Off-Grid Solar: PV Array, Battery Bank and Charge Controller

PV array, module count, battery capacity for days of autonomy and charge controller current for an off-grid system from daily energy and sun hours.

Method: Off-grid PV sizing by energy balance (peak sun hours, autonomy, depth of discharge) (definitions)

Input parameters

Unit system: SI

Parameter	Value	Unit
Daily energy use (Wh)	5,000.0	
Peak sun hours (design month)	4.5000	
System efficiency (wiring, controller, inverter)	75.000	%
Battery system voltage	48.000	V
Days of autonomy	2.0000	
Usable depth of discharge	50.000	%
Module short-circuit current	13.500	A
Module rating	540.00	W

Calculated results

Parameter	Value	Unit
PV array power	1.4815	kW
Modules (rounded up)	3.0000	
Battery capacity at system voltage (Ah)	555.56	
Charge controller output current (MPPT: 1.25 × array power / battery voltage)	42.188	A

Notes for this case

- For a PWM controller size on the array short-circuit current instead: 1.25 × parallel strings × I_sc; with all 3 modules in parallel that is 50.6 A (divide by the modules per series string).
- Controller current estimated as 1.25 × array power/battery voltage (MPPT output side). Size for the worst month; add margin for module temperature derating in hot climates.

Formula and method

$$P_{PV} = \frac{E_d}{PSH \cdot \eta_s}, \quad C = \frac{E_d n}{V_{sys} DoD \, \eta_s}, \quad I_{cc} = \frac{1.25 \, n_{mod} P_{mod}}{V_{sys}} \ (\text{MPPT}), \quad I_{PWM} = 1.25 \, n_p I_{sc,mod}$$

Variables

E_d	Daily energy use (Wh)	-
PSH	Peak sun hours (design month)	-
η_s	System efficiency (wiring, controller, inverter)	-
V_{sys}	Battery system voltage	V
n	Days of autonomy	-
DoD	Usable depth of discharge	-
$I_{sc,mod}$	Module short-circuit current	A
P_{mod}	Module rating	W
P_{PV}	PV array power	W
n_{mod}	Modules (rounded up)	-
C	Battery capacity at system voltage (Ah)	-

I_{cc}	Charge controller output current (MPPT: 1.25 × array power / battery voltage)	A
$I_{PWM}$$, $$n_p$	PWM controller current (given in a note) and number of parallel strings	A, -

Method and standards

Energy balance.

Assumptions and limits

- Daily balance in the design month.
- The battery capacity divides by the whole system efficiency, which also includes PV-side losses not in the discharge path: slightly conservative. Module temperature derating is not included.
- The output current is for an MPPT controller; a PWM controller is sized on the array short-circuit current (note).

References

- Off-grid PV sizing by energy balance (peak sun hours, autonomy, depth of discharge) (definitions)

Report details

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Results are for engineering estimation. Verify critical designs against the referenced standards and your own data.

This calculator online

https://calc.firecad.com/electrical/solar-pv/off-grid-solar-sizing

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Reopens the calculator with the inputs of this report.