Electric Vehicle Energy per km and Range

Energy per km of an electric vehicle at steady speed from road load, drivetrain efficiency and auxiliaries, and the range from usable battery energy.

Method: Road-load energy balance (Gillespie, Fundamentals of Vehicle Dynamics (SAE, 1992), ch. 4; Larminie and Lowry, Electric Vehicle Technology Explained)

Input parameters

Unit system: SI

Parameter	Value	Unit
Battery capacity	40.000	kWh
Usable fraction	90.000	%
Vehicle mass	1,600.0	kg
Rolling resistance coefficient	0.009000	
Drag area	0.65000	m²
Steady speed	80.000	km/h
Battery-to-wheel efficiency	85.000	%
Auxiliary load (air conditioning, electronics)	1.0000	kW
Air density	1.2000	kg/m³

Calculated results

Parameter	Value	Unit
Power at the wheels	7.4180	kW
Energy per distance	121.59	Wh/km
Range	296.08	km

Notes for this case

- Level road, steady speed, still air; city driving with regenerative braking can use less, and cold weather heating much more. 1 J/m = 0.2778 Wh/km.

Formula and method

$$e = \frac{(mgC_{rr} + \frac{1}{2}\rho C_d A v^2)v/\eta + P_{aux}}{v}, \quad R = \frac{uE_b}{e}$$

Variables

E_b	Battery capacity	J
u	Usable fraction	-
m	Vehicle mass	kg
C_{rr}	Rolling resistance coefficient	-
C_dA	Drag area	m²
v	Steady speed	m/s
η	Battery-to-wheel efficiency	-
P_{aux}	Auxiliary load (air conditioning, electronics)	W
ρ	Air density	kg/m³
P_w	Power at the wheels	W
e	Energy per km (Wh/km)	-
R	Range	m

Method and standards

Energy balance.

Assumptions and limits

- Steady speed; level road; still air; no regeneration.
- The auxiliary load is drawn straight from the battery (not divided by the drivetrain efficiency).
- Energy per km is shown in Wh/km in every unit system (1 J/m = 0.2778 Wh/km).

References

• Road-load energy balance (Gillespie, Fundamentals of Vehicle Dynamics (SAE, 1992), ch. 4; Larminie and Lowry, Electric Vehicle Technology Explained)

Report details

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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-range-energy

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.