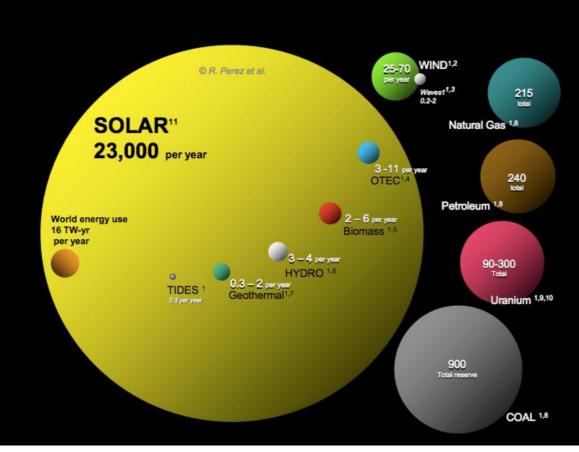


Electricity from sun Introduction to off-grid photovoltaic systems for vulnerable households 2020 Daniel Rodik senior expert

Source: Initiative "Ljudi za ljude"



Worldwide renewable energy potentials



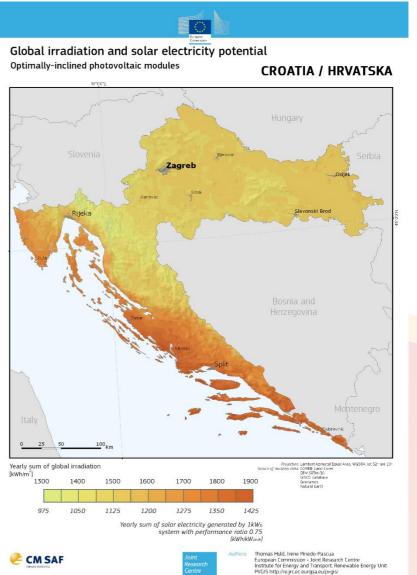
Source: Perez & Perez, 2009.



Natural potential shows the amount of energy being irradiated from Sun compared to world energy needs and other energy sources.

Global irradiation and solar electricity potential in Croatia

- Annualy from 1500 to 1900 kWh by 1kWp installed
- Optimaly inclined solar panels

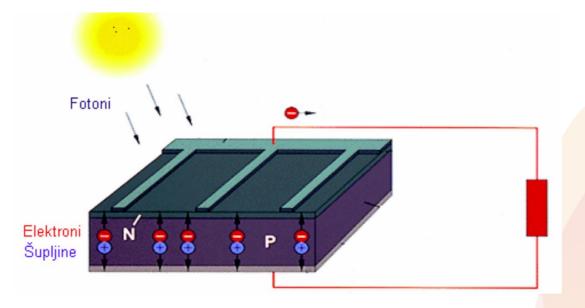




Photovoltaic (PV) effect

What is it?

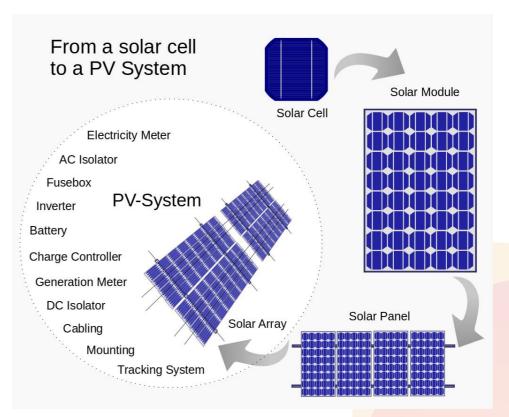
The photovoltaic effect is the generation of voltage and electric current in a material upon exposure to light.





PV cells, modules, panels

- PV (solar) cell
- Solar module
- Solar panel
- PV system





PV Efficiency on the market

Туре	Crystalline Si cells		Thin film technologies			
Material	Mono crystalline	Poly crystalline	Amorphous Si	Cadmium telluride (Cd-Te)	Gallium arsenide (GaAs)	Copper indium gallium selenide (CIGS)
Efficiency (%)	15 – 20	13 – 16	6 – 8	12	27	20
Ratio power/surface (kW/m ²)	140	130	50	160	300	160



PV specifics



Source:<u>https://www.compile-project.eu/</u>

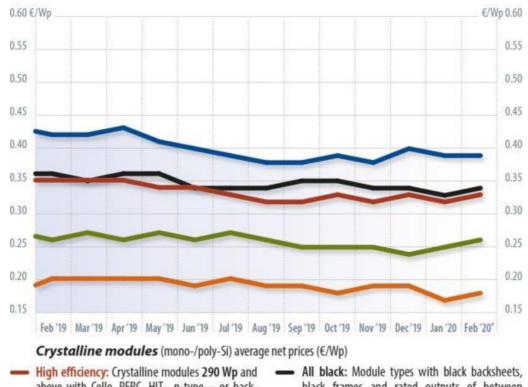


Source: LINAK solar tracking systems



Prices and economic viability

EU spot market module prices by technology



- High efficiency: Crystalline modules 290 Wp and above with Cello, PERC, HIT-, n-type – or backcontact cells or combinations thereof
- Mainstream: Modules with usually 60 cells, standard aluminum frames, white backing and 260 Wp to 285 Wp – the majority of modules on the market
- Bifacial: Modules with bifacial cells, transparent backsheet or glass-glass, framed and unframed
- All black: Module types with black backsheets, black frames and rated outputs of between 200 Wp and 320 Wp
- Low cost: Reduced-capacity modules, factory seconds, insolvency goods, used modules (crystalline), products with limited or no guarantee
 - * Data up to February 17, 2020 More information: www.pvXchange.com



PV systems type

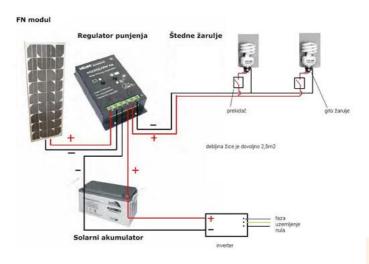
Off grid or stand alone

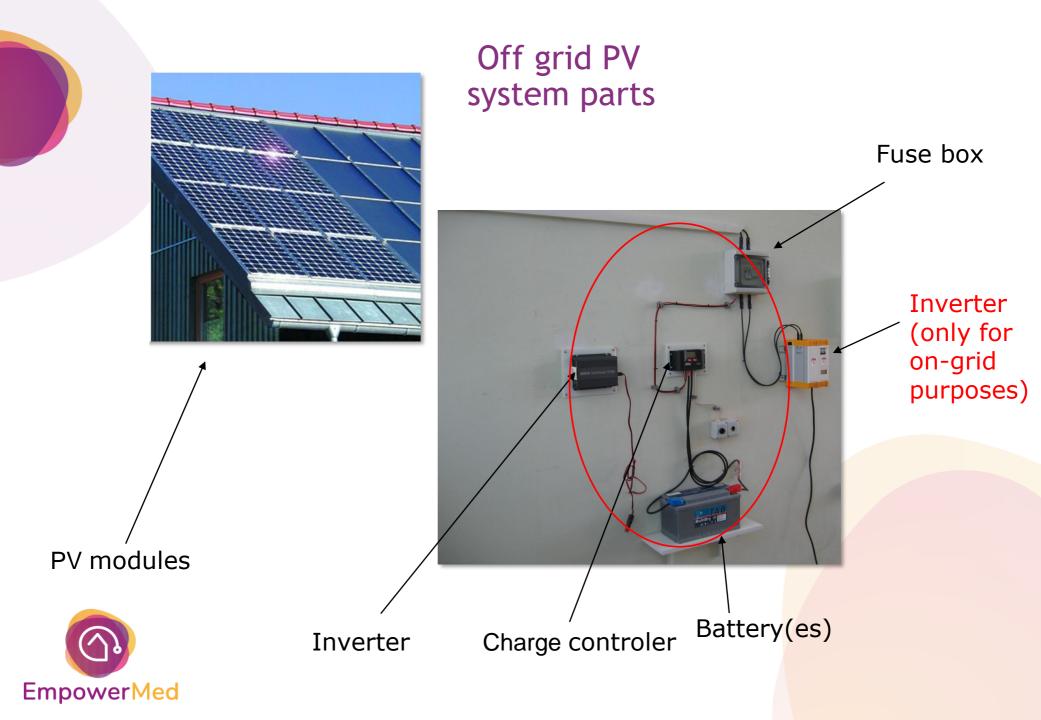
- Electricity is generated and consumed in the same time (water pumps) or is stored in the batteries which serve as power source.
- Advantages: grid independent, ideal for remote areas and islands
- Downsides: less secure supply, higher cost per power, demand side management needed

On grid

EmpowerMed

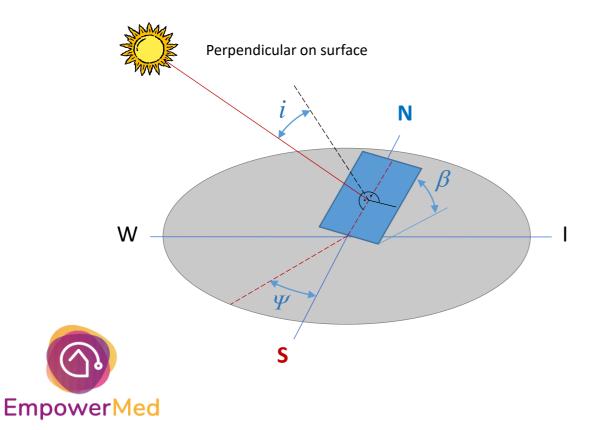
- Generated electricity is fed in the grid, electrodistribution system on low or middle voltage.
- Advantages: lower cost per power installed (no batteries needed), net metering possibility and selling the surplus generated, secure supply
- Downsides: connection to the grid is a precondition, no autonomy





PV installation

Surface inclination β (°) Surface Azimuth Ψ (°) Drop angle *i* (°)

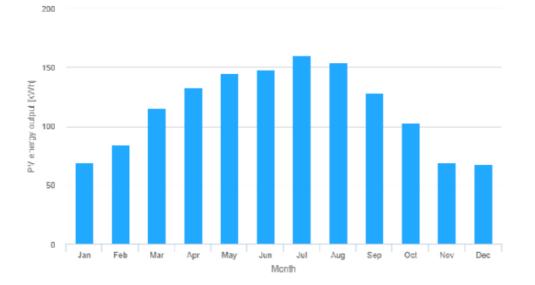


⇒ Optimal orientation
of insolated surface is
South, 30° inclination.

⇒ Usefull roof orientation is azimuth from SE-S-SW and inclination 10° and 50° (energy gain losses are not above10%)

How much electricity we can get from Sun?

Monthly energy output from fix-angle PV system:



Location: Zadar, Croatia PV technology: Crystalline silicon PV installed: 1 kWp Yearly PV energy production: **1375.24 kWh** Yearly in-plane irradiation:

Yearly in-plane irradiation 1800.48 kWh/m²

Monthly PV energy and solar irradiation

Empower

Month	E_m	H(i)_m	SD_m
January	69.1	83.9	12.9
February	<mark>84</mark> .1	102.8	1 6 .9
March	115.5	145.4	18.7
April	132.5	172.4	14.6
May	144.4	191.4	15.7
June	147.5	200.6	10.5
July	160.4	221.8	8.5
August	153.8	211.0	12.3
September	128.2	171.0	9.1
October	102.9	132.0	11.2
November	69.0	86. <mark>0</mark>	14.1
December	67.9	82.5	10.9

E m: Average monthly electricity production from the given system [kWh].

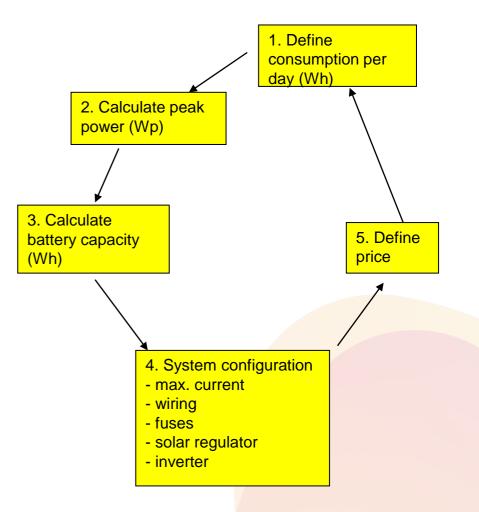
 $H(i)_m$: Average monthly sum of global irradiation per square meter received by the modules of the given system [kWh/m²].

SD_m: Standard deviation of the monthly electricity production due to year-to-year variation [kWh].

Source: https://re.jrc.ec.europa.eu/pvg_tools/en/tools.html#PVP

How to calculate the size of off-grid PV system?

How much electricity do we need? (per day, per month, per year)





Source: https://www.wholesalesolar.com/solar-information/battery-bank-sizing

Consumption patterns

Consumption	A Power (W)	B No. Of appliances	C=A x B Total power (W)	D Approx. Daily working hours (h)		F Losses factor, (AC=1,1 DC=1,02)	G=C x D x F Total daily consumption (Wh)
LED bulb	10	3	30	3	AC	1,1	99
TV	40	1	40	2	AC	1,1	
			Max peak power (W)				Average daily consumption (Wh)



Off grid PV system prices

Prices per W

Large systems: 2-3 Eur/W of installed PV power

Small systems: 8-11 Eur/W

Source: https://www.off-grid-europe.com/off-grid-systems



THANK YOU !





www.empowermed.eu



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N° 847052. The sole responsibility for the content of this document lies with the authors. It does not necessarily reflect the opinion of the European Union. Neither the EASME nor the European Commission are responsible for any use that may be made of the information contained therein.

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