

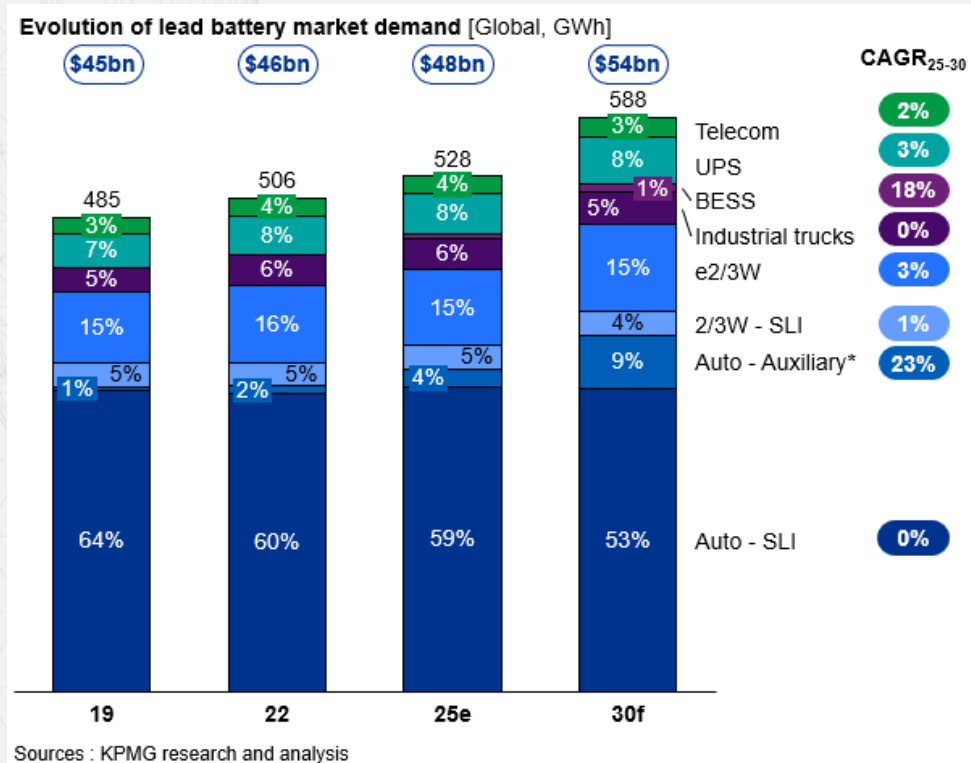
CBI Battery Roadmap

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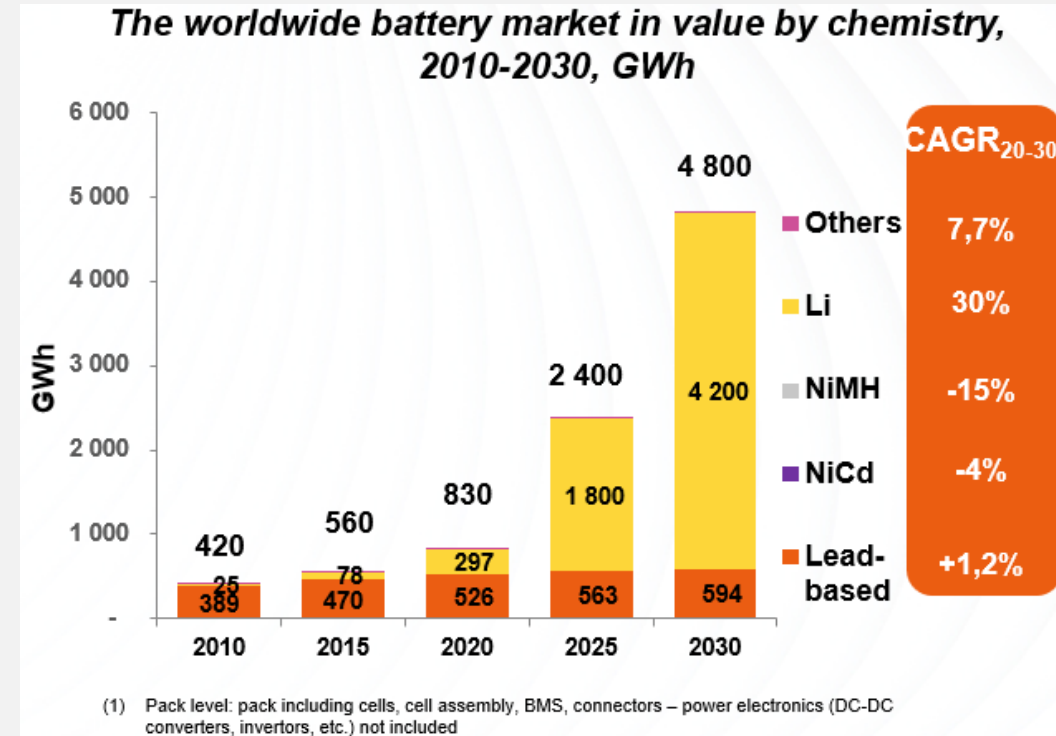
ALBA in Mainz, Germany



Battery Market



- Increase in the global battery market for lead batteries with steady growth in many applications – especially in automotive auxiliary and BESS



- Significant growth of the Li-ion industry due to strong industrialization push from China
- Oversupply has pushed lithium-ion battery prices to historic lows (below \$100/kWh), while regional incentives are strengthening manufacturing in the US and Europe.

Automotive - Auxiliary

Three different categories according to IEC 60095-8

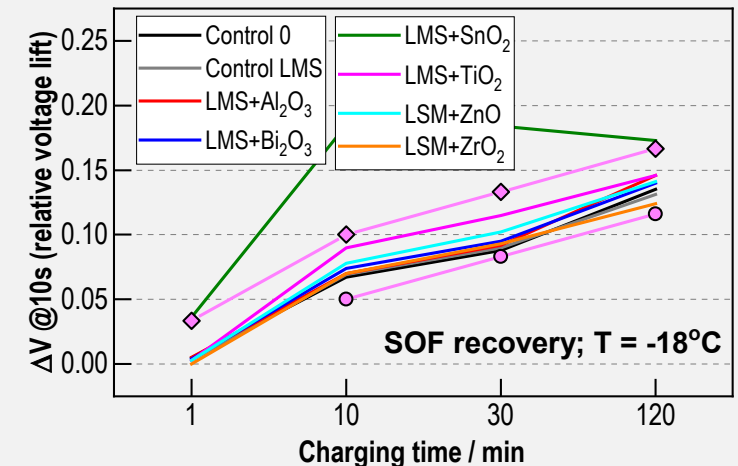
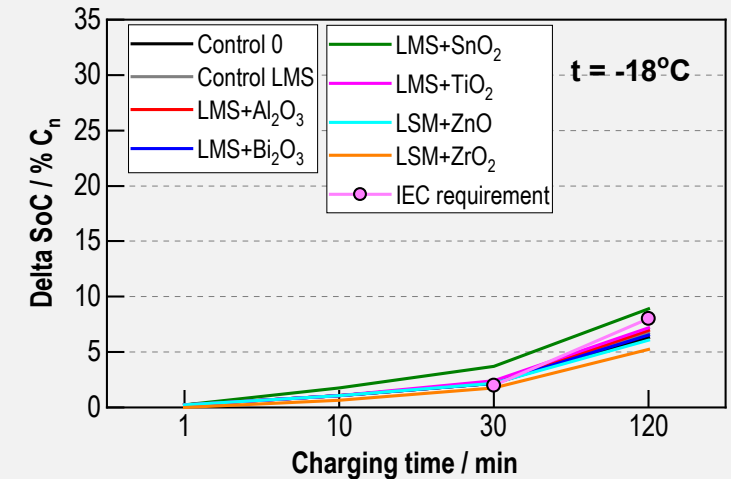
- 12V central storage (main) battery – Category 1
→ most functions of modern automotive batteries except engine starting
- 12V back up battery – Category 2
→ voltage stabilization and emergency power (safety relevant)
- 12V auxiliary batteries in Start/Stop and Micro-hybrids – Category 3
→ voltage stabilization during engine start (not safety relevant)

Charge recovery (CR)

- CR determines restoration of power (state-of-function) and energy (state-of-charge)
- CR is measured on a time scale of minutes to hours compared to DCA (recuperation events lasting seconds)

Pulse power characterization (PPC)

- Engine cranking is not a requested function for auxiliary and back-up batteries
- PPC test is used as an indicator of general power performance
- PPC test includes a sequence of progressively increasing short pulses at constant current at full and PSOC and low temperature



Automotive – Auxiliary

Performance metric		2025	2027	2030
Research Goals				
Charge recovery IEC 60095-8	SOC recovery (30')	$Q(30') \geq 4 \%C_n$	$Q(30') \geq 12 \%C_n$	$Q(30') \geq 15 \%C_n$
	SOC recovery (120')	$Q(120') \geq 15 \%C_n$	$Q(120') \geq 22 \%C_n$	$Q(120') \geq 30 \%C_n$
	SOF recovery (1')	$\Delta U_{10s} \geq 0.2 \text{ V}$	$\Delta U_{10s} \geq 0.5 \text{ V}$	$\Delta U_{10s} \geq 0.8 \text{ V}$
	SOF recovery (10')	$\Delta U_{10s} \geq 0.5 \text{ V}$	$\Delta U_{10s} \geq 0.8 \text{ V}$	$\Delta U_{10s} \geq 1.1 \text{ V}$
	SOF recovery (30')	$\Delta U_{10s} \geq 0.7 \text{ V}$	$\Delta U_{10s} \geq 1.0 \text{ V}$	$\Delta U_{10s} \geq 1.3 \text{ V}$
	SOF recovery (120')	$\Delta U_{10s} \geq 0.9 \text{ V}$	$\Delta U_{10s} \geq 1.2 \text{ V}$	$\Delta U_{10s} \geq 1.4 \text{ V}$
PPC IEC 60095-8	Category 1	Within IEC 60095-8 (Tables 18-21) voltage requirements are suggested for PP1 and PP2 pulse profiles conducted at BOL and EOL and at 25°C (BOL) and -18°C (BOL, EOL).		
	Category 2&3			
Requirements, no longer need development				
Static charge acceptance at 0°C (IEC 60095-1)		Used as a comparison for charge recovery at 0°C.		
All charge retention, endurance cycling, vibration resistance, corrosion, water loss tests		Conform to requirements in IEC 60095-8.		
CCA - AUX		$U_{10s} \geq 7.5V$; must be on label		
Service life		5 years	7 years	7 years

- Research goals are concentrated on charge recovery (SOC and SOF recovery)
- CR goals are ambitious, assuming all AUX batteries reach state-of-the-art baseline performance by 2030
- For PPC, voltage requirements according to IEC shall be met
- Additional regulatory and supplementary tests should be followed
- Service life requirements are based on developing AUX batteries that only require one change over the life of the vehicles (average taken as 12.5 years)