EV Wall-to-Wheel Energy and Efficiency Chain

Energy drawn from the grid per kilometre from wheel energy through gearbox, motor and inverter, battery and charger efficiencies, with each stage's losses.

Method: Series efficiency chain

Input parameters

Unit system: SI

Parameter	Value	Unit
Energy at the wheels per km	120.00	Wh/km
Gearbox efficiency	97.000	%
Motor and inverter efficiency	90.000	%
Battery charge–discharge efficiency	93.000	%
Charger efficiency	90.000	%
Annual distance	15,000	km

Calculated results

Parameter	Value	Unit
Battery terminal energy per km	137.46	Wh/km
Grid energy per km	164.23	Wh/km
Wall-to-wheel efficiency	73.070	%
Charger loss per km	16.423	Wh/km
Annual grid energy	2,463.4	kWh

Notes for this case

• Each stage divides the energy: wheel ← gearbox ← motor/inverter ← battery (round trip) ← charger. Regenerated energy can be included by lowering the wheel energy to the net traction energy. Typical wall-to-wheel efficiency is 70–80 %; DC fast charging has lower charger losses in the car but more in the station.

Formula and method

$$e_{wall} = \frac{e_w}{\eta_g \eta_m \eta_b \eta_c}, \quad \eta_{tot} = \eta_g \eta_m \eta_b \eta_c$$

Variables

e_w	Energy at the wheels per km	J/m
η_g	Gearbox efficiency	-
η_m	Motor and inverter efficiency	-
η_b	Battery charge–discharge efficiency	-
η_c	Charger efficiency	-
d	Annual distance	m
e_b	Battery terminal energy per km	J/m
e_{wall}	Grid energy per km	J/m
η_{tot}	Wall-to-wheel efficiency	-
Δe_c	Charger loss per km	J/m
E_{year}	Annual grid energy	J

Method and standards

Efficiency chain.

Assumptions and limits

- Constant stage efficiencies.

References

Series efficiency chain

Report details

Report reference	FCC-08T0-02N4 (the same inputs always give the same reference)
Generated	23 November 2026, 18:18 UTC
Calculator	EV Wall-to-Wheel Energy and Efficiency Chain
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/automotive/electric-vehicles/ev-wall-to-wheel-efficiency

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.