



Electric Vehicle Batteries

Considerations for Fleet Operators

Jared Walker – Sawatch Labs



The Premier Fleet Electrification Analytics Firm

- Founded in 2017
- Deep expertise in
 - Fleet electrification & sustainability
 - Energy modeling
 - Duty cycle characterization
 - Telematics
 - Clean energy
 - Fleet safety
- Industry respected neutral advisor



500 million
Miles Analyzed

70 million
Trips Assessed

225,000 tons
Annual GHG Reductions

\$220 million
Savings Potential

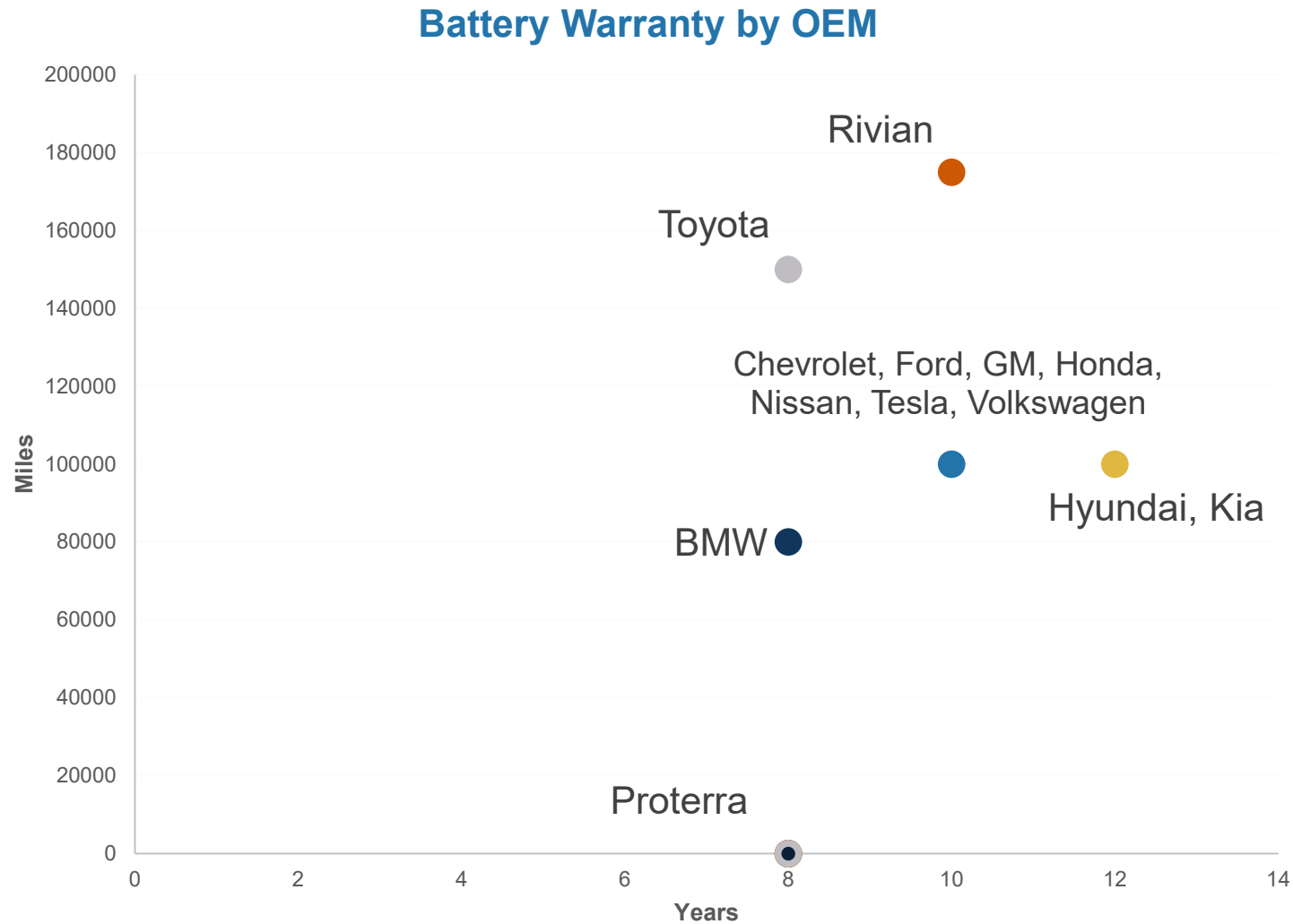
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Electric Vehicle Batteries

Warranty Considerations for Fleets and Battery Recycling



EV Battery Warranties by Manufacturer



EV Battery Life Expectancy

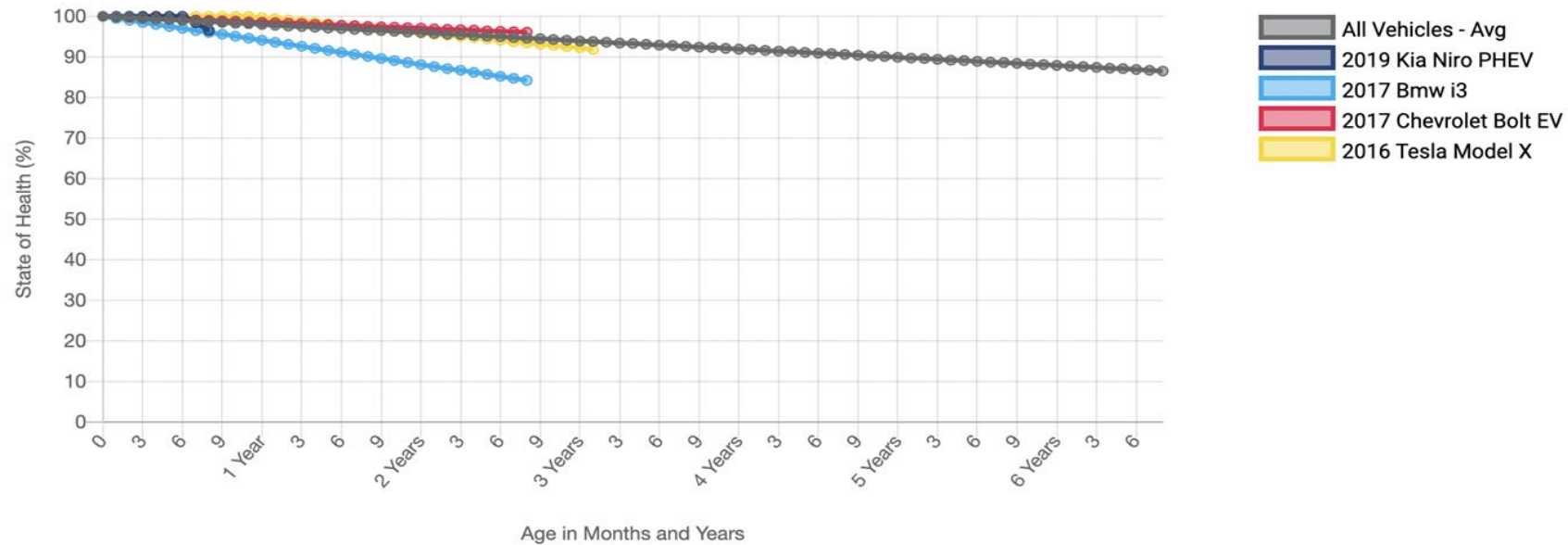
Powered by **GEOTAB**

EV Battery Degradation Comparison Tool

Compare average battery degradation over time for different vehicle makes and model years. Degradation is based on observed data so newer model years will have shorter degradation lines.

Add vehicles by clicking the +. To remove a vehicle from the chart, click its name in the legend.

Make & Model Year





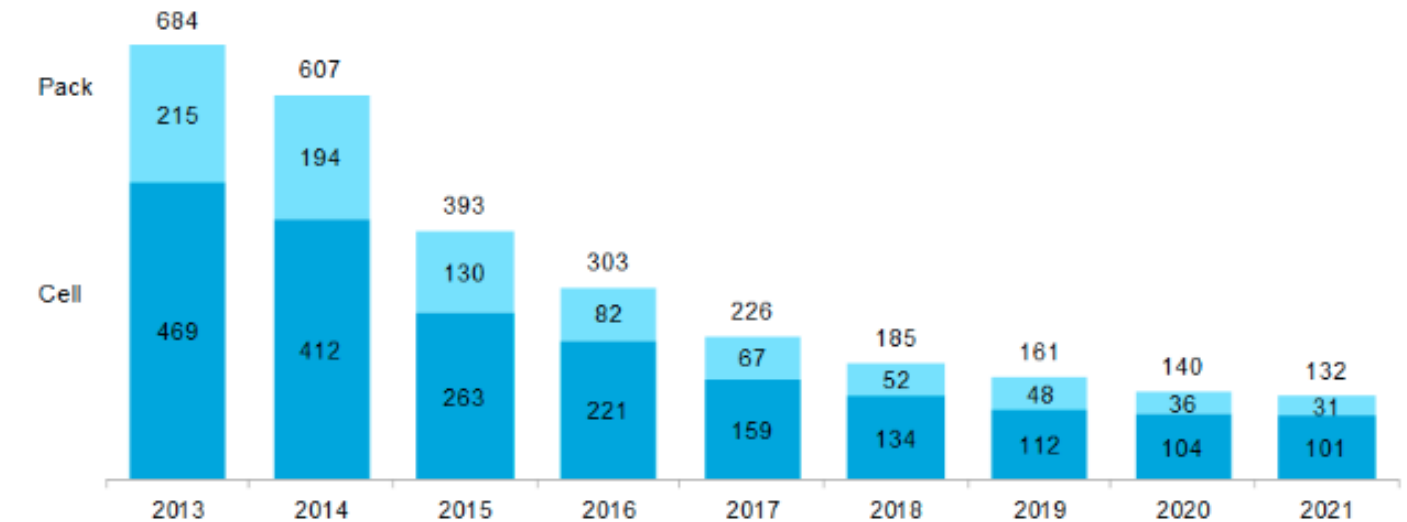
Battery Recycling

Fleet considerations



The Cost of Raw Materials Defines EV Costs

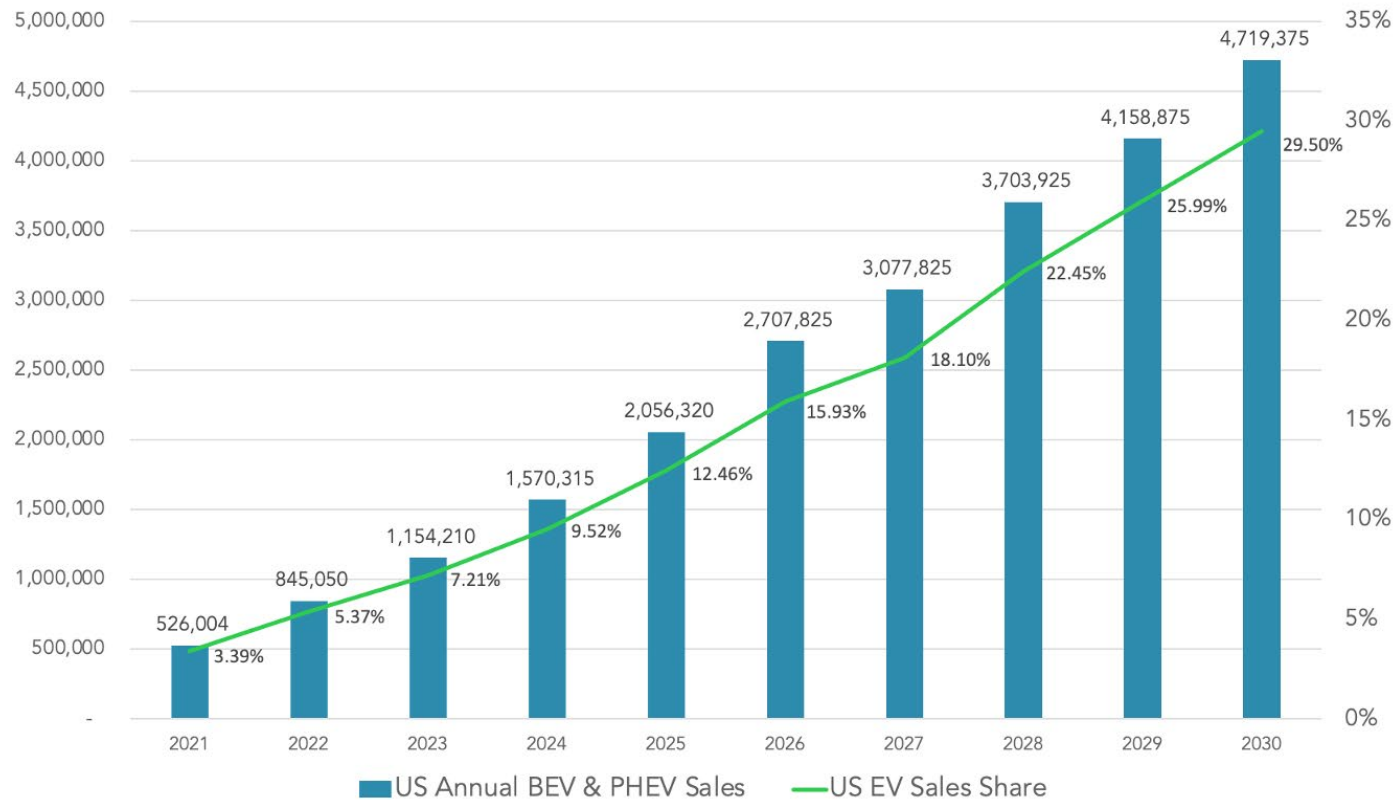
- EV battery manufacturing can make up 70%+ of total manufacturing costs
- Battery Manufacturing costs have decreased from \$1,200/kWh (2011) to \$132/kWh (2021)
- High cost financially and environmentally of minerals like cobalt, nickel, lithium
- Much of the mining of these minerals takes place in places with lax standards
- Geopolitical instability and concentration of deposits impacts supply



Source: BloombergNEF.

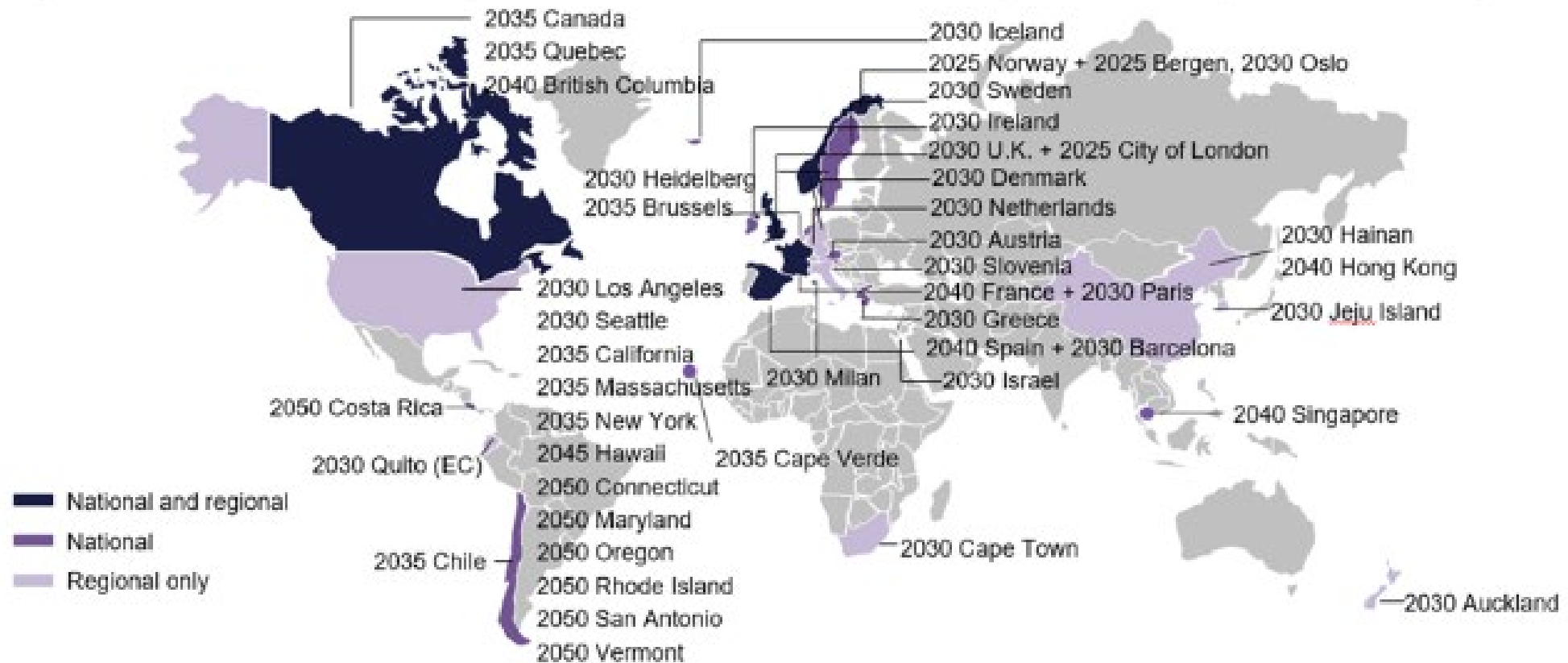
Increased Demand Creates Upward Price Pressure

US EVs (BEV & PHEV) Sales & Sales Share Forecast: 2021-2030



Historical Sales Data: GoodCarBadCar.net, InsideEVs, IHS Markit / Auto Manufacturers Alliance, Advanced Technology Sales Dashboard | Research & Chart: Loren McDonald/EVAdoption

National ICE Vehicle Phase-out Targets



Source: Bloomberg NEF



How Will the Auto Industry Meet Demand?

- Minerals can be reclaimed through a hydro -metallurgical process
- Recycling makes ethical and environmental sense but is currently not financially viable
- Labor intensive: collection, transport, battery chemistry sorting, shredding, separation of metallic and non -metallic materials, neutralizing hazardous substances, smelting, and then purification

An Issue of Scale - OEM investment

- Ford
- Audi
- Volkswagen
- Toyota
- Volvo
- Proterra

Redwood Materials and Ford Motor Company Announce Strategic Relationship



Redwood's mission is to create a circular supply chain for batteries and help partners across the electric vehicle and clean energy industries with pathways, processes, and technologies to recycle and remanufacture lithium-ion batteries. Today we announce that we'll be working with Ford Motor Company to create a closed loop for battery recycling and a domestic supply chain for critical battery



EV Battery Recycling - Long Term Outlook

- The majority of EVs produced are still on the road - supply of used EV batteries is currently not significant enough to scale
- While the EV battery recycling industry matures, demand for repurposed batteries will continue to increase
- Automakers and others are beginning to offer battery lease programs
- EV Battery chemistry is changing:
 - Tesla phasing out Cobalt
 - Nissan phasing in longer lasting, solid -state batteries by 2028

EV Battery Recycling - Near Term Outlook

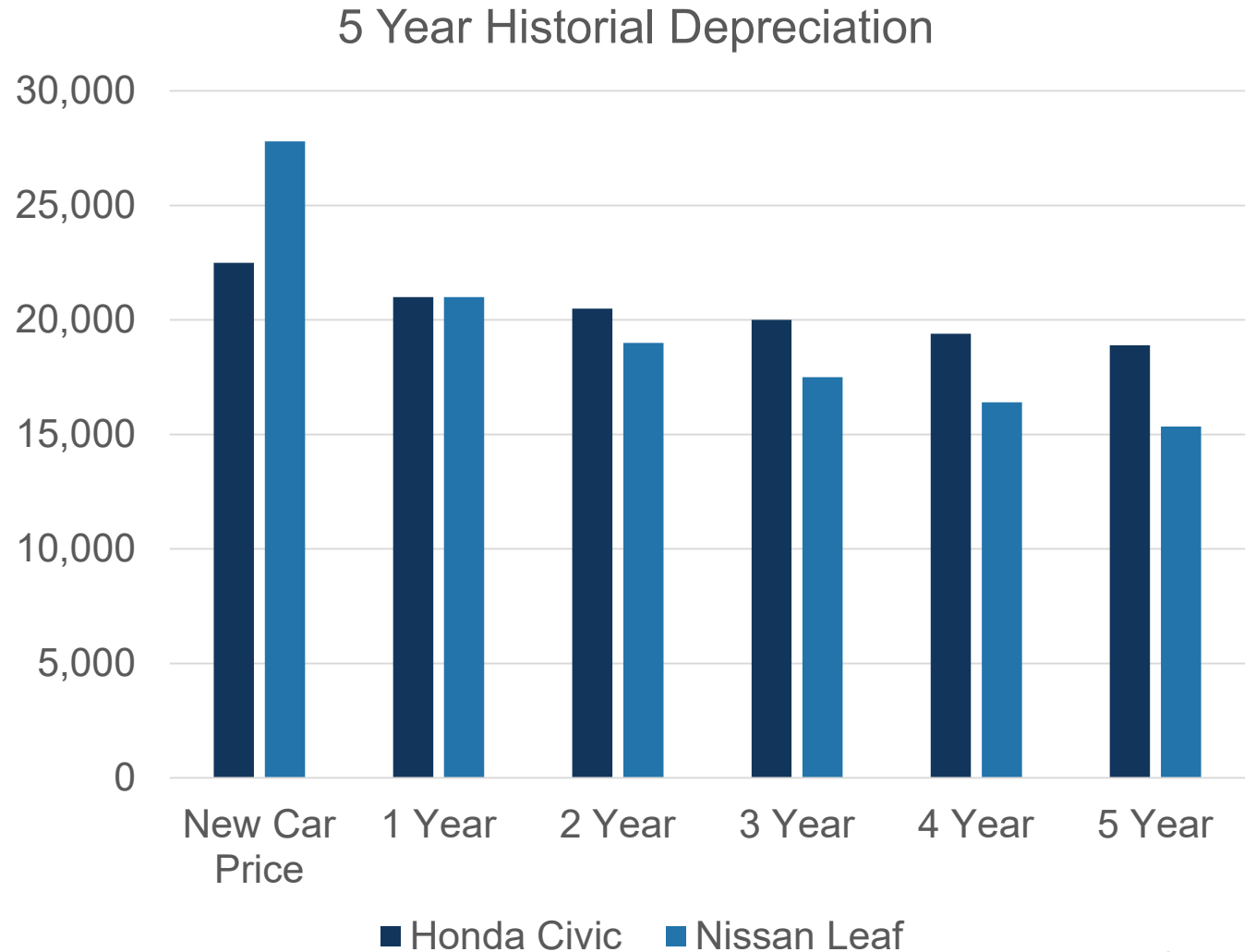
- The simplest way to recycle an EV battery is to repurpose it at 70%
- This facility sells energy for up to \$200/MWh and charges for \$25MWh



Historically EVs Have Depreciated Faster Than ICE Vehicles

Honda Civic depreciation over 5 years is ~16%

Nissan Leaf depreciation over 5 years is ~44%





EV Battery Warranties - Key Takeaways

- EV Li-ion batteries have much longer lives than Li-ion batteries in phones or laptops due to their sophisticated BMS.
- Most EV batteries will outlast the vehicles they were installed in.
- Industry standard is 8 year/100,000 mile

Thank You

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