



EnerGAIN

Проект: Промовирање на децентрализирано производство на енергија од обновливи извори на енергија

Interreg - IPA CBC
CCI 2014TC16I5CB006



ИНФОРМАТИВЕН СЕМИНАР: ДИМЕНЗИОНИРАЊЕ НА ФВ СИСТЕМИ

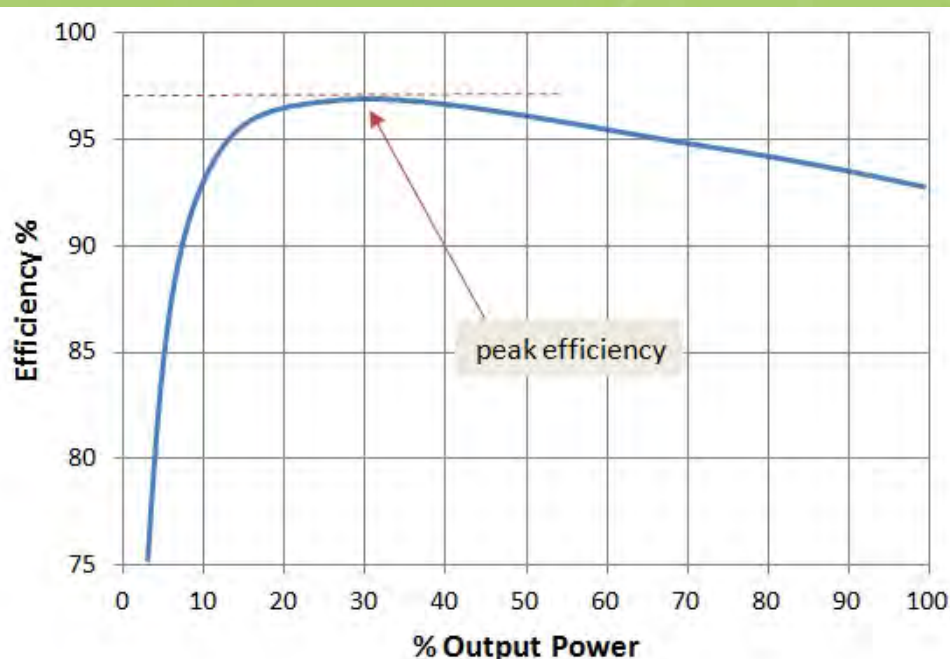
ОСНОВНИ ДИМЕНЗИОНИРАЊА КАЈ ФОТОВОЛТАИЧНИТЕ СИСТЕМИ



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Гевгелија, 14 септември 2017 год.

ЕФИКАСНОСТ НА ИНВЕРТОРИТЕ (peak, CEC, EURO)



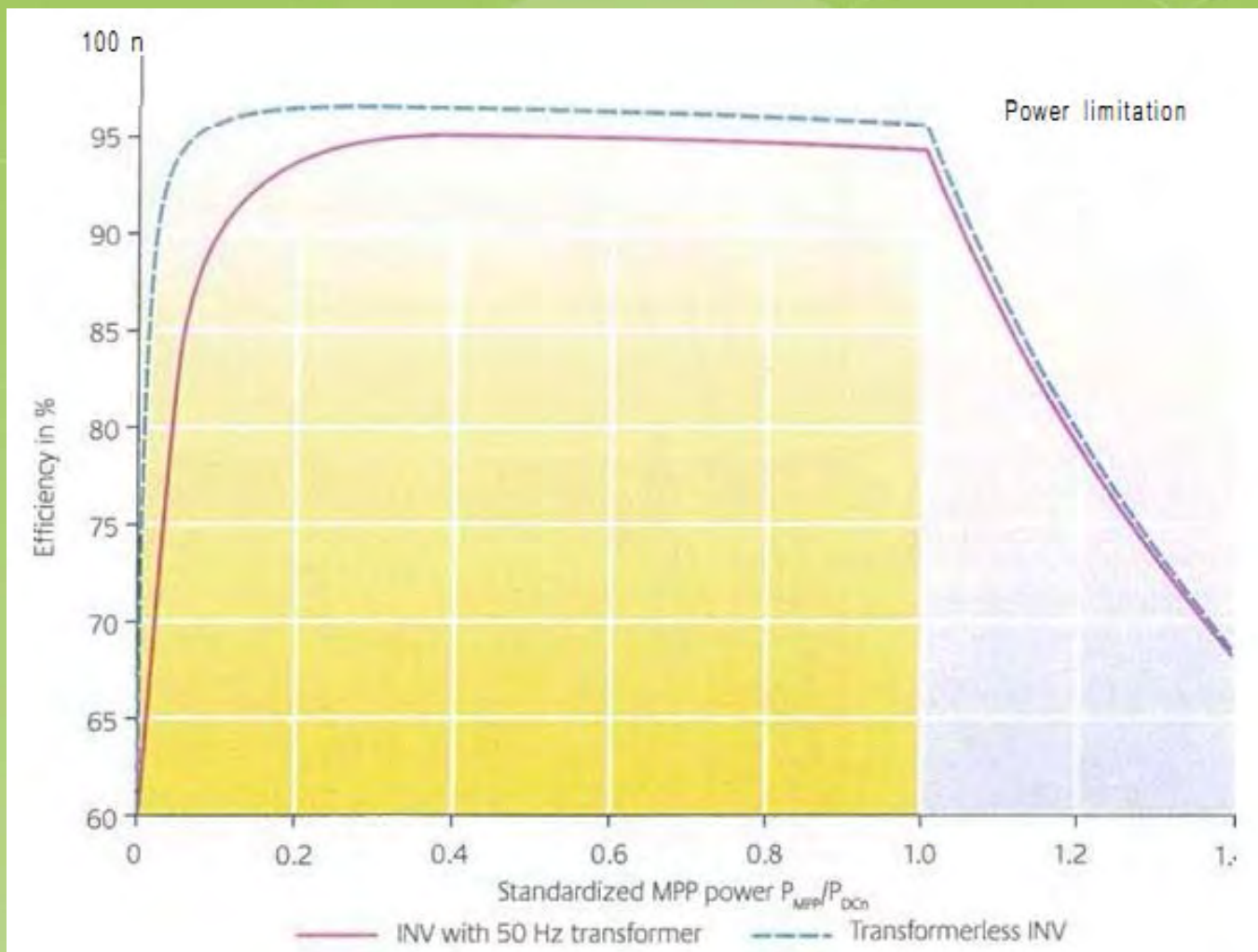
California Energy Commission (CEC) weighted efficiency

$$\eta_{CEC} = 0.04 \cdot \eta_{10\%} + 0.05 \cdot \eta_{20\%} + 0.12 \cdot \eta_{30\%} \\ + 0.21 \cdot \eta_{50\%} + 0.53 \cdot \eta_{75\%} + 0.05 \cdot \eta_{100\%}$$

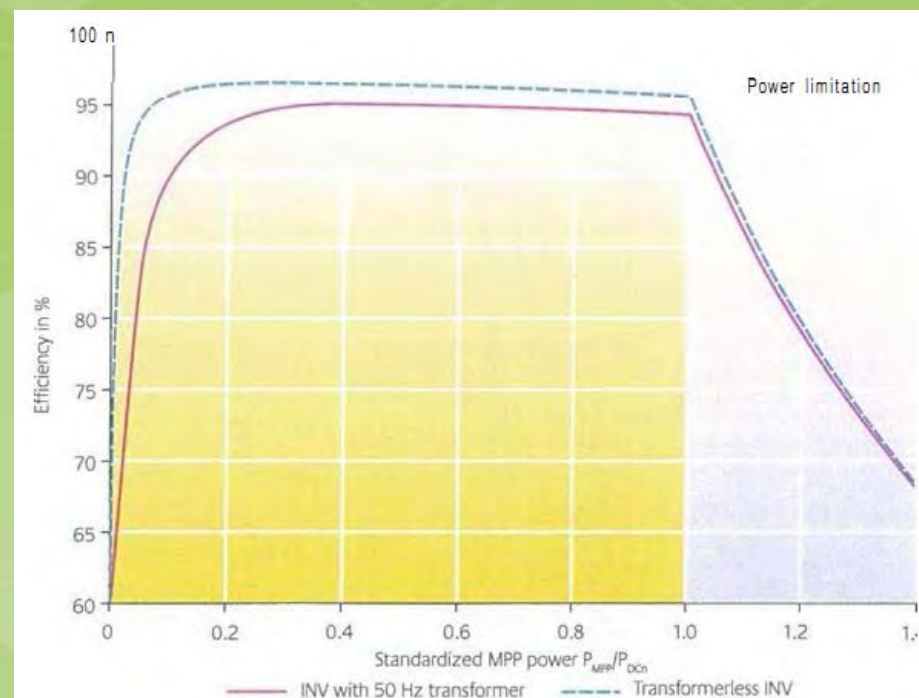
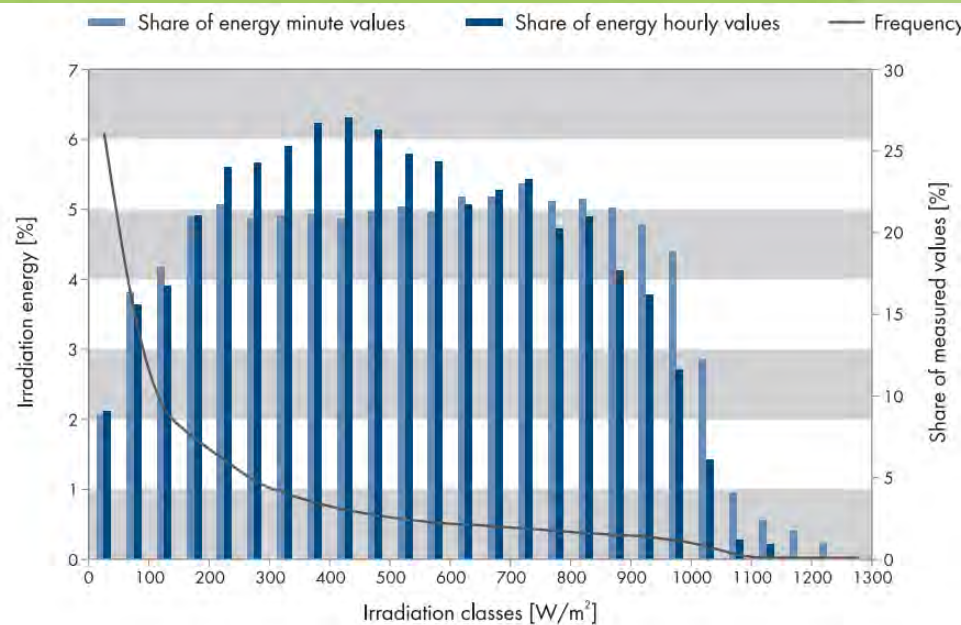
European weighted efficiency

$$\eta_{EU} = 0.03 \cdot \eta_{5\%} + 0.06 \cdot \eta_{10\%} + 0.13 \cdot \eta_{20\%} \\ + 0.10 \cdot \eta_{30\%} + 0.48 \cdot \eta_{50\%} + 0.20 \cdot \eta_{100\%}$$

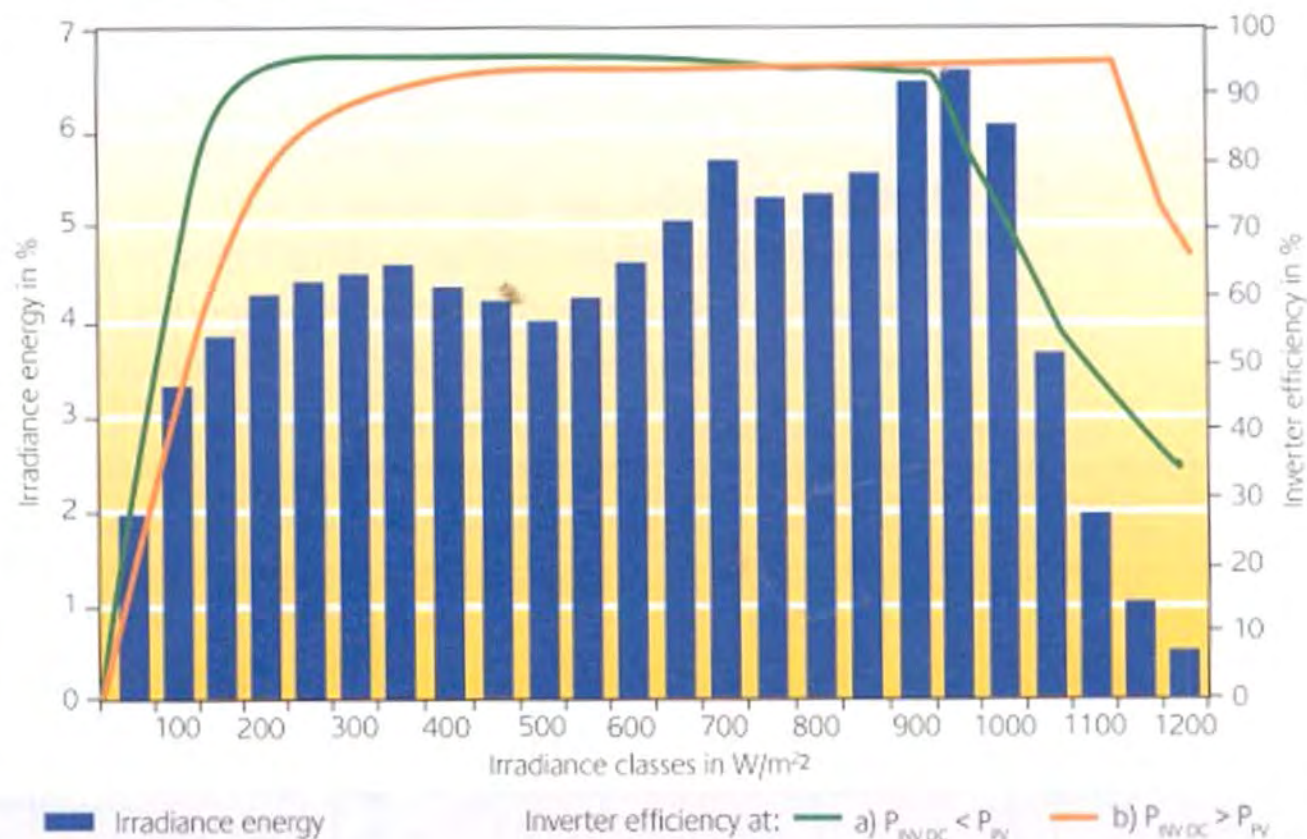
ЕФИКАСНОСТ НА ИНВЕРТОРИТЕ



ИНСТАЛИРАНА МОЌНОСТ : ИНВЕРТОР vs. ФВ ГЕНЕРАТОР

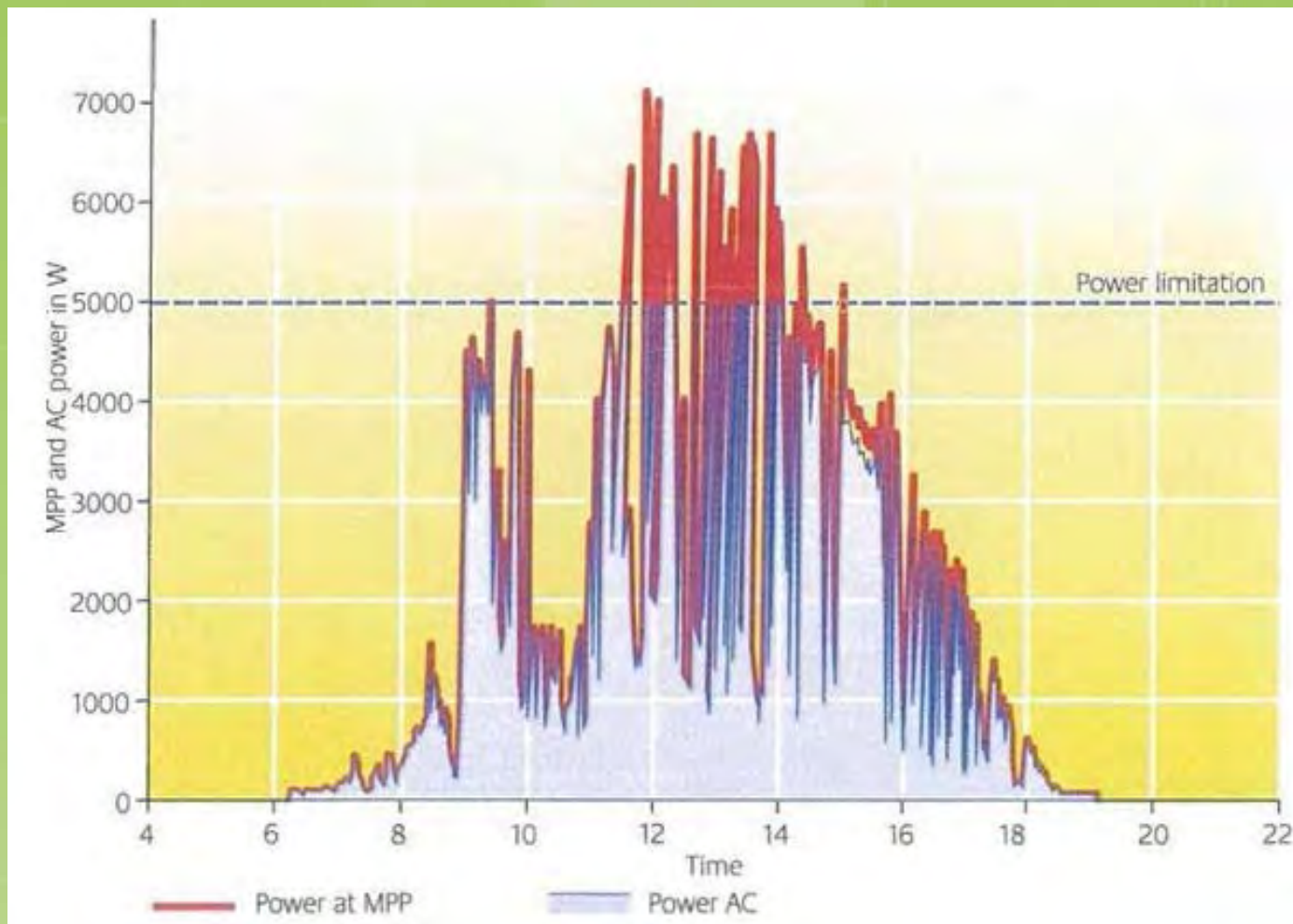


ДИМЕНЗ. НА ФВ ГЕНЕРАТОР/ИНВЕРТОР



$$0.8 \times P_{PV} < P_{INV DC} < 1.2 \times P_{PV}$$

ДИМЕНЗ. НА ФВ ГЕНЕРАТОР/ИНВЕРТОР



ТЕХНИЧКИ ПОДАТОЦИ ЗА ИНВЕРТОРИ

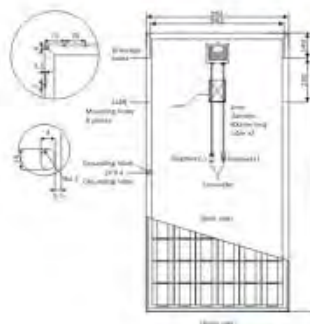
Technical Data	Sunny Tripower 20000TL	Sunny Tripower 25000TL
Input (DC) Input (DC)		
Max. DC power (@ $\cos \phi = 1$)	20440 W	25550 W
Max. input voltage	1000 V	1000 V
MPP voltage range / rated input voltage	320 V to 800 V / 600 V	390 V to 800 V / 600 V
Min. input voltage / start input voltage	150 V / 188 V	150 V / 188 V
Max. input current input A / input B	33 A / 33 A	33 A / 33 A
Number of independent MPP inputs / strings per MPP input	2 / A:3; B:3	2 / A:3; B:3
Output (AC)		
Rated power (@ 230 V, 50 Hz)	20000 W	25000 W
Max. AC apparent power	20000 VA	25000 VA
AC nominal voltage	3 / N / PE; 220 / 380 V 3 / N / PE; 230 / 400 V 3 / N / PE; 240 / 415 V	3 / N / PE; 220 / 380 V 3 / N / PE; 230 / 400 V 3 / N / PE; 240 / 415 V
Nominal AC voltage range	160 V to 280 V	160 V to 280 V
AC grid frequency / range	50 Hz, 60 Hz / -6 Hz to +5 Hz	50 Hz, 60 Hz / -6 Hz to +5 Hz
Rated power frequency / rated grid voltage	50 Hz / 230 V	50 Hz / 230 V
Max. output current	29 A	36.2 A
Power factor at rated power	1	1
Adjustable displacement power factor	0 overexcited to 0 underexcited	0 overexcited to 0 underexcited
Feed-in phases / connection phases	3 / 3	3 / 3
Efficiency		
Max. efficiency / European Efficiency	98.4 % / 98.0 %	98.3 % / 98.1 %
Protective devices		
DC-side disconnection device	●	●
Ground fault monitoring / grid monitoring	● / ●	● / ●
DC surge arrester (type II) can be integrated	○	○
DC reverse polarity protection / AC short-circuit current capability / galvanically isolated	● / ● / -	● / ● / -
All-pole sensitive residual-current monitoring unit	●	●
Protection class (according to IEC 62103) / overvoltage category (according to IEC 60664-1)	I / III	I / III
General data		
Dimensions (W / H / D)	665 / 690 / 265 mm (26.2 / 27.2 / 10.4 inch)	665 / 690 / 265 mm (26.2 / 27.2 / 10.4 inch)
Weight	61 kg (134.48 lb)	61 kg (134.48 lb)
Operating temperature range	-25 °C to +60 °C (-13 °F to +140 °F)	-25 °C to +60 °C (-13 °F to +140 °F)
Noise emission (typical)	51 dB(A)	51 dB(A)
Self-consumption (at night)	1 W	1 W
Topology / cooling concept	Transformerless / OptiCool	Transformerless / OptiCool
Degree of protection (as per IEC 60529)	IP65	IP65
Climatic category (according to IEC 60721-3-4)	4K4H	4K4H
Maximum permissible value for relative humidity (non-condensing)	100 %	100 %
Features		
DC connection / AC connection	SUNCLIX / spring-cage terminal	SUNCLIX / spring-cage terminal
Display	-	-
Interface: RS485, Speedwire/Webconnect	○ / ●	○ / ●
Multifunction relay / Power Control Module	○ / ○	○ / ○
Guarantee: 5 / 10 / 15 / 20 / 25 years	● / ○ / ○ / ○ / ○	● / ○ / ○ / ○ / ○
Planned certificates and permits (more available on request)	AS 4777, BDEW 2008, C10/11, CE, CEI 0-16, CEI 0-21, EN 50438 ¹ , G59/3, IEC61727, IEC 62109-1/2, NEN EN 50438, NRS 097-2-1, PPC, RD 1699, RD 661/2007, SI4777, UTE C15-712-1, VDE 0126-1-1, VDE-AR-N 4105, VFR 2014	
Type designation	STP 20000TL30	STP 25000TL30

ТЕХНИЧКИ ПОДАТОЦИ ЗА ФВ МОДУЛИ

POLY CRYSTALLINE MODULE 60x6"/200-245W



Qualified, IEC61215
Qualified, IEC61730



Electrical Characteristics

Model	Pm(Wp)	Tolerance	Vm(V)	Im(A)	Voc(V)	Isc(A)	η
SYP200S	200W	0~+3%	28.60	7.00	36.50	7.65	>12.30%
SYP210S	210W	0~+3%	29.00	7.25	36.50	7.88	>12.93%
SYP215S	215W	0~+3%	29.20	7.37	36.70	7.92	>13.23%
SYP220S	220W	0~+3%	29.50	7.46	37.00	8.10	>13.53%
SYP225S	225W	0~+3%	29.60	7.61	37.00	8.14	>13.85%
SYP230S	230W	0~+3%	29.80	7.73	37.00	8.22	>14.16%
SYP235S	235W	0~+3%	30.00	7.84	37.10	8.28	>14.46%
SYP240S	240W	0~+3%	30.20	7.96	37.20	8.33	>14.78%
SYP245S	245W	0~+3%	30.30	8.09	37.30	8.34	>15.07%

Valued at STC (AM 1.5, 1000W/m², 25°C)

Temperature Coefficients

Temperature Coefficient of VOC(β)	-0.33%/°C
Temperature Coefficient of ISC(α)	+0.033%/°C
Temperature Coefficient of Pmax	-0.39%/°C
Nominal Operating Cell Temperature (NOCT)	45±2°C

Permissible Operating Conditions

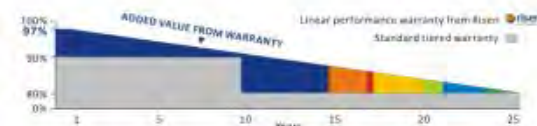
Maximum system voltage	1000VDC
Operating temperature	-40~+85°C
Snow load	Max 5400 Pa
Wind load	Max 120km/h

Mechanical Characteristics

Number of poly crystalline solar cell	60pcsx6"
Aluminum frame, dimension	1640x992x50/45/40/35mm
Glass thickness	3.2mm
Weight	20.5kg/20kg/19.5kg/19kg
Junction box	IP65
Module	IP65
Tolerance of Rating	0~+3%
Number of bypass diodes	6

Warranty

- 10 years with 100% product warranty
- 12 years 90% rated power output
- 25 years 82% rated power output



ТЕХНИЧКИ ПОДАТОЦИ ЗА ФВ МОДУЛИ

200-245 Watt POLY-CRYSTALLINE SOLAR PANEL

Excellent Quality

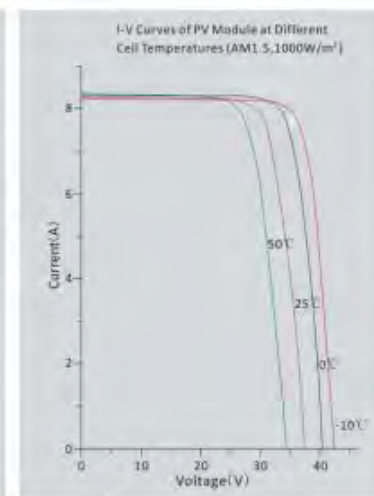
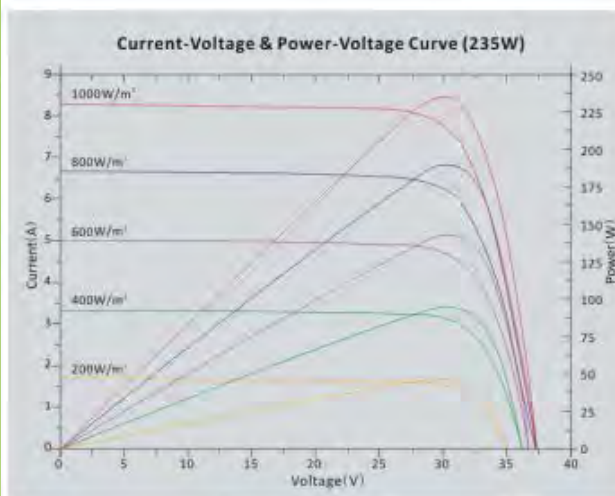
- Automatic production and testing processes;
- More than 18 IEC tests program in State-Level PV Laboratory of Risen;
- Third party liability and quality insurance;
- ISO9001, ISO14001 and OHSAS18001 management system.

Easy for installation

- Low weight, convenient format;
- Horizontal and Vertical installation applicable;
- Compatible with all standard rooftop and ground mounting systems.

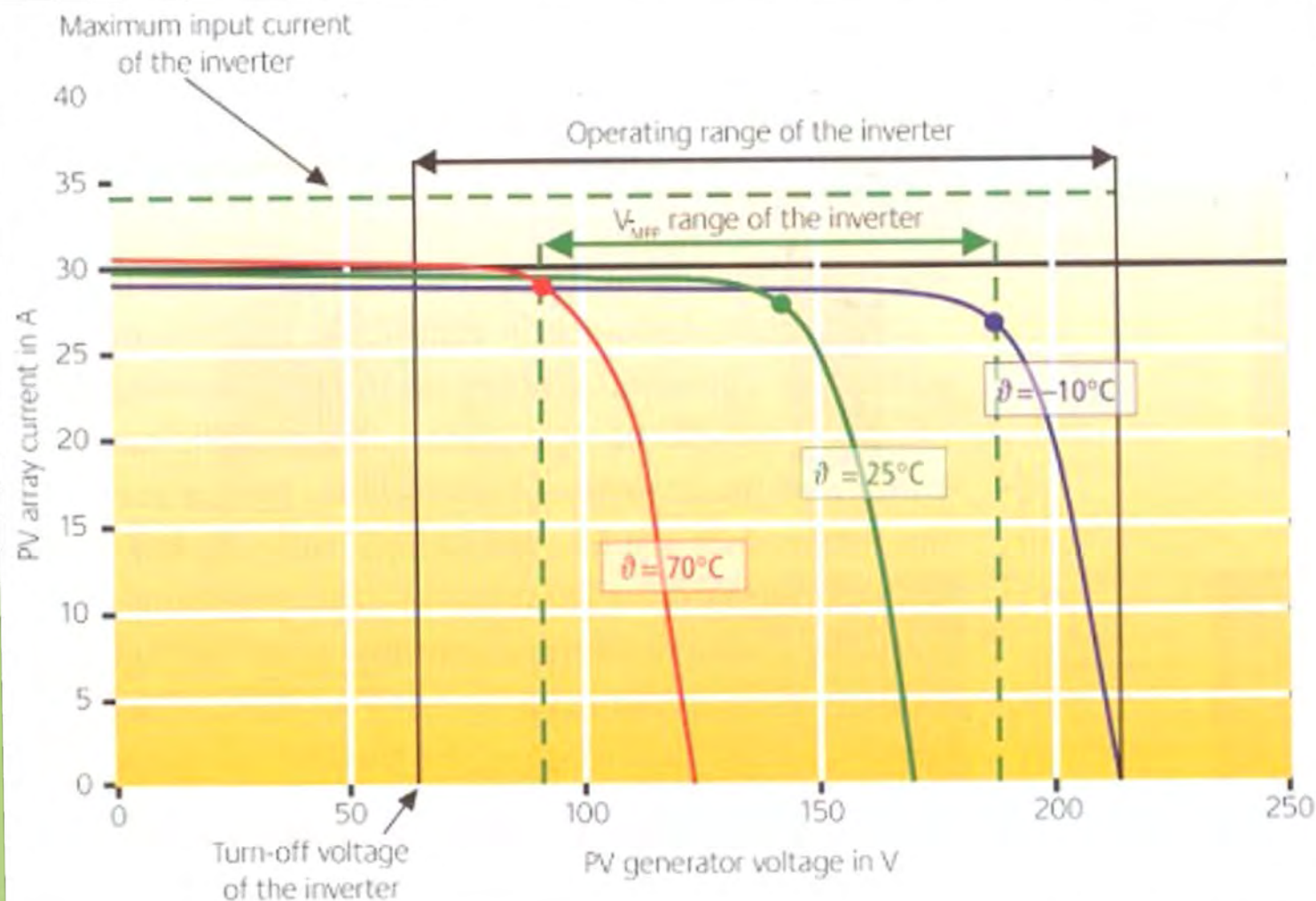
Maximum Yield

- Only Positive tolerance asserted;
- Photon test with TOP performance;
- Averagely, installed projects actual power yield is 5% higher than theoretical yield.

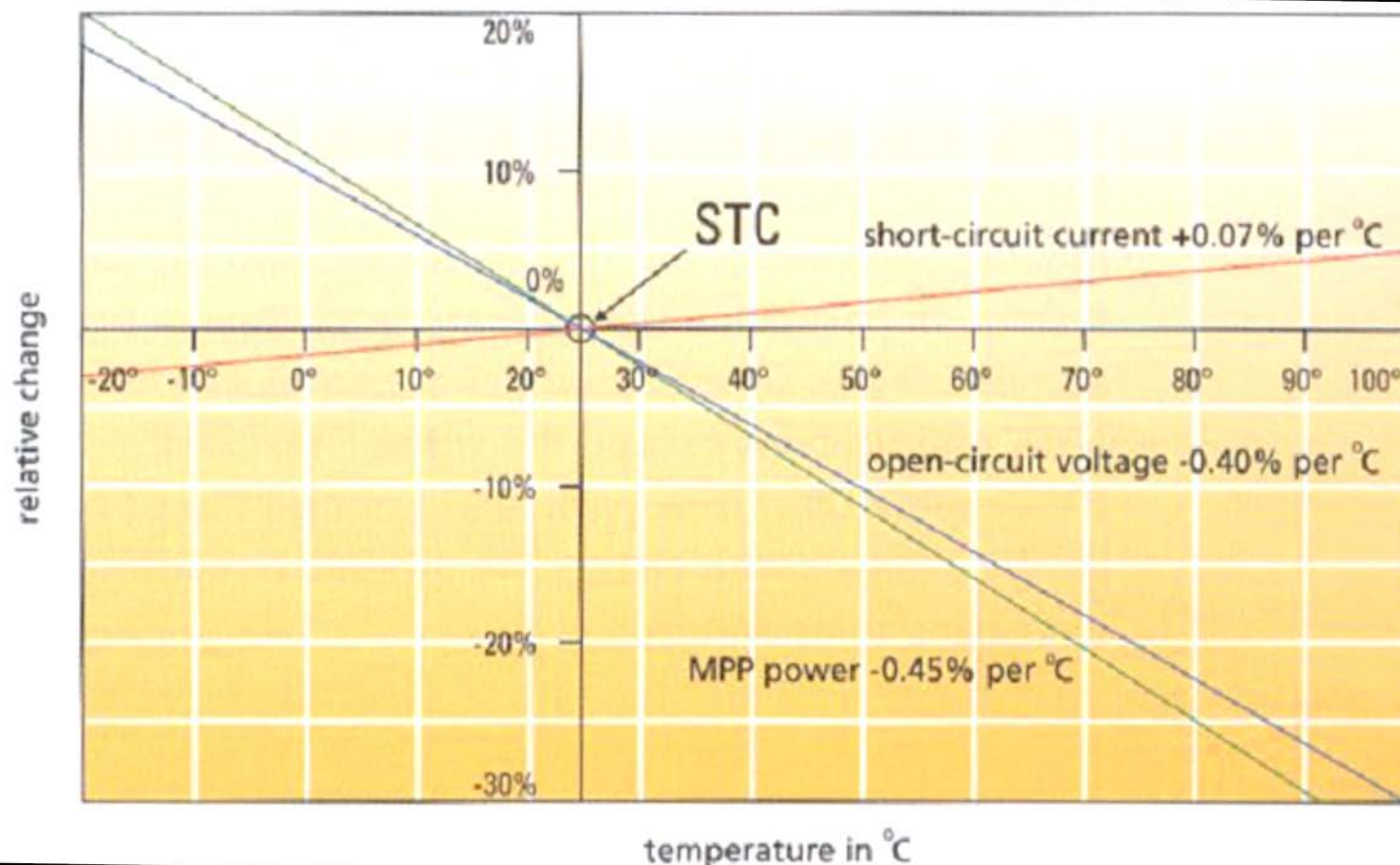


- ① 1. Tempered Glass
- ② 2. EVA (Ethylene Vinyl Acetate)
- ③ 3. Solar Cells
- ④ 4. EVA (Ethylene Vinyl Acetate)
- ⑤ 5. Backsheet

ДИМЕНЗИОНИРАЊЕ НА ФВ ГЕНЕРАТОР



ДИМЕНЗИОНИРАЊЕ НА ФВ ГЕНЕРАТОР



МАКСИМАЛЕН БРОЈ НА МОДУЛИ ПО СТРИНГ

Максимален број на ФВ модули во еден стринг:

$$\eta_{\max} = \frac{V_{\max (\text{INV})}}{V_{\text{OC (module } -10^{\circ}\text{C)}}$$

Напон на празен од при -10°C на еден модул:

$$V_{\text{OC (module } -10^{\circ}\text{C)}} = (1 - 35^{\circ}\text{C} \times \Delta V / 100) \times V_{\text{OC (STC)}}$$

$$V_{\text{OC (module } -10^{\circ}\text{C)}} = V_{\text{OC (STC)}} - 35^{\circ}\text{C} \times \Delta V$$

$$V_{\text{OC (module } -10^{\circ}\text{C)}} = 1.14 \times V_{\text{OC (STC)}}$$

МИНИМАЛЕН БРОЈ НА МОДУЛИ ПО СТРИНГ

Минимален број на ФВ модули во еден стринг:

$$\eta_{\min} = \frac{V_{\text{MPP (INV min)}}}{V_{\text{MPP (module 70}^{\circ}\text{C)}}$$

Напон во MPP при 70 °C на еден модул:

$$V_{\text{MPP (module 70}^{\circ}\text{C)}} = (1 + 45^{\circ}\text{C} \times \Delta V / 100) \times V_{\text{MPP (STC)}}$$

$$V_{\text{MPP (module 70}^{\circ}\text{C)}} = V_{\text{MPP (STC)}} + 45^{\circ}\text{C} \times \Delta V$$

$$V_{\text{MPP (module 70}^{\circ}\text{C)}} = 0.82 \times V_{\text{OC (STC)}}$$

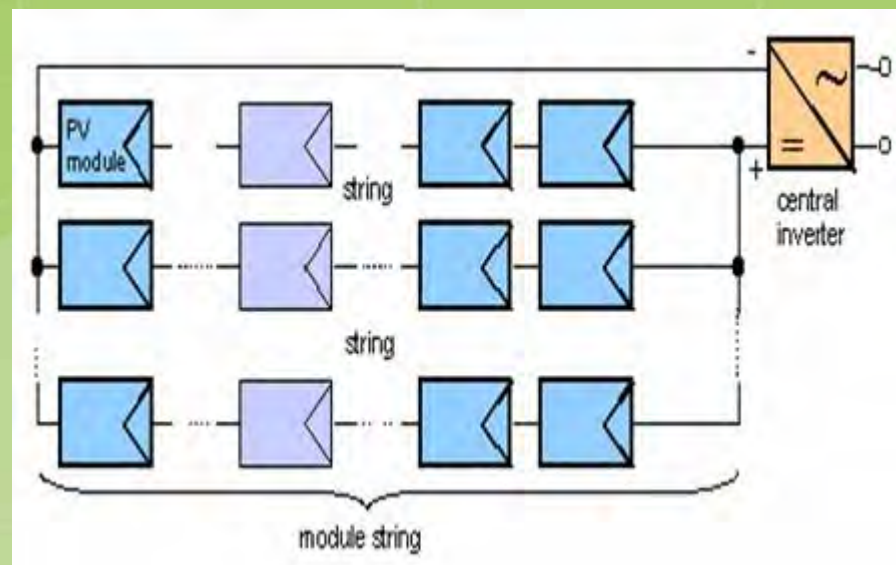
ПРИМЕР

ФВ систем од 25 kW се состои од:

- Еден инвертор SMA Tripower 25000TL
- ФВ модули Risen Energy SYP230S

Да се определи:

- максималниот број на ФВ модули во еден стринг
- минималниот број на ФВ модули во еден стринг
- бројот на паралелно врзани стрингови



ПРИМЕР

Максимален број на ФВ модули во еден стринг

1. Се определува максималниот напон на отворено коло (празен од)
2. Тој се добива при најниската можна температура на воздухот (на пр. $T_{amb} = -10^{\circ}\text{C}$)

$$\begin{aligned} V_{OC(T_{amb})} &= V_{OC, STC} \left[1 - \mu_{OC} (T_{STC} - T_{amb}) \right] = \\ &= V_{OC, STC} \left[1 - \mu_{OC} (25^{\circ}\text{C} - (-10^{\circ}\text{C})) \right] = V_{OC, STC} [1 - 35 \cdot \mu_{OC}] \end{aligned}$$

3. Од каталогот за ФВ модулот Risen Energy SYP230S се очитуваат:

$$V_{OC, STC} = 37 \text{ V}, \text{ а } \mu_{STC} = -0,33 \% / ^{\circ}\text{C}$$

$$V_{OC(-10^{\circ}\text{C})} = 37 \cdot \left[1 - 35 \cdot \left(\frac{-0,33}{100} \right) \right] = 37 \cdot [1 + 35 \cdot 0,0033] = 37 \cdot 1,1155 = 41,28 \text{ V}$$

4. Макс. дозволениот DC напон во инверторот е $U_{inv, max} = 1000 \text{ V}$, па макс. број на ФВ модули во еден стринг е:

$$n_{s, max} = \frac{U_{inv, max}}{V_{OC(-10^{\circ}\text{C})}} = \frac{1000}{41,28} = 24,22 \Rightarrow 24 \text{ модули}$$

ПРИМЕР

Минимален број на ФВ модули во еден стринг

1. Се определува минималниот напон во точката на максимална моќност MPP.
2. Тој се добива при највисока можна температура на ќелиите (на пр. $T_c = 70^\circ\text{C}$)

$$\begin{aligned} V_{\text{MPP}(T_c=70^\circ\text{C})} &= V_{\text{MPP, STC}} \left[1 - \mu_{\text{MPP}} (T_{\text{STC}} - T_c) \right] = \\ &= V_{\text{MPP, STC}} \left[1 - \mu_{\text{MPP}} (25^\circ\text{C} - 70^\circ\text{C}) \right] = V_{\text{MPP, STC}} [1 + 45 \cdot \mu_{\text{MPP}}] \end{aligned}$$

3. Од каталогот за ФВ модулот Risen Energy SYP230S се читуваат:

$$V_{\text{MPP, STC}} = 29,8 \text{ V}, \text{ а } \mu_{\text{MPP}} = -0,39 \% / ^\circ\text{C}$$

$$V_{\text{MPP}(T_c=70^\circ\text{C})} = 29,8 \cdot \left[1 + 45 \cdot \left(-\frac{0,39}{100} \right) \right] = 29,8 \cdot 0,8245 = 24,57 \text{ V}$$

4. Мин. DC напон во инверторот при кој сеуште функционира е $U_{\text{MPP, min}} = 390 \text{ V}$, па мин. број на ФВ модули во еден стринг е:

$$n_{s, \text{min}} = \frac{U_{\text{MPP, min}}}{V_{\text{MPP}(70^\circ\text{C})}} = \frac{390}{24,57} = 15,83 \Rightarrow 16 \text{ модули}$$

ПРИМЕР

Број на стрингови

1. Се усвојува моќност на ФВ генераторот (на пр. $0,8 P_{inv} < P_{pv} < 1,2 P_{inv}$) $P_{pv} = 25 \text{ kW}_p$.
2. Претходно е усвоен број на ФВ модули во еден стринг (на пр. $n_s = 20$ ФВ модули)

$$n_p = \frac{P_{PV}}{P_{MPP,STC} \cdot n_s} = \frac{25000}{230 \cdot 20} = 5,4 \text{ стрингови}$$

3. Препорачливо е да се направат повеќе варијанти:

	$P_{pv} [\text{Wp}]$				
n_s	24000	25000	26000	27000	28000
16	6,5	6,8	7,1	7,3	7,6
17	6,1	6,4	6,6	6,9	7,2
18	5,8	6,0	6,3	6,5	6,8
19	5,5	5,7	5,9	6,2	6,4
20	5,2	5,4	5,7	5,9	6,1
21	5,0	5,2	5,4	5,6	5,8
22	4,7	4,9	5,1	5,3	5,5
23	4,5	4,7	4,9	5,1	5,3
24	4,3	4,5	4,7	4,9	5,1



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