Supercapacitor Usable Energy and Constant-Power Discharge Time

Stored and usable energy of a supercapacitor bank between two voltages and the discharge time at constant power, including the loss in its series resistance.

Method: Capacitor energy and constant-power discharge with series resistance

Input parameters

Unit system: SI

Parameter	Value	Unit
Capacitance	1.5000e+08	µF
Starting voltage	48.000	V
Minimum voltage	24.000	V
Equivalent series resistance	0.006000	Ω
Constant load power	5.0000	kW

Calculated results

Parameter	Value	Unit
Energy stored at V_max	172.80	kJ
Usable energy between V_max and V_min	129.60	kJ
Usable fraction	75.000	%
Discharge time ignoring resistance	25.920	s
Discharge time with resistance	25.277	s
Starting current	105.56	A
Final current	220.49	A
Energy lost in the resistance	3.2134	kJ

Notes for this case

• E = ½CV²; between V_max and V_min the usable share is 1 − (V_min/V_max)². With series resistance R the current at capacitor voltage V is I = [V − √(V² − 4PR)]/(2R) and the time is ∫C dV/I.

Formula and method

$$E_u = \frac{1}{2} C \left(V_{max}^2 - V_{min}^2\right), \quad I = \frac{V - \sqrt{V^2 - 4PR}}{2R}, \quad t = \int_{V_{min}}^{V_{max}} \frac{C\,dV}{I}$$

Variables

C	Capacitance	F
V_{max}	Starting voltage	V
V_{min}	Minimum voltage	V
R_{ESR}	Equivalent series resistance	Ω
P	Constant load power	W
E	Energy stored at V_max	J
E_u	Usable energy between V_max and V_min	J
E_u/E	Usable fraction	-
t_0	Discharge time ignoring resistance	s

t	Discharge time with resistance	s
I_1	Starting current	A
I_2	Final current	A
E_{loss}	Energy lost in the resistance	J

Method and standards

Capacitor energy balance.

Assumptions and limits

- Ideal capacitance (no voltage dependence or leakage).

References

Capacitor energy and constant-power discharge with series resistance

Report details

Report reference	FCC-VAH0-G0ZP (the same inputs always give the same reference)
Generated	23 November 2026, 17:35 UTC
Calculator	Supercapacitor Usable Energy and Constant-Power Discharge Time
Method last reviewed	17 November 2026
Software release	FireCAD Calc, release of 22 November 2026
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/environmental/hydrogen-fuel-cells/supercapacitor-energy-discharge

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.