Superconducting Magnetic Energy Storage (SMES)

Energy stored in a superconducting coil from its inductance and current, the usable energy down to a minimum current and the discharge time at a given power.

Method: Energy stored in an inductor

Input parameters

Unit system: SI

Parameter	Value	Unit
Coil inductance	10,000	mH
Operating current	2,000.0	A
Minimum current fraction (converter limit)	50.000	%
Discharge power	2.0000	MW

Calculated results

Parameter	Value	Unit
Energy stored at I_max	20.000	MJ
Usable energy down to I_min	15.000	MJ
Discharge time at P	7.5000	s
Usable energy	4.1667	kWh

Notes for this case

• E = ½LI²; discharging to I_min leaves f² of the energy in the coil. SMES suits seconds-long, very high-power duties (power quality, ride-through) because refrigeration and conductor cost make long durations uneconomic.

Formula and method

$$E = \frac{1}{2} L I^2, \quad E_u = E \left[1 - \left(\frac{I_{min}}{I_{max}} \right)^2 \right]$$

Variables

L	Coil inductance	H
I_{max}	Operating current	A
I_{min}/I_{max}	Minimum current fraction (converter limit)	-
P	Discharge power	W
E	Energy stored at I_max	J
E_u	Usable energy down to I_min	J
t	Discharge time at P	s

Method and standards

Inductor energy.

Assumptions and limits

- Lossless superconducting coil.

References

Energy stored in an inductor

Report details

Report reference	FCC-8K6M-379F (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/smes-energy

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.