Compressed Air Energy Storage: Cavern Air Mass and Exergy

Air mass and isothermal exergy stored in a compressed air energy storage cavern between two pressures, and the electrical output at a chosen efficiency.

Method: Isothermal exergy of compressed air in a constant-volume store

Input parameters

Unit system: SI

Parameter	Value	Unit
Cavern or vessel volume	300,000	m³
Maximum pressure (absolute)	7.0000	MPa
Minimum pressure (absolute)	4.5000	MPa
Stored air temperature	40.000	°C
Ambient pressure	101.33	kPa
Conversion efficiency from exergy to electricity	70.000	%

Calculated results

Parameter	Value	Unit
Air mass cycled	8,343.8	t
Isothermal exergy between p_max and p_min	839.71	MWh
Exergy per cubic metre of storage (kWh/m³)	2.7990	
Electrical output at the efficiency entered	587.80	MWh

Notes for this case

• Isothermal exergy of air in a fixed volume relative to ambient pressure: E_x = V[p ln(p/p₀) − (p − p₀)]. Diabatic plants (Huntorf, McIntosh) also burn fuel in the expander, so their output is not limited to this figure; adiabatic and isothermal designs approach it.

Formula and method

$$E_x = V\left[p\ln\frac{p}{p_0} - (p - p_0)\right], \quad \Delta m = \frac{V(p_{max} - p_{min})}{RT}$$

Variables

V	Cavern or vessel volume	m³
p_{max}	Maximum pressure (absolute)	Pa
p_{min}	Minimum pressure (absolute)	Pa
T	Stored air temperature	K
p_0	Ambient pressure	Pa
η	Conversion efficiency from exergy to electricity	-
Δm	Air mass cycled	kg
ΔE_x	Isothermal exergy between p_max and p_min	J
$\Delta E_x/V$	Exergy per cubic metre of storage (kWh/m³)	-
E_{el}	Electrical output at the efficiency entered	J

Method and standards

Exergy of stored compressed air.

Assumptions and limits

- Ideal gas; isothermal storage at T.

References

Isothermal exergy of compressed air in a constant-volume store

Report details

Report reference	FCC-CY1F-ZZ5T (the same inputs always give the same reference)
Generated	23 November 2026, 17:35 UTC
Calculator	Compressed Air Energy Storage: Cavern Air Mass and Exergy
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/compressed-air-energy-storage-capacity

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.