

Second-Life Batteries Cheat Sheet

Reusing retired EV lithium-ion packs: thresholds, costs, projects

ENGINEERING
CHEAT SHEET

Key equations

Quantity	Equation	Notes
State of health	$SOH = C_{\text{now}} / C_{\text{rated}}$	EV packs are typically retired at 70–80% SOH
Usable energy	$E_{\text{use}} = E_{\text{rated}} \cdot SOH \cdot DoD$	DoD = depth of discharge allowed in the new application
Pack energy	$E \text{ (kWh)} = V \cdot Ah / 1000$	Sizing check for stationary storage
Cost saving vs. new	$\text{Saving} = 1 - C_{\text{SLB}} / C_{\text{new}}$	McKinsey estimate: 30–70% savings in 2025
Second-life cost range	\$25–49 per kWh (all expenses)	The guide's estimate; new EV packs quoted at \$19–131/kWh
Carbon / energy benefit	–8–17% footprint, –2–6% energy demand	Second life vs. direct recycling after EV use (Tao et al.)

Key takeaways

- Lifecycle: first life in the EV (to ~70–80% capacity), second life in stationary storage (down to ~30%), then recycling below ~30%.
- Best use is **grid storage**: frequency regulation, peak shaving, renewable smoothing and energy arbitrage. Also home and commercial backup, off-grid power, EV charging support.
- Stationary second-life service is estimated at roughly 6 to 30 years depending on duty.
- Biggest hurdles: dangerous manual disassembly (up to 24 steps, up to 16 hours), no cell standardization, and uncertain falling battery prices.
- Cost split: about 56% buying retired packs, 13% labor, 13% administration.
- Cells can be inconsistent inside a pack, so over-discharge and thermal runaway are real risks. Disassembly can be done live under voltage.
- Europe's second-life market is forecast at 8 GWh by 2030 and 75 GWh by 2035.

OEM projects

OEM	Project	Scale
Nissan / Enel	Melilla, Spain, 78 Leaf packs	1.7 MWh
BMW / Bosch	Hamburg grid support (i3 cells)	2,800 kWh
Audi / RWE	Herdecke pumped-storage site	~4.5 MWh
BMW / Off Grid Energy	Off-grid charger	up to 180 kWh