Power - Calculations for Solar Arrays and Battery Backup

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Calculations for Solar Arrays and Battery Backup

Please feel free to use the calculator below to do your own calculations for solar arrays and battery backup.

Equations

Use the following equations to determine solar array size and battery backup requirements based on 12V nominal system voltage.

Power consumption for each piece of equipment	Power = voltage × current	W = V × A
Daily amp-hour load for each piece of equipment	Amp-hour load = power / voltage × hours of operation per day (h) Add up amp-hour load for whole system.	Ah = W / V × hours of operation per day (h)
Efficiency and loss-corrected load for whole system	Corrected load = amp-hour load / 0.8	Ah(corr) = Ah / 0.8
Worst case equivalent sun hours (ESH) (h)	Determine from charts or meteorological data.	
Solar array current requirement (A)	Solar current req. = Corrected load / ESH (h)	A = Ah(corr) / ESH (h)
Number of solar panels in parallel (N)	No. of panels = solar current req. / current output per panel	N(panel) = A / A/panel
Autonomy or reserve time (Ah)	Autonomy = no. of days × corrected load / % discharge rate	Ah(res) = N(days) × Ah(corr) / % discharge rate
Battery bank (backup) size	Battery bank = autonomy (Ah) / Ah per battery	Bank = Ah(res) / Ah/battery

Calculator

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7	8	9		+/-	%
4	5	6		+	-
1	2	3		*	/
0	.				=

Example

A permanent station with a Trimble receiver, cellular phone, modem, and computer located in Boulder, Colorado, approximately at latitude 40´02´´N, 105´14´´W, elevation 1602 meters.

Power consumption:

Equipment	Power	Hours/day
Trimble 4000SSi receiver	9W	24
Cellular phone	15W	4
Cellular phone modem	10W	4
Computer	20W	4

Daily amp-hour load:

Equipment	Calculation	Ah
Trimble 4000SSi receiver	9W/12V x 24h	18.0
Cellular phone	15W/12V x 4h	5.0
Cellular phone modem	10W/12V x 4h	3.33
Computer	20W/12V x 4h	6.67
Total		**33.0**

Efficiency and loss-corrected load:

33 Ah / 0.8 = 42 Ah.

Worst case equivalent sun hours (ESH) for Boulder, CO:

3.5 hours

Solar array current requirement:

42 Ah / 3.5 h = 12A

Number of solar panels in parallel:

Three solar modules are currently being used in UNAVCO designs:

- Siemens PC-4JF rated at 75W (4.4 A @ 17.0 V)
- Siemens M75 rated at 48W (3.02 A @ 15.9 V)
- Solarex MSX-30 rated at 30W (1.68 A @ 17.8 V)

Choosing the M75 module, four panels are needed to cover the solar array current requirements: 12A / 3.02A per panel = 3.97 panels

Autonomy or reserve time:

Choosing five days of autonomy with 50% maximum discharge:
5 × 42 Ah / 50% = 420Ah battery bank

Battery bank (backup) size:

Three types of sealed deep cycle batteries are currently being used in UNAVCO designs:

- Deka 90Ah
- Deka 66Ah
- Deka 30Ah

As an example, if you choose the Deka 90Ah, five batteries are needed to provide the required autonomy. 420Ah / 90Ah per battery = 4.67 batteries.

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