Battery Coulombic, Voltage and Round-Trip Energy Efficiency

Coulombic, voltage and energy (round-trip) efficiency of a battery from charge and discharge ampere-hours and average voltages, and the energy lost per cycle.

Method: Battery efficiency definitions

Input parameters

Unit system: SI

Parameter	Value	Unit
Charge put in	105.00	Ah
Average charging voltage	54.500	V
Charge taken out	100.00	Ah
Average discharging voltage	50.500	V
Auxiliary consumption over the cycle (BMS, cooling)	0.10000	kWh

Calculated results

Parameter	Value	Unit
Coulombic efficiency	95.238	%
Voltage efficiency	92.661	%
Energy efficiency (cell)	88.248	%
Round-trip efficiency with auxiliaries	86.733	%
Energy lost per cycle	0.77250	kWh

Notes for this case

• η_E = η_C·η_V = Q_outV̄_out/(Q_inV̄_in). Lithium-ion cells reach about 95–98 % energy efficiency, lead-acid about 75–85 % (low coulombic efficiency from gassing). System round-trip adds converter and auxiliary losses: about 85–90 % for lithium storage plants.

Formula and method

$$\eta_C = \frac{Q_{out}}{Q_{in}}, \quad \eta_V = \frac{\bar{V}_{out}}{\bar{V}_{in}}, \quad \eta_E = \eta_C \eta_V, \quad \eta_{sys} = \frac{E_{out}}{E_{in} + E_{aux}}$$

Variables

Q_{in}	Charge put in	C
$\bar{V}_{in}$	Average charging voltage	V
Q_{out}	Charge taken out	C
$\bar{V}_{out}$	Average discharging voltage	V
P_{aux}	Auxiliary consumption over the cycle (BMS, cooling)	J
η_C	Coulombic efficiency	-
η_V	Voltage efficiency	-
η_E	Energy efficiency (cell)	-
η_{sys}	Round-trip efficiency with auxiliaries	-
ΔE	Energy lost per cycle	J

Method and standards

Battery efficiency.

Assumptions and limits

- One full cycle at a steady state of health.

References

Battery efficiency definitions

Report details

Report reference	FCC-6STJ-Z732 (the same inputs always give the same reference)
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Release checks	3 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/battery-round-trip-efficiency

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.