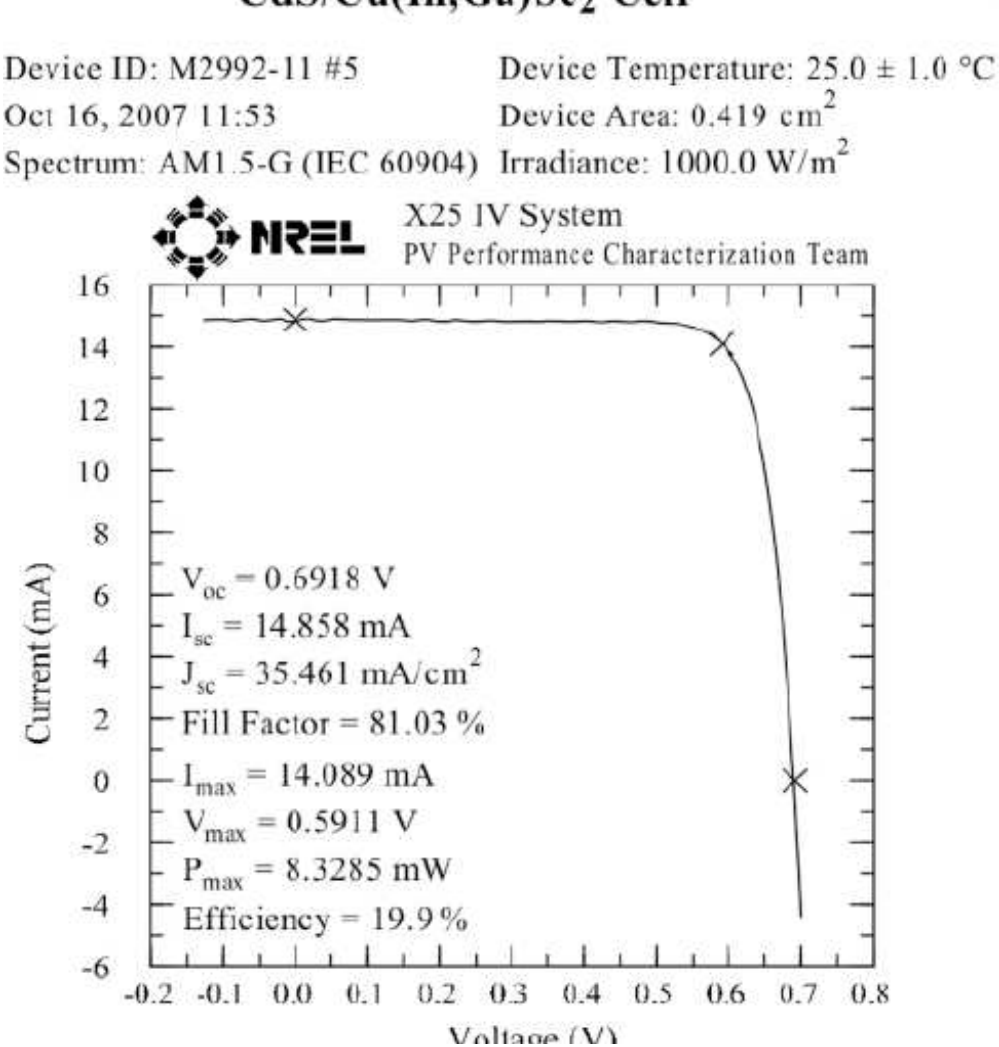


Vir: Lawrence Kazmerski, 2008, NREL

Rekordne sončne celice (2G)

CIS celica:

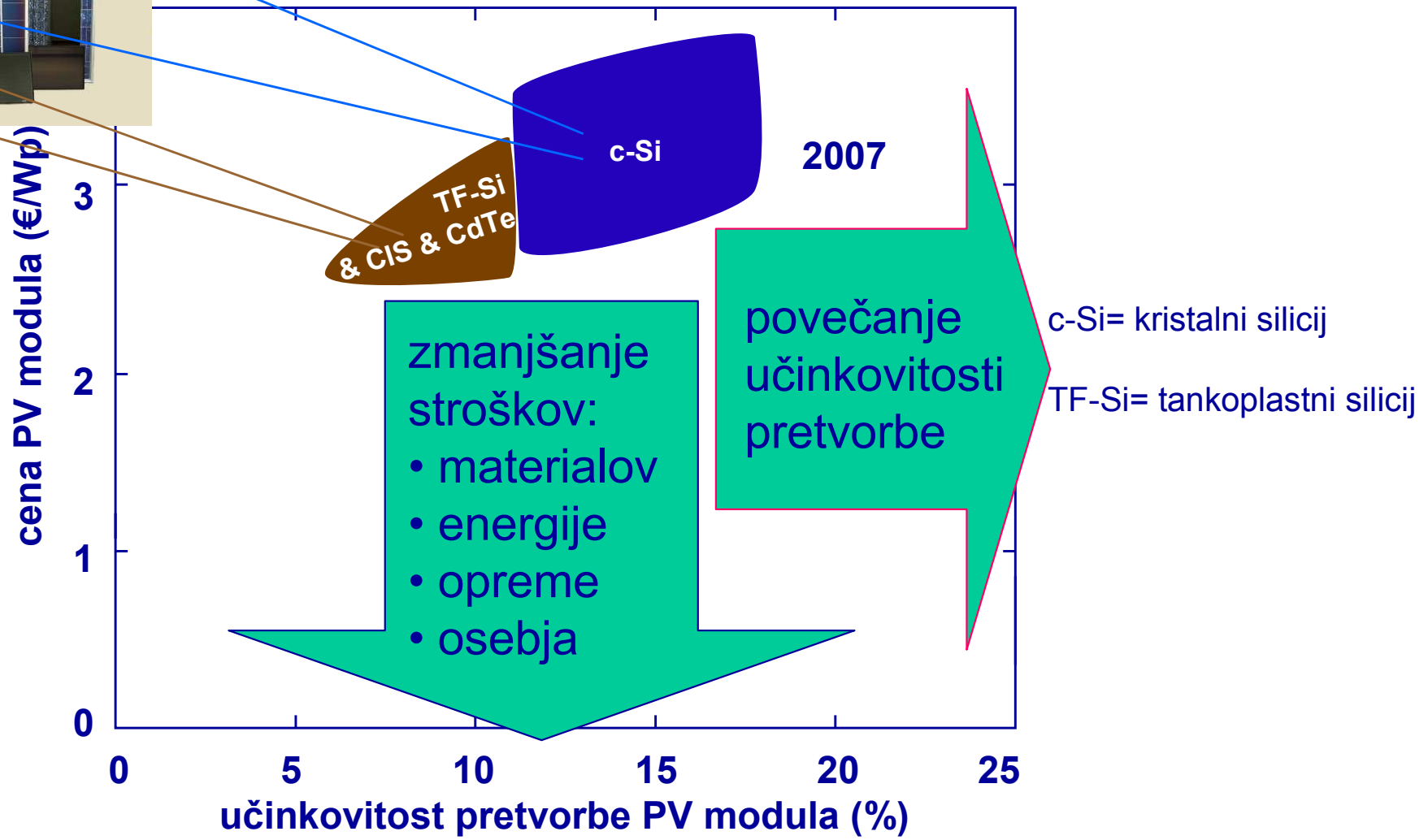




Vir: Lawrence Kazmerski, 2008, NREL

Industrijski R&D trendi PV modulov



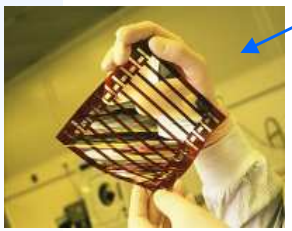


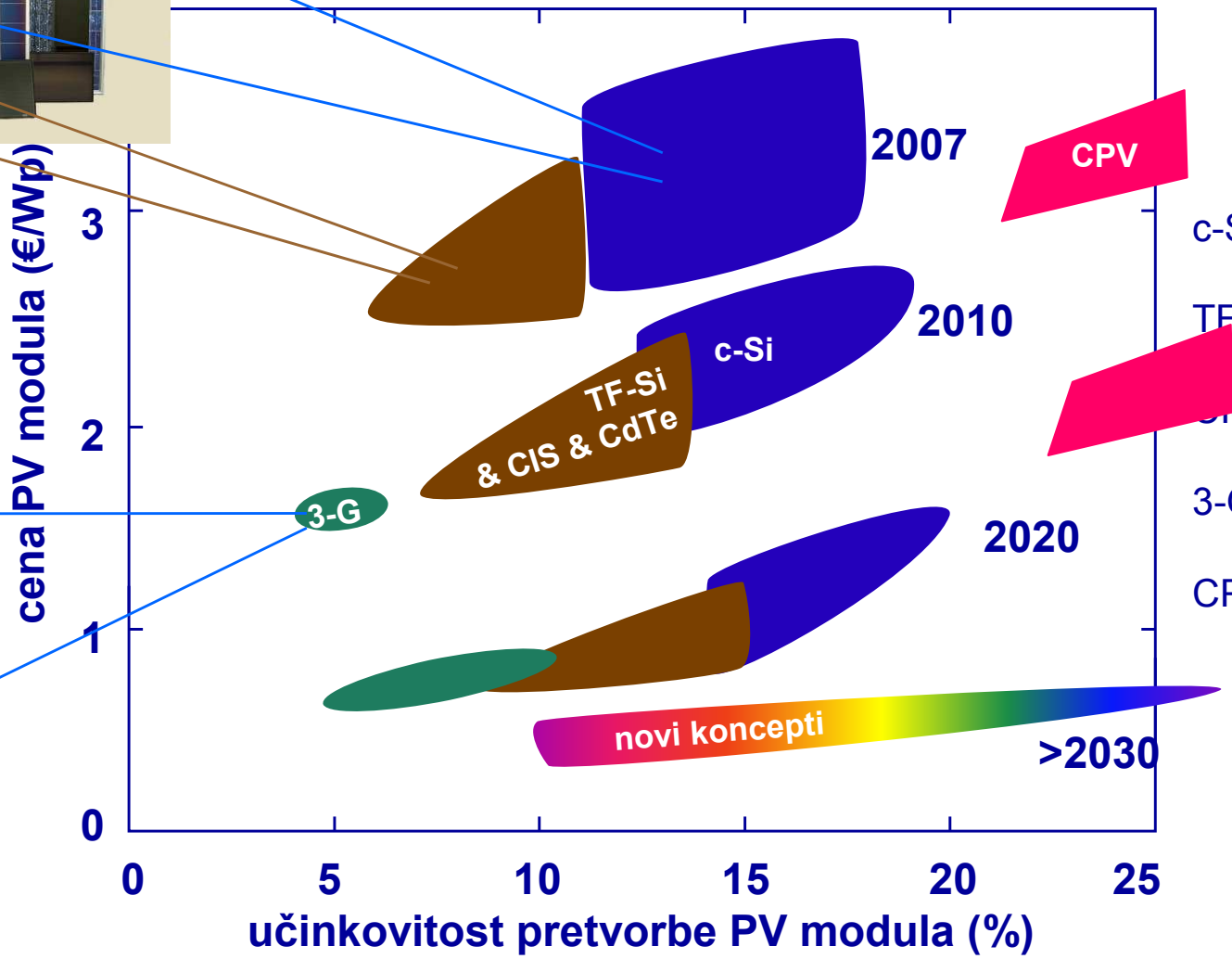
Vir: Wim Sinke, Generalna skupščina EU PV TP, 19. 5. 2006

Tehnološki trendi celic in modulov









c-Si= kristalni silicij

TF-Si= tankoplastni silicij

CIS= $Cu(In,Ga)(Se,S)_2$

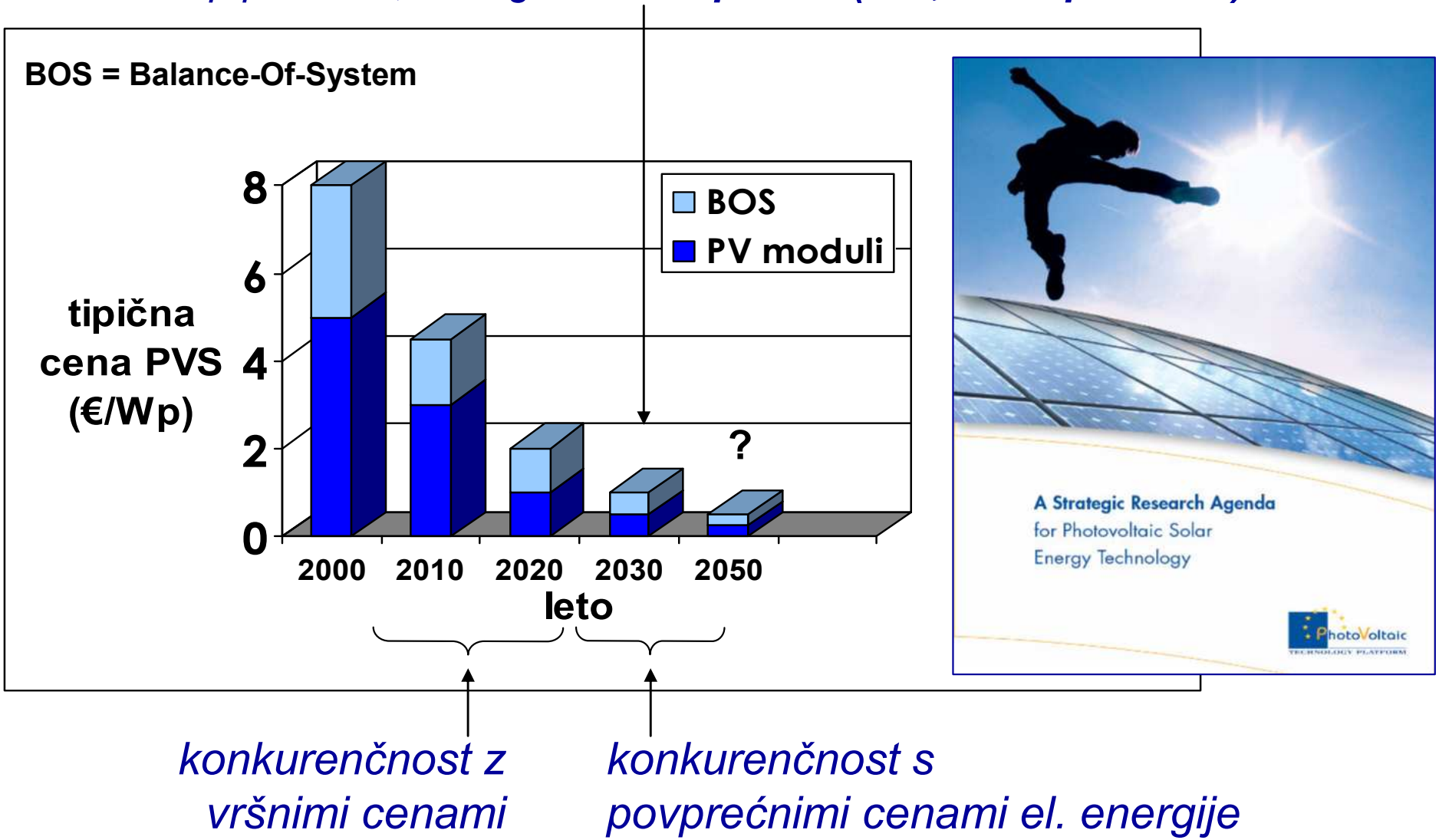
3-G = 3. generacije

CPV - koncentratorske večspojne GaAs

Vir: Wim Sinke, Generalna skupščina EU PV TP, 19. 5. 2006

EU strateška razvojna agenda

*1000 GWp po svetu, od tega **200 GWp v EU (200,000 zaposlenih)***



konkurenčnost z vršnimi cenami

konkurenčnost s povprečnimi cenami el. energije

Vir: Wim Sinke et al., A Strategic Research Agenda for Photovoltaic Solar Energy Technology, 2007.

Zahvala vsem članom LPVO

