

EV Battery Comparison Guide

The following table provides a quick comparison of the main types of Electric Vehicle (EV) batteries with a glossary of the comparison points underneath.

The red, amber and green shading aims to provide an overall impression of the features of each battery type. In general, battery types with mostly green shading are those with the highest performance, lowest weight, best safety record and have the least environmental impact. Those with mostly red shading offer lower performance, are heavier and have a greater impact on the environment. Amber shading is used to indicate a rating between the two.

	Lead Acid (SLA)	Silicon	Ni-Cad	NiMh	Lithium-ion	Lithium-Polymer	Lithium-Phosphate
Initial purchase cost	Low	Medium	Medium	Medium	Medium	High	Medium/high
Lifetime cost	High	Medium	Medium	Medium	Low	Very Low	Lowest
Safety	Good	Very good	Good	Good	Good	Very good	Excellent
Environmental impact	High	Low	High	Medium / High	Medium / Low	Low	Very Low
Cycle life	200	400	250	400-500	400-600	>1000	>2000
Nominal voltage	2	2	1.2	1.2	3.4	3.6	3.7
Wh/Kg Energy density (gravimetric)	35	50	41	80	120	160 - 180	120
Volumetric energy density	80	130	120	200	280	>320	270
Self discharge (% per month)	<0	<0	<10	<20	<5	<5	<5
Memory effect	No	No	Yes	Rarely	No	No	No
Operating temperature (C)	-15° to +50°	-50° to +70°	-20° to +50°	-20° to +60°	-20° to +60°	-20° to +60°	-45° to +70°
Flexible form factor	No	No	Yes	No	No	Yes	Yes
Weight	Heavy	Heavy	Light	Light	Lightest	Lightest	Very Light
Charge time	Long	Fast	Moderate	Moderate	Fast	Fast	Fastest
Range	Very Good	Very Good	Good	Good	Very Good	Excellent	Outstanding

Initial purchase cost:	Initial purchase cost is obviously a factor but the most useful cost is the lifetime cost.
Lifetime cost:	The relative lifetime cost is based on range and cycle life to give a meaningful comparison between different battery types.
Safety:	This alludes to the safety record to date for batteries of a given type (for charging, discharging and storage) so is a reasonably general view.

Environmental impact:	The relative impact from production and disposal of each battery type. All EV batteries are recyclable.
Cycle life:	This describes the life span of the battery and is related to the number of complete charge/discharge cycles that a battery can perform before it degrades to about two thirds of its capacity. Sometimes manufacturers multiply this by the range to provide an overall guide to the life of the battery in miles or kilometres – treat this as a very approximate guide.
Nominal Voltage	The typical voltage <i>per cell</i> is fairly constant for each type of battery. Cells are combined in series to provide the useful voltage required by the motor – so gives an indication of how many cells are needed. Fewer cells provide fewer points of failure and generally less heat.
Energy density:	Energy density is the amount of energy that can be stored in a battery per unit of mass (gravimetric) or per unit of volume. Think of it as the power to weight ratio. It is a useful guide between battery types.
Self discharge:	Self-discharge is the reduction in the stored charge of the battery when not in use, it decreases the shelf-life of batteries and tends to occur more quickly at higher temperatures.
Memory effect:	'Memory effect' or 'floating voltage' are the common terms for voltage depression which is usually associated with Nickel Cadmium (Ni-Cad) and some Nickel Metal Hydride (NiMH) rechargeable batteries. The effect is that the battery fails to deliver its original full capacity, seemingly to have 'remembered' previous part charge levels. This can be cured by fully discharging individually affected cells but not the whole battery – a tricky process so prevention is better than cure.
Operating temperature:	Batteries function best at room temperature but each type has discharge temperature limits outside which performance will degrade or cease altogether.
Flexible form factor:	Battery types with thin cells can be created in any form, shape and size.
Weight:	Performance is directly affected by weight which varies considerably between battery types. Weight figures for batteries and overall electric bike weight are usually supplied for easy comparison.
Charge time:	The time taken to reach a full charge from fully discharged. Figures for part charging are also useful.
Range:	Not really influenced by battery type but included here for completeness – peak power output is a more useful guide to range. Manufacturers will provide figures for the maximum range on a single charge. These will have been measured under ideal conditions. They are useful for comparison purposes across model ranges from the same manufacturer but less so between manufacturers. Note that you're unlikely to see results that match the stated figures due varying environmental factors.