Power-to-Hydrogen-to-Power Round-Trip Efficiency

Round-trip efficiency, electricity needed per MWh returned and hydrogen per MWh when storing electricity as hydrogen and converting it back.

Method: Energy chain efficiency of hydrogen storage

Input parameters

Unit system: SI

Parameter	Value	Unit
Electrolysis system specific energy	55.000	kWh/kg
Compression and storage energy	2.5000	kWh/kg
Storage and handling losses of hydrogen	1.0000	%
Reconversion efficiency (LHV; fuel cell or turbine)	50.000	%

Calculated results

Parameter	Value	Unit
Round-trip efficiency	28.683	%
Electricity in per unit out	3.4864	
Hydrogen per MWh returned	60.027	kg
Power-to-hydrogen efficiency (LHV)	57.945	%

Notes for this case

• η_RT = LHV(1 − l_s)η_g/(e_el + e_c) with the hydrogen lower heating value (about 33.3 kWh/kg). Hydrogen per MWh returned counts the hydrogen burned in the reconversion step. Batteries reach 85–90 % but only for hours; hydrogen suits seasonal storage despite 30–40 %.

Formula and method

$$\eta_{RT} = \frac{LHV(1 - l_s)\eta_g}{e_{el} + e_c}$$

Variables

e_{el}	Electrolysis system specific energy	J/kg
e_c	Compression and storage energy	J/kg
l_s	Storage and handling losses of hydrogen	-
η_g	Reconversion efficiency (LHV; fuel cell or turbine)	-
η_{RT}	Round-trip efficiency	-
E_{in}/E_{out}	Electricity in per unit out	-
m_{H_2}	Hydrogen per MWh returned	kg
η_{P2H}	Power-to-hydrogen efficiency (LHV)	-

Method and standards

Storage chain efficiency.

Assumptions and limits

- Steady average efficiencies.

References

Energy chain efficiency of hydrogen storage

Report details

Report reference	FCC-TBFZ-BAEH (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/environmental/hydrogen-fuel-cells/power-to-hydrogen-round-trip

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.