UPS Battery Ah Sizing for Backup Time

Battery capacity in ampere-hours for a UPS or DC system from the load, backup time, DC voltage, inverter efficiency, depth of discharge and ageing and temperature factors.

Method: Energy balance of the battery discharge with correction factors

Input parameters

Unit system: SI

Parameter	Value	Unit
Load on the UPS (active power)	10.000	kW
Backup time	30.000	min
Nominal battery (DC bus) voltage	220.00	V
Inverter efficiency	92.000	%
Allowed depth of discharge	80.000	%
Ageing factor	1.2500	
Temperature correction factor Above 1 for batteries kept in a cold room; from the battery maker.	1.0000	
Battery voltage for the current, as a share of nominal 1 sizes on the nominal voltage. A constant-power load draws most current at the end of discharge: for lead-acid ending at 1.75 V per 2 V cell enter 0.875 for a conservative size.	100.00	%

Calculated results

Parameter	Value	Unit
Battery capacity needed	38.599	Ah
Average battery discharge current	49.407	A
Energy drawn from the battery	5.4348	kWh

Notes for this case

- Current taken at the nominal voltage. Under constant power the current rises as the voltage falls; at the end of discharge (about 1.75 V per lead-acid cell) it is about 14 % higher, so this Ah figure can be 10–15 % low. Enter a voltage share of 0.875 to size on the end voltage.
- Capacity at the backup-time discharge rate: high discharge rates give less than the 10-hour rated capacity; check the battery maker's discharge tables.

Formula and method

$$I_{dc} = \frac{P}{k_v V_{dc} \eta_i} \qquad C = \frac{I_{dc}\, t\, k_a\, k_t}{DoD} \qquad E = \frac{Pt}{\eta_i}$$

Variables

P	load	W
t	backup time	s
V_{dc}	DC bus voltage	V
η_i	inverter efficiency	–
DoD	depth of discharge	–
k_a	ageing factor	–
k_t	temperature factor	–
k_v	battery voltage for the current as a share of nominal (1 = nominal)	–
C	capacity needed (shown in Ah)	C
I_{dc}	discharge current	A

E	energy drawn	J

Method and standards

Constant-power discharge converted to a constant current at nominal voltage, with ageing, temperature and depth-of-discharge factors.

Assumptions and limits

- Constant power; factors as entered.
- With k_v = 1 the current is taken at the nominal voltage, which understates it: under constant power the current rises as the battery voltage falls, to about 14 % above the nominal-voltage value at a lead-acid end voltage of 1.75 V per cell. k_v = 0.875 sizes on the end voltage (conservative); a value near 0.95 approximates the average discharge voltage.
- A load of zero is rejected.

References

- Energy balance of the battery discharge with correction factors

Report details

Report reference	FCC-2PV0-J093 (the same inputs always give the same reference)
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Release checks	4 reference cases of this calculator, computed independently, are checked on every release

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

This calculator online

https://calc.firecad.com/electrical/batteries-ups/ups-battery-sizing

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.