

1 Kalkulasi : Solar Panel & Battery Bank

1 Average Solar Radiation/Day (SR)

Average Solar Radiation for Medan

4.374 kWh/m²/day
4.374 hour of 1000 W/m²/day
equivalent

Solar Radiation each Panel (SR)

4.374 kWh/m²/day
4.374 hour of 1000 W/m²/day
4.374 Wh/Wp/day

2 PV Array Sizing

Watt Peak/Panel (<Wp/Pn>)

a) PV Derating Factor (DF_{pv})

- 1) PV module nameplate DC rating (DF_{pv1})
 - 2) Soiling (DF_{pv2})
 - 3) System availability (DF_{pv3})
 - 4) Shading (DF_{pv4})
 - 5) Sun-tracking (DF_{pv5})
 - 6) Age (DF_{pv6})
 - 7) Temperature losses (DF_{pv7})
 - 8) Low radiance losses (DF_{pv8})
 - 9) Fundamental module losses (DF_{pv9})
 - 10) Bad string (DF_{pv10})
 - 11) Bad cascade controller (DF_{pv11})
- $$DF_{pv} = (DF_{pv1}) \times (DF_{pv2}) \times (DF_{pv3}) \times (DF_{pv4}) \times (DF_{pv5}) \times (DF_{pv6}) \times (DF_{pv7}) \times (DF_{pv8}) \times (DF_{pv9}) \times (DF_{pv10}) \times (DF_{pv11})$$

b) Panel Generation Factor (PGF)

PGF = (Solar Radiation) x (PV Derating Factor)
PGF = (SR) x (DF_{pv})

c) Energy Losses Factor (LF)

Wiring and connection losses (WL)
Battery losses (BL)
LF = (WL) + (BL)

d) Energy Consumption (E)

Total Power Drain (TPD) (24 hour operation)
 $E = (\text{Total Power Drain}) \times (1 + (\text{Energy Losses Factor}))$
 $E = (TPD) \times (1 + (LF))$

e) Total Required Wp (Wp_{tot})

$Wp_{tot} = (\text{Energy Consumption}) / (\text{Panel Generation Factor})$
 $Wp_{tot} = (E) / (PGF)$

f) Total No of PV Required (T_{pv})

Type
Maximum Power (P_{max})
Voltage at Pmax (V_{mp})
Current at Pmax (I_{mp})
 $T_{pv} = (\text{Total Required Wp}) / (\text{Maximum Power})$
 $T_{pv} = (Wp_{tot}) / (P_{max})$
T_{pv} (Roundup)

Battery Bank Sizing

Voltage Rated (VR)
Battery Backup Time-Hours (BB_h)
Battery Backup Time-Days (BB_d)

1000.000 W/m²

0.963
0.960
0.988
0.981
0.996
0.900
0.957
0.954
0.866
0.975
0.980

0.606

2.650 Wh/Wp/day

DOCUMENT REVIEW STATUS			
☒	APPROVED		
☐	APPROVED WITH COMMENT		
☐	May Proceed to the next stage, resubmit corrected document for final approval		
☐	REVIEWED / COMMENTED		
☐	Resubmit corrected document for approval		
☐	FOR INFORMATION ONLY		
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CHECK BY	Initial	Sign	Date
ACKN BY	Initial	Sign	Date

10%
20%
30%

3.970.560 Wh/day

3.970.560
From : Load List Calculation

5.161.728 Wh/day

1.947.707 Wp

260.000	Wp
30.700	V
8.560	A

7.491

8 Unit modules

24.000	V
72	Hours
3	Day

a) Total Load AH (AH_L)

$$AH_L = (\text{Total Power Drain}) / (\text{Nominal Battery Bank Voltage})$$

$$AH_L = (TPD) / (VR)$$

165,440 AH

b) Battery Derating Factor (DF_{batt})

1) Temperature factor (DF_{batt1})

2) Depth of discharge (DOD) factor (DF_{batt2})

$$(DF_{batt}) = (DF_{batt1}) \times (DF_{batt2})$$

0.850
0.800
0.680

c) Battery Bank Capacity (Cap)

$$Cap = ((\text{Total Load AH}) \times (\text{Battery Backup Time-Days})) / (\text{Battery Derating Factor})$$

$$Cap = ((AH_L) \times (BB_D)) / (DF_{batt})$$

729,882 AH

- 1) Volts Per Cell
- 2) Rating of Constant Current (at end of VPC during 72 hours) (RCC)

1.800 VPC
11.000 A

3) Unit Module Rate (UMR) = (Rating of Constant Current) x (Battery Backup Time-Hours)

$$\text{Unit Module Rate (UMR)} = (RCC) \times (BB_H)$$

792,000 AH at C₇₂

4) Zbattery_{Parallel} = (Battery Bank Capacity) / (Unit Module Rate)

$$Zbattery_{Parallel} = (Cap) / (UMR)$$

0.922 Unit

$$Zbattery_{Parallel} (\text{Roundup})$$

1 Unit

5) System Rated = (Zbattery_{Parallel}) x (Unit Module Rate)

$$\text{System Rated} = (Zbattery_{Parallel}) \times (UMR)$$

792,000 AH at C₇₂

6) Unit Module Nominal Voltage (UMNV)

2.000 V

7) Zbattery_{Series} = (Voltage Rated) / (Unit Module Nominal Voltage)

12 Unit

$$Zbattery_{Series} = (VR) / (UMNV)$$

8) Zbattery_{Total} = (Zbattery_{Parallel}) x (Zbattery_{Series})

12 Unit Modules

4

Solar Charge Controller Rating

$$\text{PV Total Current (I}_{PV\text{ Tot}}) = (\text{Current at Pmax}) \times \text{Total No of PV Required}$$

$$\text{PV Total Current (I}_{PV\text{ Tot}}) = (I_{MP}) \times (T_{PV})$$

68,480 A

$$(1/2) \text{ PV Total Current (I}_{PV\text{ Tot}}) = (1/2) (I_{MP}) \times (T_{PV})$$

34,240 A