The Power Behind Performance

CROWN BATTERY SINCE 1926

LEAD

Energy Storage Market Share

The Power Behind Performance

CROWN BATTERY SINCE 1926

Lead-Acid Battery

TIME ON MARKET PROVEN IN THE FIELD	1859: Invented Over 100 years' use, including renewable energy
LIFESPAN	20+ year lifespan is possible (based on more than 40 years' testing and case studies) 5-7 year life is common
COST/ROI	Most affordable (often 50% – 90% cheaper) Flooded: Cost per kWh ~$65 VRLA: Cost per kWh ~$120
RECYCLABILITY	99% recycled – the highest of any product in the U.S. (Source: EPA) 98% of material can be recycled/ reused, not down-cycled
USABLE ENERGY STORAGE / DENSITY	Medium power density, maximum surge capacity
SURGE CAPACITY (ability to handle high-draw loads such as A/C and refrigerators)	High surge capacity Among other factors, lead-acid systems are often sized for 50% DoD

EFFECTIVELY STORES ENERGY DURING QUICK CHARGES (e.g. from solar panels)	YES
USES STANDARD RATING?	YES
EASE OF INSTALLATION	Easy to install No battery management system (BMS) required
WEIGHT AND SIZE	Lighter and smaller than saltwater per kWh Heavier and larger than lithium-ion
SAFETY	Over 100 years' safe use Flooded lead-acid batteries must be properly ventilated Highest recycling rate of any product Decades of published safety standards and best practices
MAXIMUM DEPTH OF DISCHARGE (DoD)	50% DoD recommended (100% DoD possible but will shorten lifespan)

INDUSTRIAL MARKET

Material Handling

- About 63% of new units in NAmerica are electric (150,000/yr) .
- 2500-3000 (1.6-2.0%) units are alternative chemistry (primarily Lithium).
  - Note: ~1/3 of Lithium-ion units sold are IC conversions.

More Market Promotion

Less Market Erosion

PASSENGER VEHICLE MARKET

AUTOMOTIVE

Cranking

- Pb-acid
- Lion penetration limited to the hobbyist.
- Luxury cars offer(-ed) an “optional” lithium-ion starting battery.
- ($Cost & Performance)

Start/Stop

- Pb-Acid
- ($Cost)

48V

- European Luxury cars
- Ram 1500 Truck - 330 Wh Li-NMC battery, with a conventional 12V Pb-acid starter battery.
- (Performance)
- Opportunity for Bipolar Pb-acid ($Cost Advantage)

Advanced Pb-Acid Technology

BIPOLAR

- Advanced Battery Concepts
- Gridtential

CBI CRADA with Argonne National Lab

- Accelerating development

Pb-acid Chemistry unchanged for 100+ years.

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Future (5-7 Years)

Material Handling

- Pb-acid retains majority of market
- Lithium - Niche Penetration

Passenger Vehicles

- Lithium in Higher Voltage systems

✓ Penetration of Bipolar Pb-acid into Lithium market.