Battery Energy Storage Systems (BESS) 2035 Market Outlook and Opportunities

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Report commissioned by the Consortium for Battery Innovation (CBI) and the International Lead Association (ILA)

CBI / ILA commissioned KPMG to report on the booming BESS market

KPMG

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BESS characterization & technology assessment

- Market segmentation and technology assessment per BESS application
- Project scope: Batteries (Lead-, Lithium-, Sodium-based) & Flow batteries

BESS market size, and growth trajectory

- Market sizing per application and per region (China, USA, Europe, India)
- Market growth forecasting per application and per region

Growth opportunities for battery industry by 2035

- Growth opportunities with supply chain, geopolitical, recycling and cost considerations
- Focus on lead battery opportunities and key areas of development

Agenda

01	**Applications**
02	Market size and dynamics
03	2035 opportunities for lead batteries

BESS are getting increasingly popular for their ability to manage energy consumption in various applications…

Front of the meter

Generation support & bulk storage
Firm capacity, Demand response, arbitrage

Transmission & distribution
Grid upgrade deferral

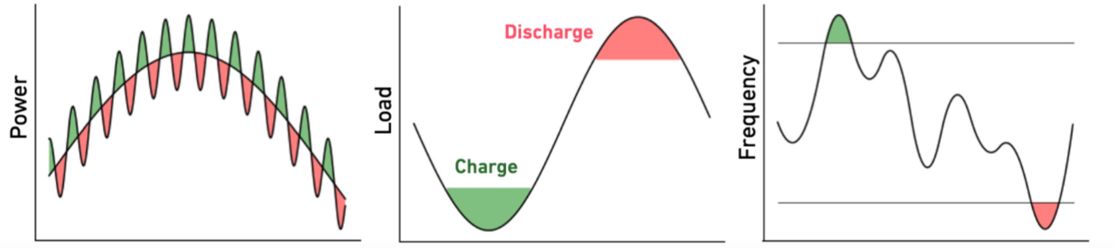
Ancillary services
Frequency regulation, Spinning & non-spinning reserve, Black start

Behind the meter

C&I – exc. EV infrastructure
Bill management*, Back-up, micro-grid

EV infrastructure
Operation costs reduction, Grid upgrade deferral

Residential
Bill management*, Back-up, micro-grid



Sources: Lazard, expert interviews, KPMG research & analyses

(*) self-consumption, peak shaving, demand charges

… With different battery technologies serving these applications based on a unique value proposition

Current battery performance broken down by electrode chemistry

Battery type	Response time	Discharging time	Cycle life	Safety	Cost efficiency	Power capability
3 Li 6.9 Lithium-based		0.15 – 6 hours				
82 Pb 207.2 Lead-based		0.25 – 10 hours*				
11 Na 23.0 Sodium-ion		1 – 4 hours				
11 Na 23.0 Sodium-sulfur		0.5 – 8 hours				
28 Ni 58.7 Nickel-based		0.5 – 8 hours				
23 V 50.9 Vanadium-based		10 – 12 hours				
30 Zn 65.4 Zinc-based		8 – 10 hours				

Sources: European Commission, S&P, AraAke, KPMG analyses

(*) Few batteries achieve a 10h+ discharging time

Legend: Strong performance / Weak performance

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03	2035 opportunities for lead batteries

We’ve identified four drivers that will push BESS market development even further

Rapid growth of renewable energies
Challenges inherent to integrating them

Development of supporting policies
Structuring the market and providing incentives for BESS

Decrease in battery costs
Making BESS projects more profitable

Improvement of technologies
Expanding the range of applications and lowering LCoS

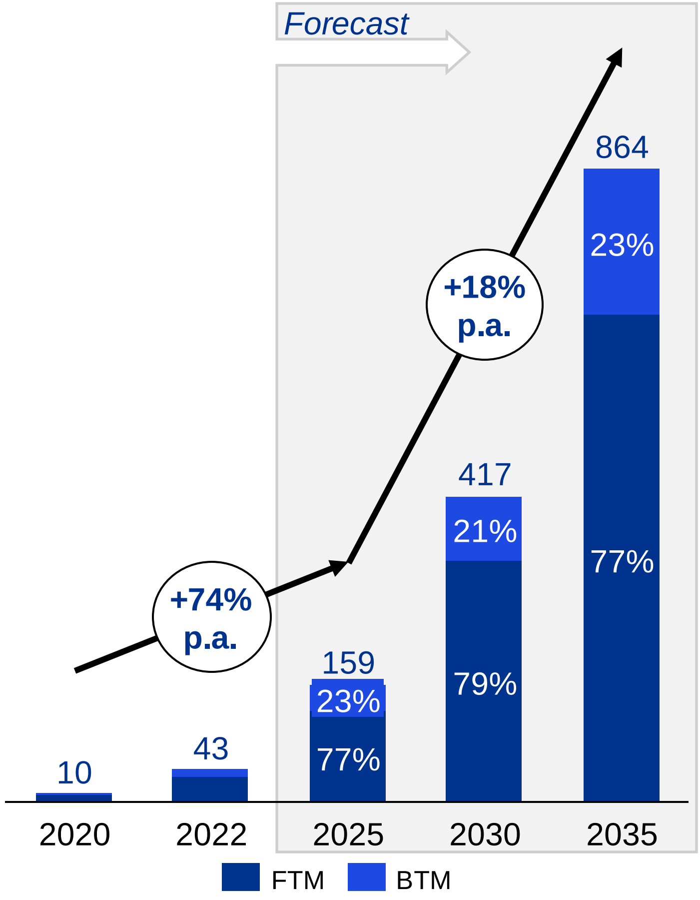
Typical applications

- Rapid growth of renewable energies: Arbitrage, firm capacity, Frequency regulation, etc.
- Development of supporting policies: Arbitrage, Frequency regulation, spinning reserve, Residential adoption, etc.
- Decrease in battery costs: Most FTM and BTM applications
- Improvement of technologies: Arbitrage, Grid upgrade deferral, black start, firm capacity, etc.

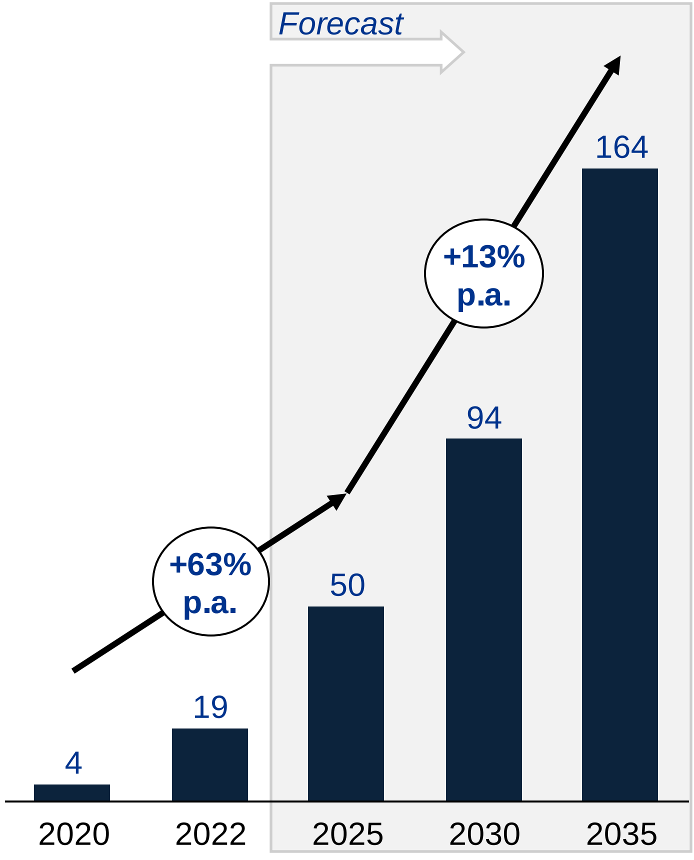
Sources: expert interviews, KPMG research & analyses

With the development of these drivers, the BESS market will reach ~865 GWh-yr in capacity additions and ~$165 billion in value by 2035

Global BESS yearly additions* [GWh]

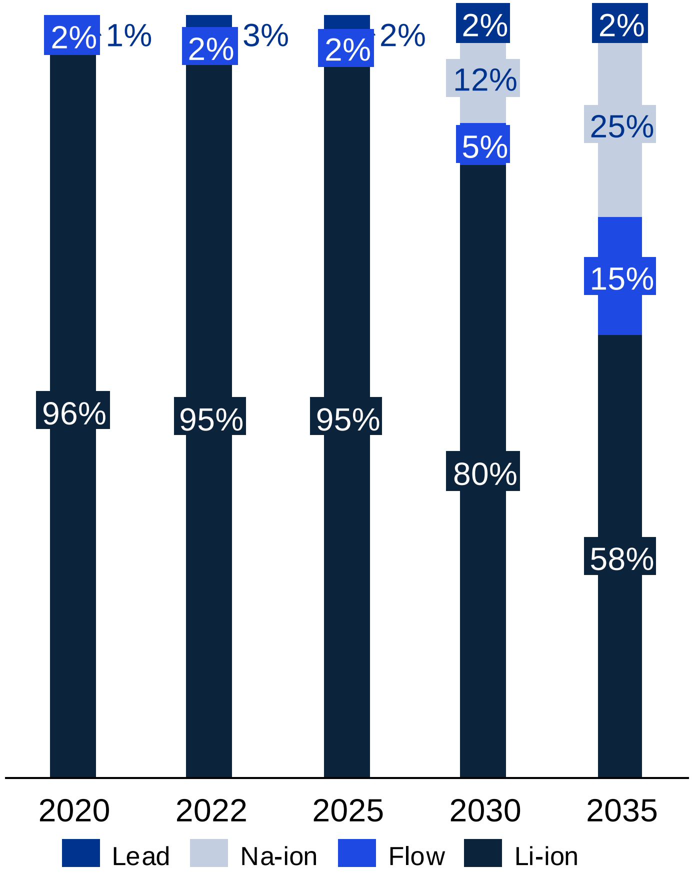


Global BESS yearly additions* [$bn]



All hardware and software costs, excluding integration and human costs

Breakdown by technology* [GWh]

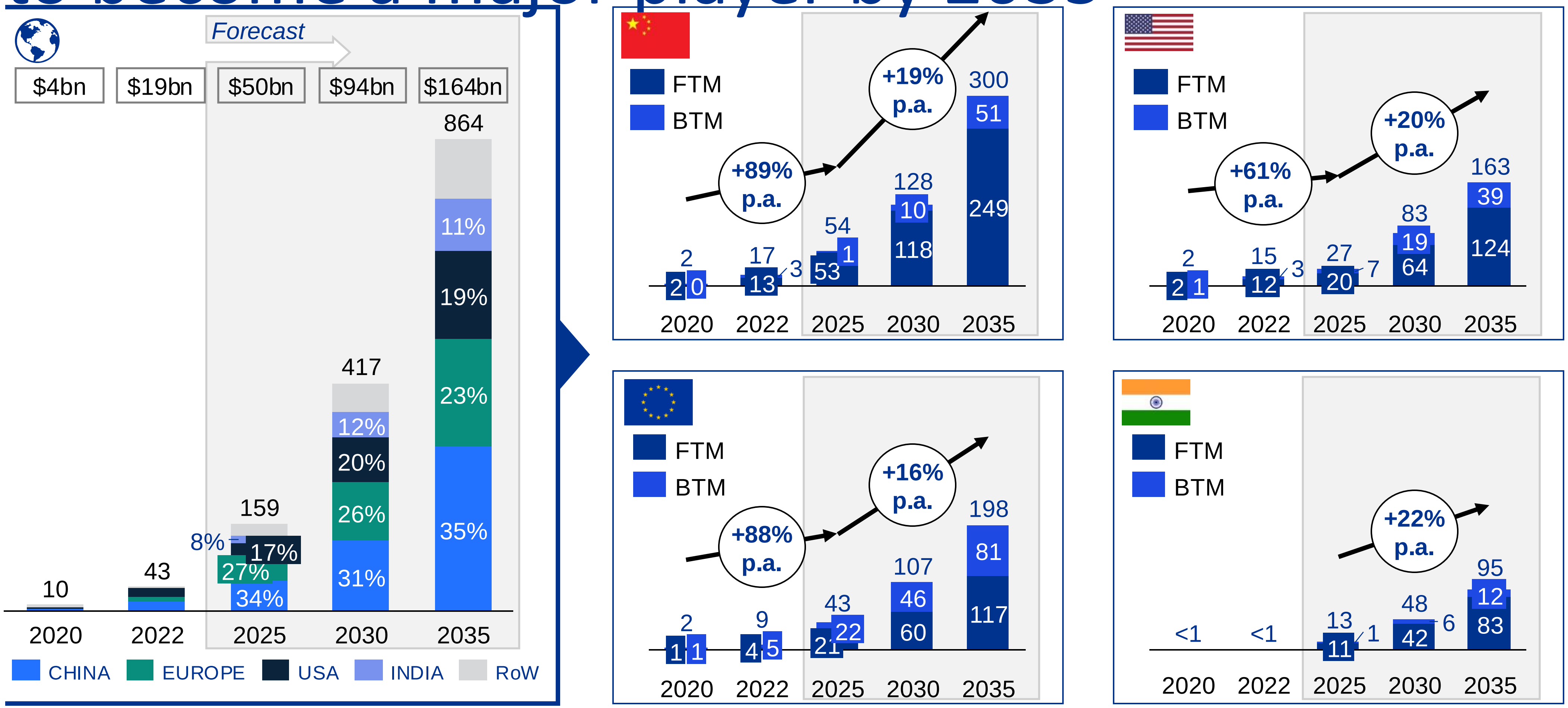


Sources: NREL, expert interviews, IEA, KPMG research & analyses

*Residential UPS-inverter market excluded, see appendix

China, Europe, and USA should take the lion's share of the BESS market, while India is expected to become a major player by 2035

Global BESS yearly additions* [GWh]



Sources: expert interviews, IEA, KPMG research & analyses

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03	**2035 opportunities for lead batteries**

Lead batteries will be particularly relevant in the booming BTM market and in emerging markets where they best fulfil requirements

Segments focus | Competitive positioning

Target BTM markets

- **Safety** is increasingly **important** for regulators of BTM applications (e.g., lithium bans or limitations in New York and China)
- **Revenue stacking** is **less necessary** for profitability **BTM**

"With its potential growth, **BTM is a logical place for lead batteries**"

CEO of ArcActive

Target emerging markets

- **India is expected to be a booming BESS market.** Many other countries in Africa have committed to deploy BESS
- **These markets need low-cost batteries to support the development of their ESS market**

"Lead BESS have a big role to **help the Indian market with electrification**"

CEO of Advanced Battery Concepts

Leverage recyclability

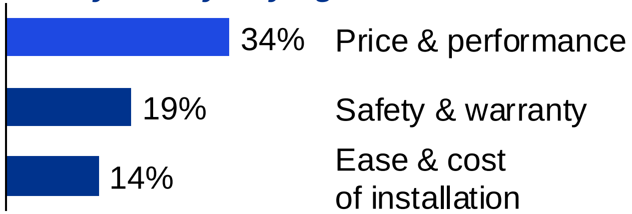
- **~90% of lead is recycled,** with near **zero loss in performance** and an **existing supply chain**
- Lead batteries **have end-of-life value,** and could benefit from the future disappearance of ICE vehicles and **high available volumes**

"Lead's recyclability is a **real strategic advantage**"

Director of CHR Metals

Adopt price-competitive positioning

2023 German* BESS customer survey on key buying factors



- **Affordable solutions** have the potential to unlock additional market share

"**Customers are simply looking for** solutions that foster **profitable projects**"

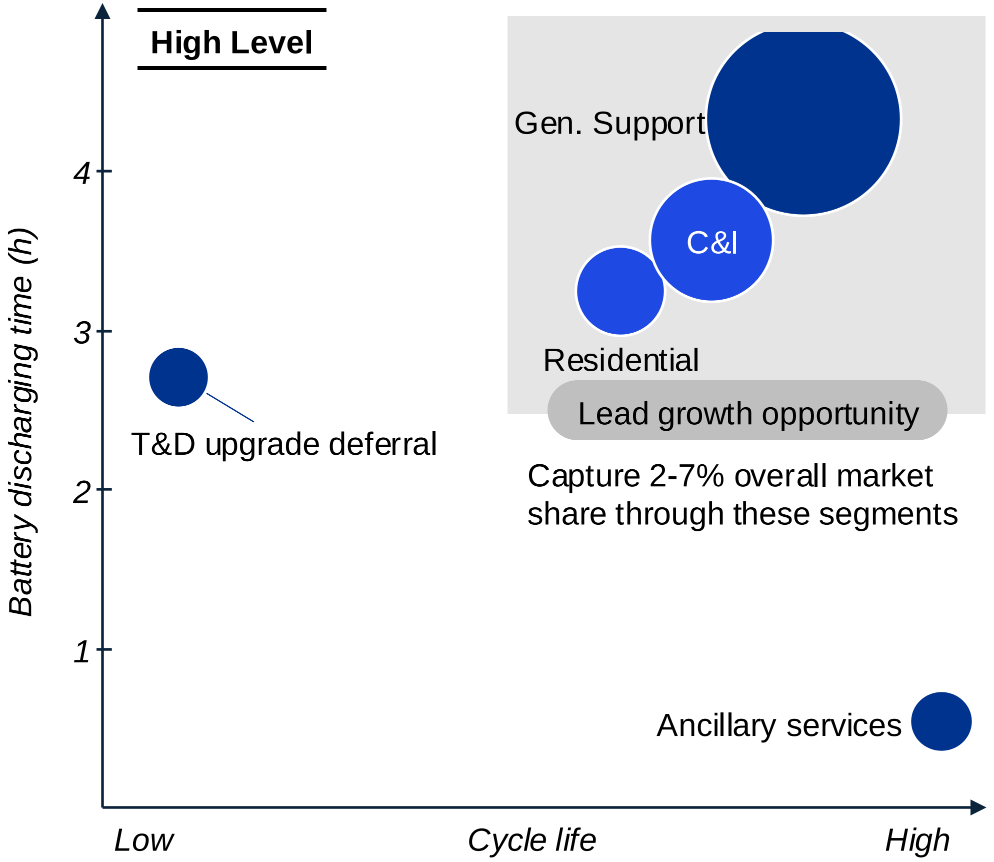
Director of Hoppecke

Sources: McKinsey, desk research, expert interviews, KPMG research & analyses

(*) Germany is the biggest market for Residential BESS

Lead batteries – today mainly present in ancillary services – can increase their market share in deeper markets by improving LCoS through R&D

BESS market applications by discharging time & cycle life



Key R&D focuses and objectives

Decrease Levelized Cost of Storage

- Increase cycle life & DoD ratio of lead batteries
- Lower manufacturing costs

"To reduce lead's LCoS, you must focus simultaneously on cycle life, DoD, and manufacturing costs", Chairman of Gridtensial

Standardization

- Create a standard for the different lead BESS systems, to improve their compatibility, decrease overall costs and increase adoption

Advanced monitoring

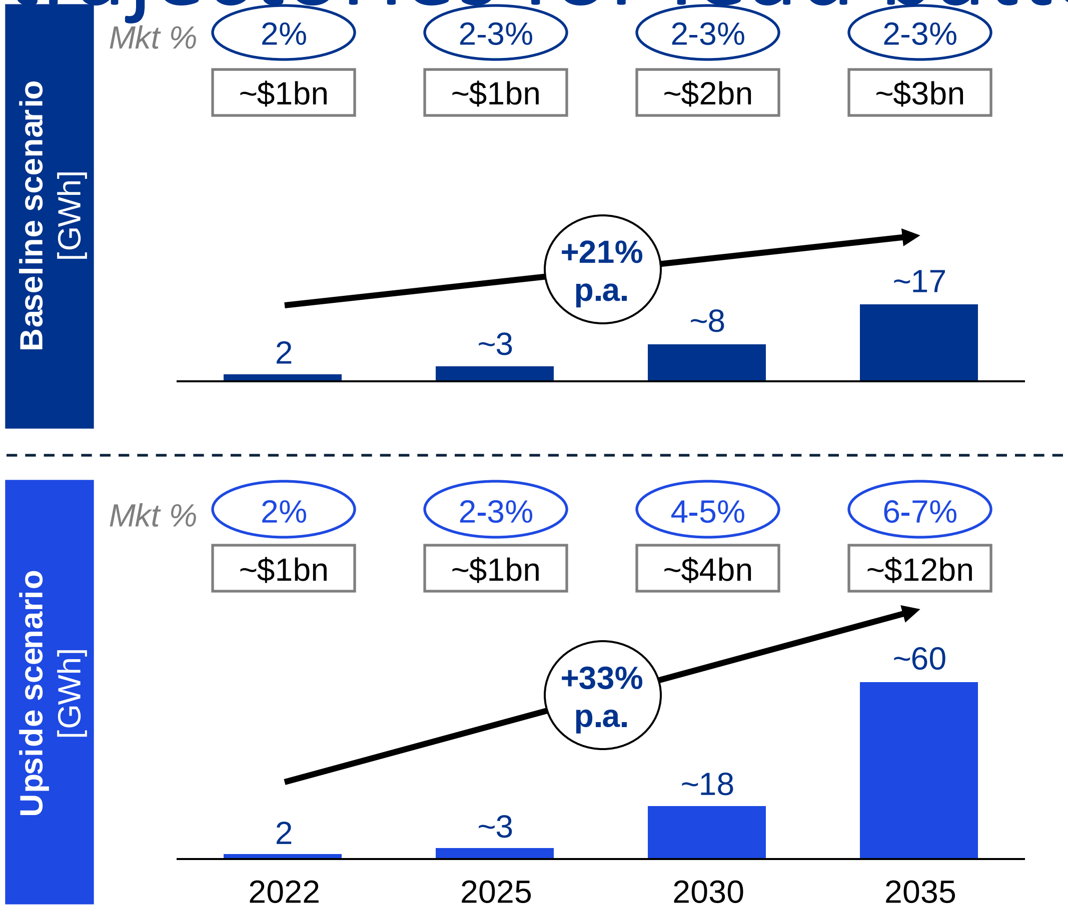
- Enhance lead-based BESS with advanced monitoring capabilities to boost battery cycle life and performance, on a par with lithium battery standards – compensating for the historical lack of needed monitoring

Sources: desk research, KPMG research & analyses

Legend: FTM BTM Area = Market size by 2035

Based on lead battery manufacturers' ability to improve LCoS, we forecasted two future trajectories for lead batteries

Forecasts of lead sales



KPMG Insights

- We estimate that lead batteries can outpace the market by securing the right positioning on the key markets previously identified
- The Upside scenario presupposes **these prerequisites across the entire lead industry:**
  - Secure R&D investment to achieve Long-Duration Energy Storage systems
  - Secure R&D investment to achieve extended cycle life, with deep discharge cycles
  - Deploy demonstrator projects to prove lead's viability to project developers

Sources: expert interviews, KPMG research & analyses

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