Global Energy Storage Report – Executive Summary

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

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

Confidential

Of the various forms of Energy Storage Systems (ESS), this study focuses on electrochemical battery technologies (BESS)...

Energy Storage Systems

Mechanical

- Pumped hydro
- Liquid air storage
- Compressed air
- Gravity systems
- Flywheels

Chemical

- Ammonia
- Drop-in fuels
- Hydrogen
- Methanol
- Synthetic fuels
- Synthetic natural gas

Electrochemical

- **Batteries**
  - Lead-based
  - Lithium-based
  - Sodium-based (e.g., NaS, Na-ion)
  - Other (e.g., metal-air, nickel, molten)
  - **Flow batteries** (incl. zinc-based)
- Hybrid supercapacitors
- Electrochemical recuperator

Electrical

- Super capacitors
- Superconducting magnetic ES

Thermal

- Latent heat storage
- Sensible heat storage

Project scope

Sources: EASE, KPMG analyses

… and their ability to manage energy consumption in various applications in an efficient, safe and cost-effective manner

BESS applications

Type	Application		Description
Front-of-the-meter	Generation support & bulk storage	Firm capacity	Maintain renewable energy power output at the agreed level
		Demand response	Manage high wholesale prices or emergency conditions
		Arbitrage	Store inexpensive electricity to sell at higher price
	Transmission & distribution	Upgrade deferral	Provide extra capacity to delay or defer grid investments
	Ancillary services	Frequency regulation	Provide immediate power (4s) to maintain generation load balance and prevent frequency fluctuations
		Spinning reserve	Maintain electricity during unexpected contingency events – immediately
		Non-spinning reserve	Maintain electricity during unexpected contingency events – within a short period
		Black start	Restore an electric power station or part of an electric grid without relying on external network
Behind-the-meter	Residential	Bill management*	Lower demand charges by using batteries when time-of-use rates are high
		Back-up / micro-grid	Provide back-up power or micro-grid islanding
	C&I**	Bill management*	Lower demand charges by using batteries when time-of-use rates are high
		Back-up / micro-grid	Provide back-up power or micro-grid islanding

(*) self-consumption, peak shaving, demand charges
(**) incl. EV infrastructure

Sources: Lazard, expert interviews, KPMG analyses

Across the different BESS applications and use cases, a set of common, core performance indicators has been identified…

Relevant KPIs for generic ESS applications

KPI	Unit	Priority
Response time	ms-hour	
Discharging time	ms-hour	
Cycle life & lifetime	#cycle/year	
Safety	Standard testing	
LCoS*	$/kWh	
Power capability	W	
Roundtrip efficiency	%	
Sustainability / Recyclability	$/kWh CO2e	
Volumetric energy	Wh/l	
Gravimetric energy	Wh/kg	

KPI

Low priority — *High priority*

- **Core set of KPIs for BESS:**
  - Same across all BESS applications
  - Deemed critical to assess which technologies are best suited to different application requirements

- **Secondary set of KPIs for BESS:**
  - Overlapping / deduced from core KPIs
  - Less relevant for stationary batteries
  - Limited impact on the choice of technology

Sources: RhoMotion, expert interviews, KPMG analyses

(*) Levelized Cost of Storage

… and their criticality assessed for each BESS application, depending on business requirements

Criticality assessment of core KPIs for ESS applications

Type	Application		Response time	Discharging time	Cycle life	Safety	System costs	Power capability
Front-of-the-Meter	Generation support & bulk storage	Firm capacity	Strong	Strong	Strong	Weak	Strong	Strong
		Demand response	Strong	Weak	Strong	Weak	Strong	Strong
		Arbitrage	Weak	Strong	Strong	Weak	Strong	Strong
	Transmission & Distribution	Upgrade deferral	Weak	Weak	Strong	Weak	Strong	Strong
	Ancillary services	Frequency regulation	Strong	Strong	Strong	Weak	Strong	Strong
		Spinning reserve	Strong	Strong	Weak	Weak	Strong	Strong
		Non-spinning reserve	Weak	Strong	Weak	Weak	Strong	Strong
		Black start	Weak	Strong	Weak	Strong	Strong	Strong
Behind-the-Meter	Residential	Bill management*	Strong	Weak	Strong	Strong	Strong	Weak
		Back-up / micro-grid	Strong	Strong	Weak	Strong	Strong	Strong
	C&I**	Bill management*	Strong	Weak	Strong	Strong	Strong	Strong
		Back-up / micro-grid	Strong	Strong	Weak	Strong	Strong	Strong

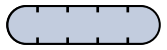
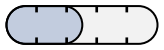
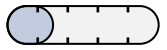
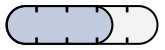
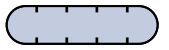
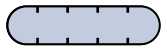
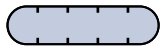
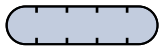
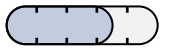
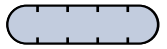
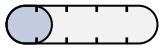
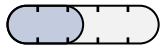
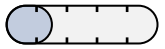
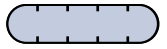
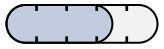
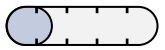
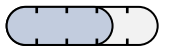
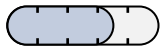
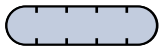
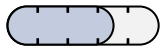
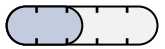
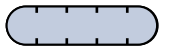
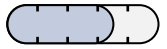
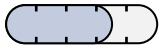
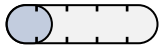
Sources: desk research, expert interviews, World Bank, KPMG analyses

(*) self-consumption, peak shaving, demand charge (**) incl. EV infrastructure

Legend: Weak Strong

To complete the picture, this approach has also been applied to battery technologies, to assess each one's ability to perform on these KPIs…

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

...and based on this, a performance matrix was drawn up to illustrate each technology's current ability to meet application requirements

Technical and economical assessment* of current battery technologies for various ESS applications

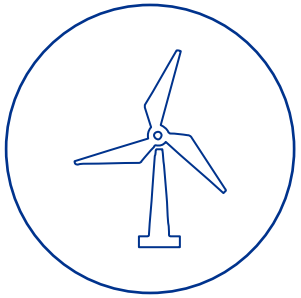
Type	Application		Lithium-based (3 Li 6.9)	Lead-based (82 Pb 207.2)	Sodium-ion (11 Na 23.0)	Sodium-sulfur (11 Na 23.0)	Nickel-based (28 Ni 58.7)	Vanad.-based (23 V 50.9)	Zinc-based (30 Zn 65.4)
Front-of-the-Meter	Generation support & bulk storage	Firm capacity							
		Demand response							
		Arbitrage							
	Transmission & Distribution	Upgrade deferral							
	Ancillary services	Frequency regulation							
		Spinning reserve							
		Non-spinning reserve							
		Black start							
Behind-the-Meter	Residential	Bill management							
		Back-up / micro-grid							
	C&I	Bill management							
		Back-up / micro-grid							

Sources: European Commission, desk research, KPMG analyses

(*) See details in core report

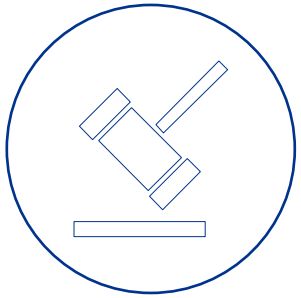
Legend: Unsuitable — Suitable for the application

BESS market development will be mainly driven by RE growth, policies, decrease in battery costs, and technological improvements



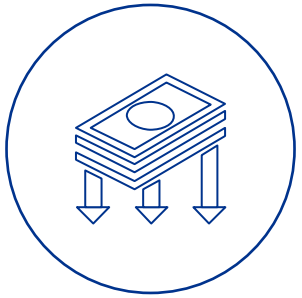
Rapid growth of renewable energies

Challenges inherent to integrating them



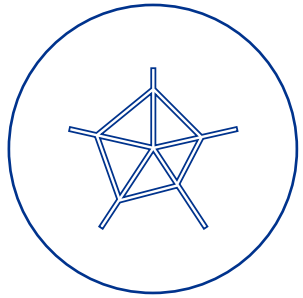
Development of supporting policies

Structuring the market and providing incentives for BESS



Decrease in battery costs

Making BESS projects more profitable



Improvement of technologies

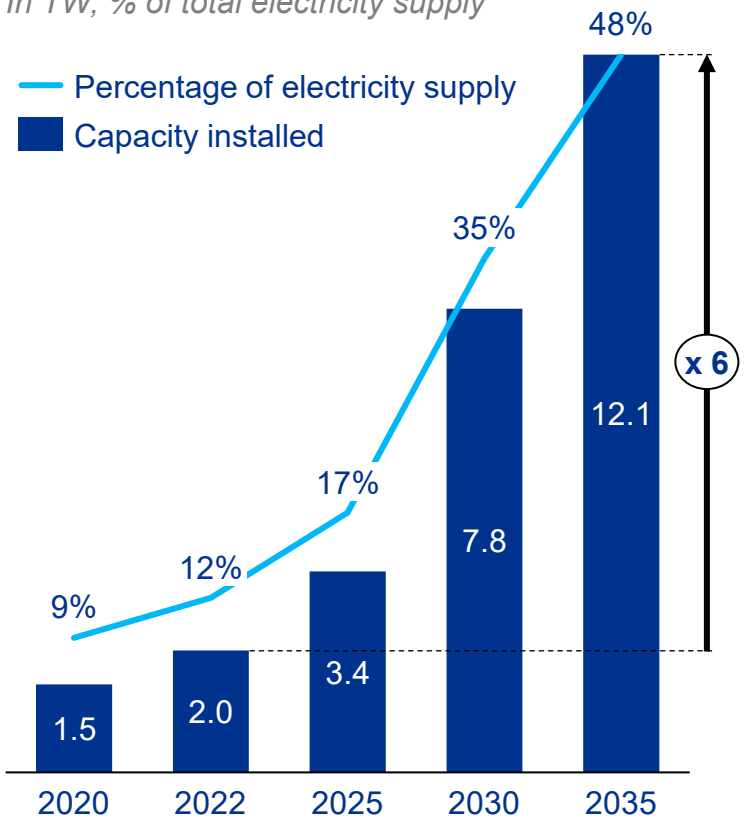
Expanding the range of applications and lowering LCoS

Sources: KPMG analyses

BESS are becoming necessary to mitigate the non-dispatchability and grid destabilization challenges inherent to RE

Global vRE (PV and Wind) forecasted evolution...

In TW, % of total electricity supply



…will create new challenges for grid operators

Balance supply and demand issues that are due to:

- **Non-dispatchability** of vRE
- **Decorrelation between production time** and consumer use time
- **Increased grid load** due to electrification trends (e.g., EVs)

Smooth intermittency resulting from:

- **Grid instability** due to non-controllable vRE generation factors (e.g., weather conditions)
- **Grid inertia reduction**

Make renewable energies more competitive:

- **Enhance forecast accuracy** regarding **future output**
- **Improve reliability** of RE projects
- **Create additional revenue streams** by selling electricity back to the grid during peak demand

Sources: IEA WOE2023 – Announced Pledged Scenario, KPMG analyses

Countries are pushing for the adoption of BESS through regulations that open up access to electricity markets and financial support

Non-exhaustive

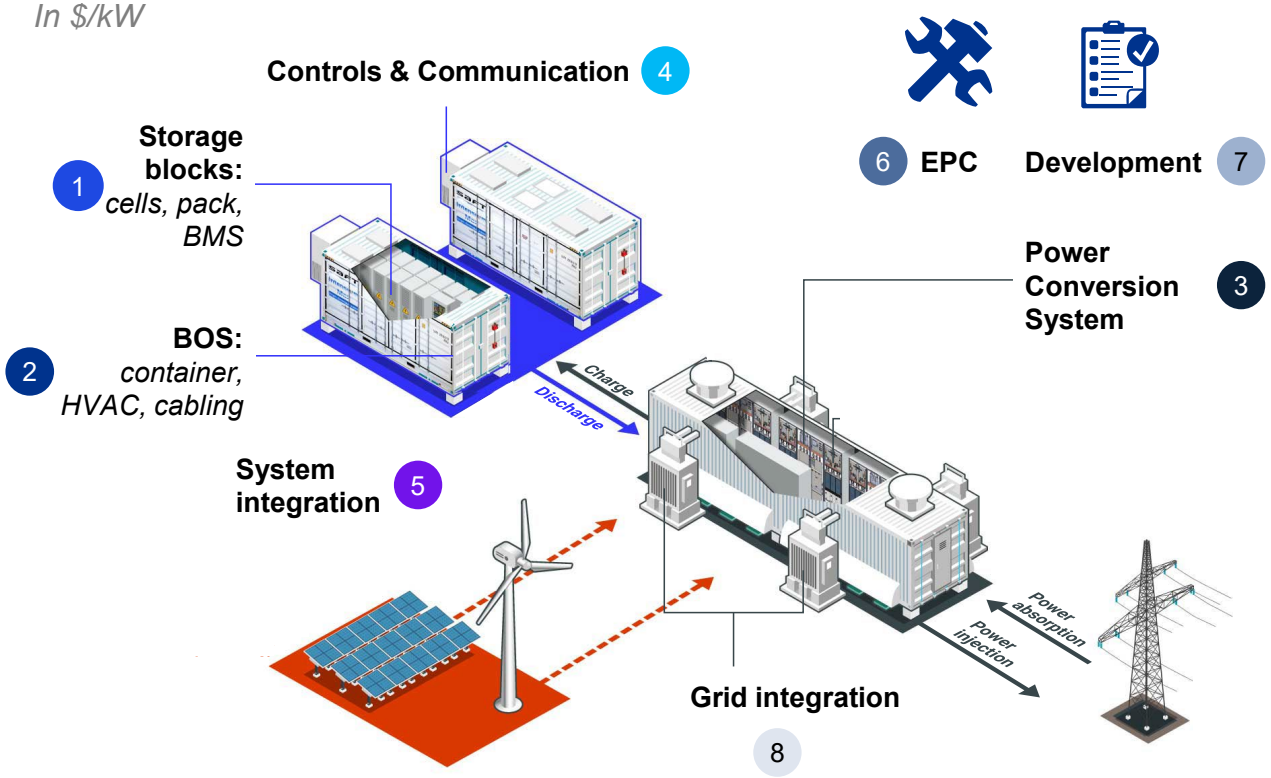
	2020 & prior	2021	2022	2023
China	**Environment Protection Law Amendment (2014):** providing environmental regulation	**14th Five-Year Plan: promoting ESS deployment** in conjunction with RE	**Notice Promoting Inclusion of ESS in the Power Market**	
European Union	**Clean Energy Package (2019):** defining ESS and **introducing them into the internal market for electricity**	**Horizon Europe:** R&D key funding program **Batt4EU:** Strategic Research & Innovation Agenda		**EU New Battery Regulation:** more stringent requirements for durability, safety, marking and second life of batteries
United States	**FERC Order 841 (2018): electric storage** to be **facilitated in the capacity, energy, and ancillary services markets**	**Bipartisan Infrastructure Act: investments in a domestic battery supply chain**	**Inflation Reduction Act:** financial support for clean energy solutions **American Battery Materials Initiative: securing supply**	
India		**National Program on ACC Battery Storage:** investment in **domestic battery production**	**Electricity (Amendment) Rules:** consideration of **ESS** as **part of the power system** **Battery Waste Management Rules**	**Mines and Minerals Amendment Act: strengthen critical materials exploration**

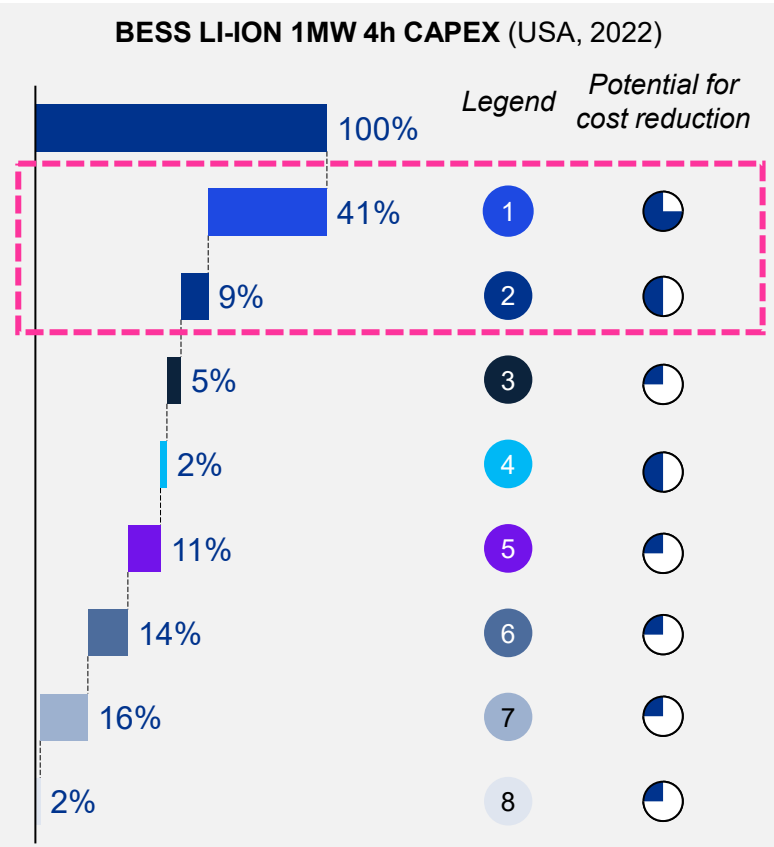
Texts related to
- Strategic guidance and financial support
- Support for R&D
- Mkt structuring
- Safety and environment

BESS total costs are expected to decrease, driven by savings from battery storage blocks (~50% of CapEx value)...

BESS Capex breakdown

In $/kW





Sources: expert interviews, TotalEnergies, NREL, KPMG analyses

Legend: Weak Moderate

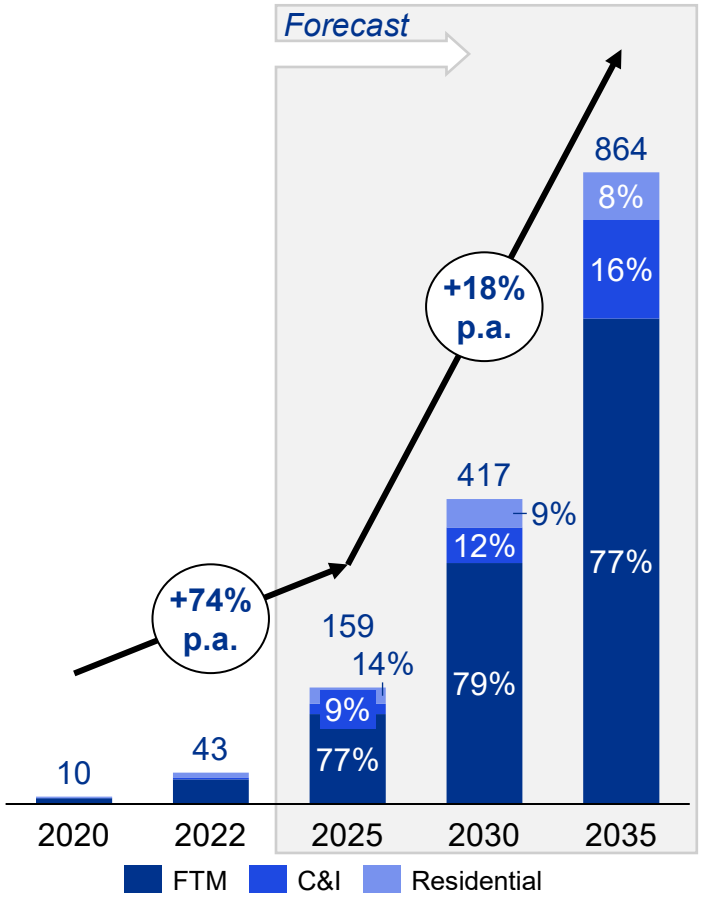
… while the existing application portfolio is expected to expand in the near future to address these challenges

		Adoption		
		Existing	**Emerging**	**Future**
	Generation support & bulk storage	• Arbitrage	• Storage services for RES support • Capacity firming • System electricity supply capacity • Minimization of RE curtailment • Support for conventional generation	• Seasonal arbitrage
	Transmission & Distribution	• Deferral of T&D grid upgrades • Dynamic local voltage control • Contingency grid support • Transmission support • Reactive power compensation • Intentional islanding	• Angular stability	
	Ancillary	• Frequency reserve (FCR, aFRR, mFRR, replacement) • Black start • Voltage support, load following	• Frequency stability of weak grids • Synthetic inertia • Fast frequency response	
	Bill management	• End user peak shaving • Time-of-use energy cost mgt. • Max. self-production & consumption		
	Backup power / micro-grid	• Higher power quality • Continuity of energy supply	• Limitation of upstream disturbances • Compensation of reactive power	
	EV	• EV infrastructure	• EV integration: vehicle-to-grid	

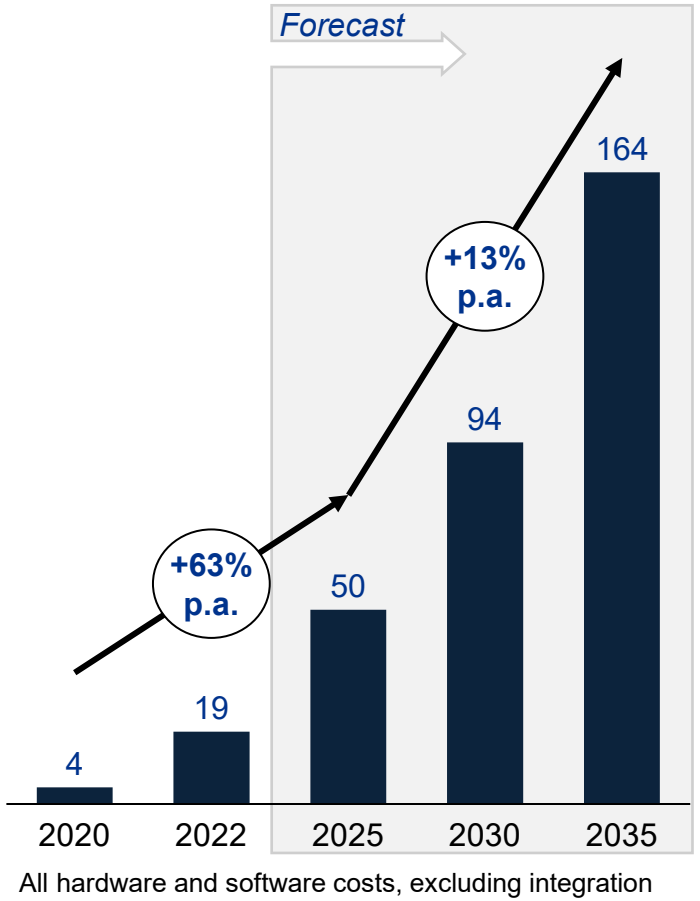
Sources: EASE, KPMG analyses

By 2035 the BESS market will reach ~865 GWh-yr in capacity additions and ~$165 billion in value

Global BESS yearly additions* [GWh]

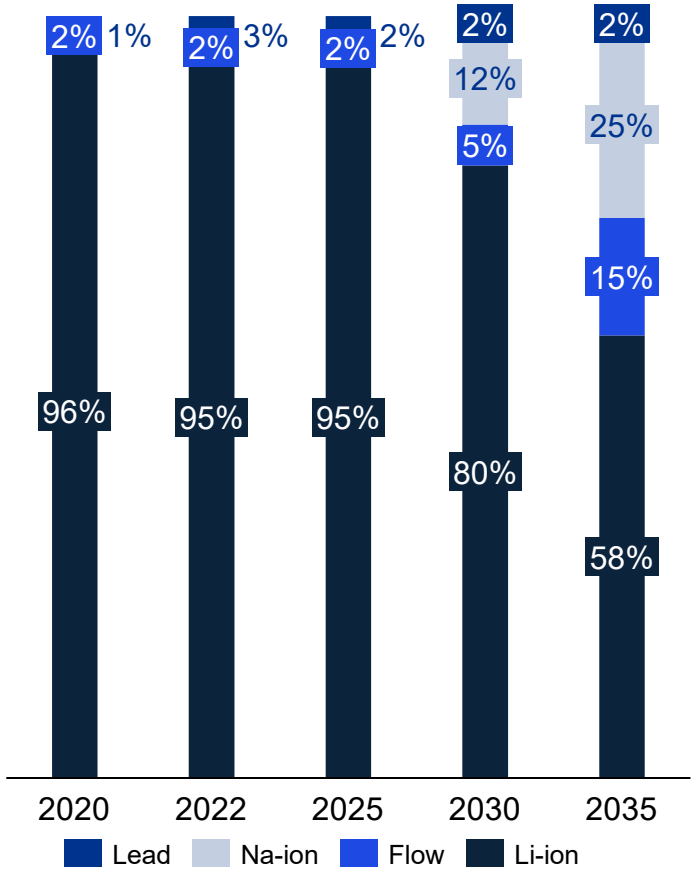


Global BESS yearly additions* [$bn]



All hardware and software costs, excluding integration and human costs

Breakdown by technology* [GWh]

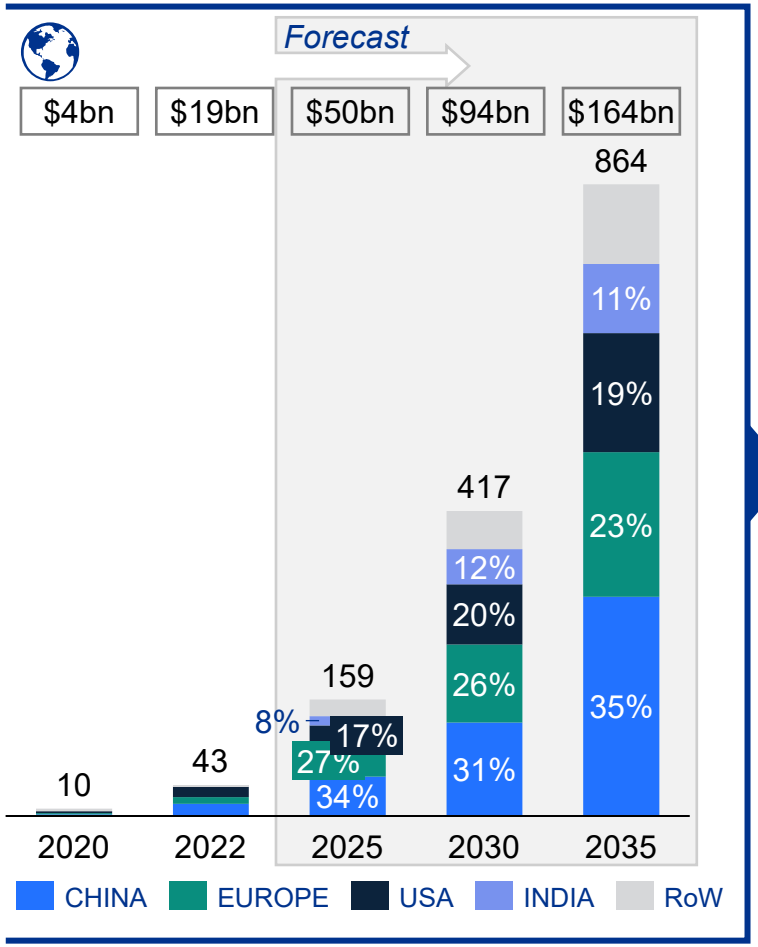


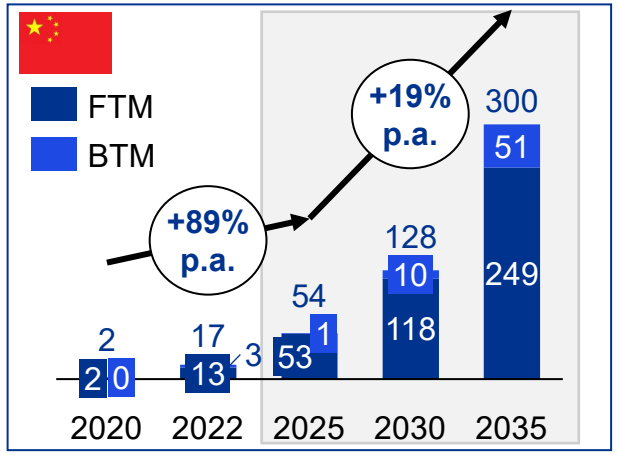
Sources: NREL, expert interviews, KPMG analyses

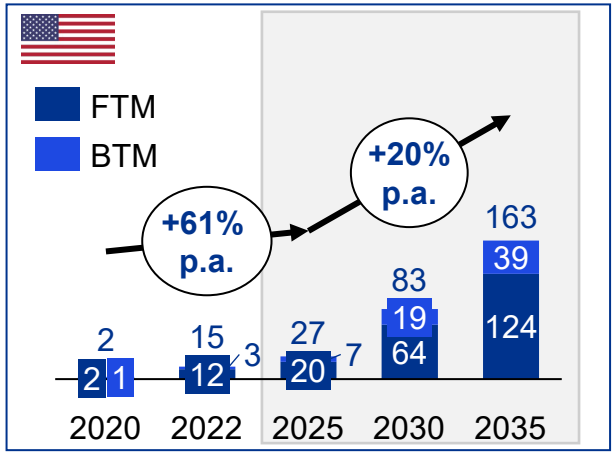
*Residential UPS-inverter market excluded, see appendix

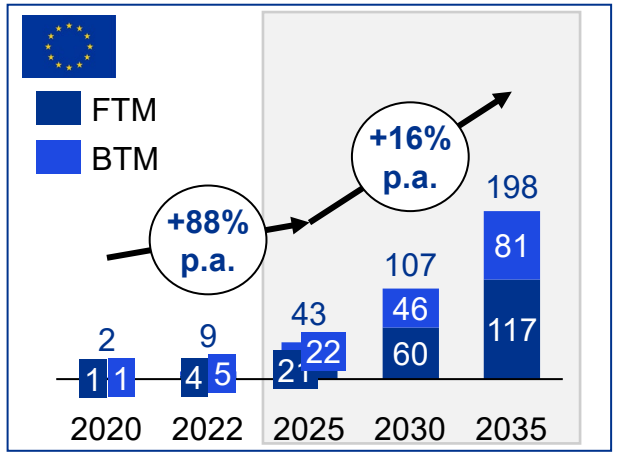
China, Europe, and USA should take the lion's share of the BESS market, while India is expected to become a major player by 2035

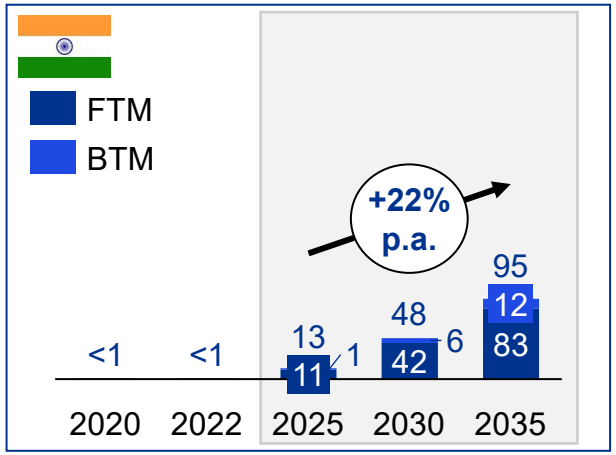
Global BESS yearly additions* [GWh]









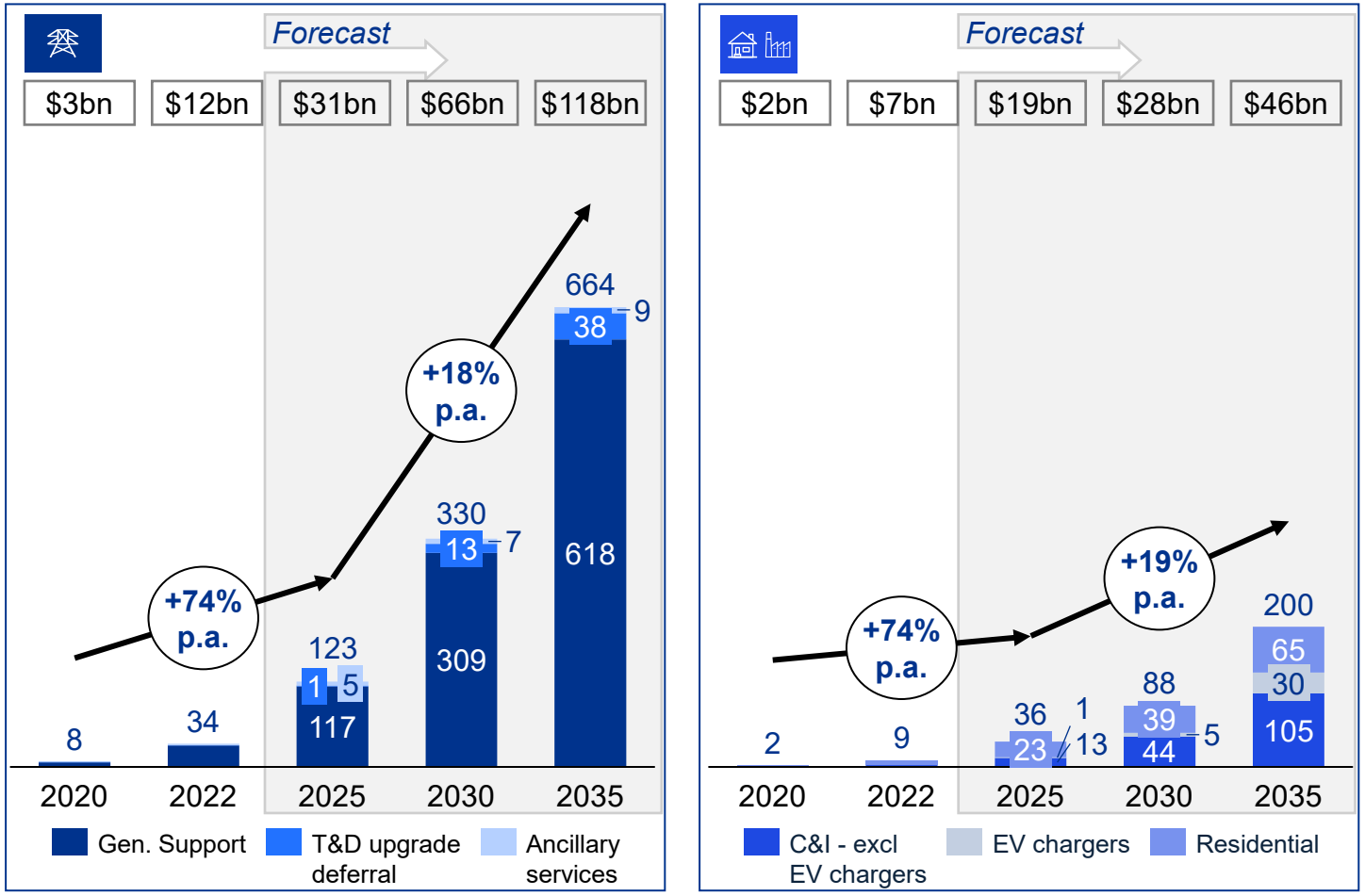


Sources: expert interviews, KPMG analyses

*Residential UPS-inverter market excluded, see appendix

Except the saturating ancillary services market, all market segments will enjoy a two-digit CAGR between 2025 and 2035

Global BESS yearly additions* [GWh]



Sources: desk research, Avicenne, KPMG analyses

KPMG Insights

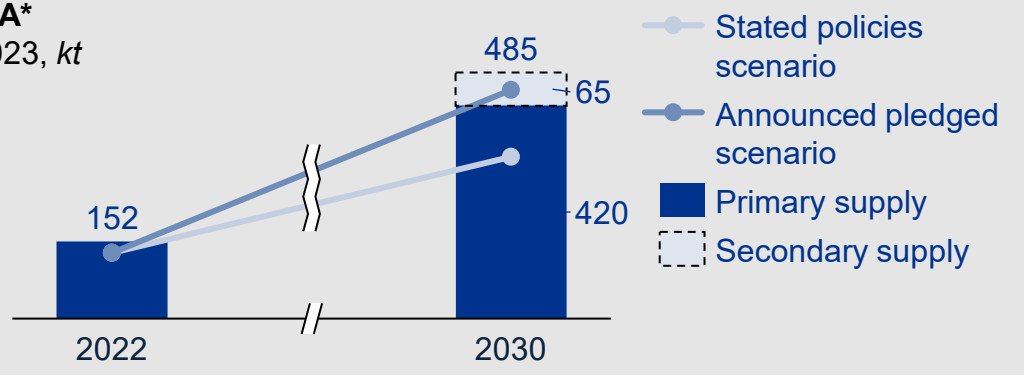
- **Generation support is expected to drive the overall growth of the market**, due to increasing RE penetration and volumes, and regulations that facilitate ESS access to electricity markets
- **Residential BESS will develop mainly in US and Europe** due to high, volatile electricity prices, pushing consumers towards bill management solutions
  - UPS-inverters* are excluded to remain consistent with other reports on BESS, despite important volumes in India (>100GWh-yr, mostly lead, see appendix)
- **BESS will promote the deployment of EV fast chargers**, allowing for deferral of costly grid upgrades and cutting electricity bills by limiting demand charges
- **The ancillary services market is structurally going to saturate.** BESS bring service revenues down as they penetrate the market, and required capacities for frequency regulation are tight

*Residential UPS-inverter market excluded, see appendix

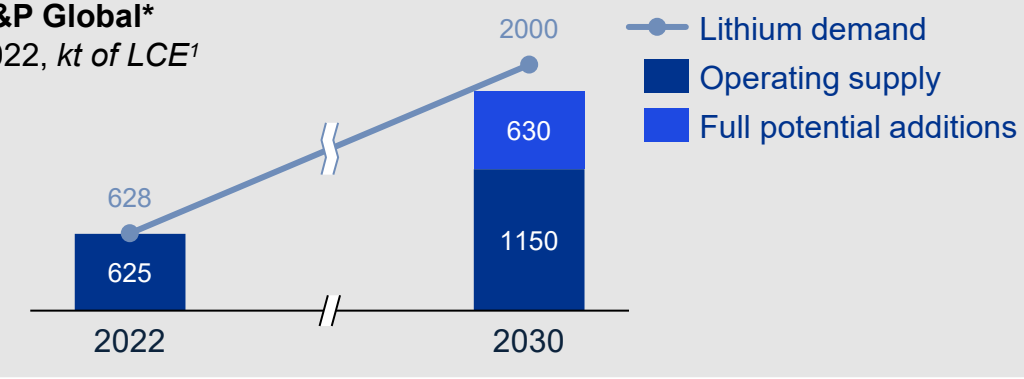
The unprecedented growth in demand for lithium can only be met if new projects are developed to double supply by 2030…

Lithium supply and demand scenarii for 2030

IEA*
2023, *kt*



S&P Global*
2022, *kt of LCE*[1]



KPMG insights

- **Multiple studies stress the risk of a lithium supply deficit by 2030**
  - The ability to meet demand may depend on the ability to provide secondary sources of lithium (e.g., recycled lithium batteries) and on the success of mine projects under way
  - With the recent reduction in EV forecasts and the unexpectedly quick advancement of some mining projects, some recent scenarios on the capacity to supply enough lithium to the market are more optimistic – but **the margin remains tight**
  - Since 2020, BESS studies have kept getting more optimistic regarding final demand by 2030, and could potentially increase total demand
- The supply of this key resource remains at risk by 2030, with a non-negligeable probability of deficit
- In addition, **the concentration of refined lithium production in China may become the main market bottleneck due to geopolitical conflicts**

(1): Lithium Carbonate Equivalent
(*) S&P Considers a scenario with 27m units of EV sold by 2030, while IEA SPS and APS scenarios consider respectively 40m and 45m yearly sales

Sources: IEA, S&P Global, KPMG analyses

...resulting in strained lithium supply, amplified by present and upcoming project delays likely to cause bottlenecks

Main reasons for lithium bottlenecks

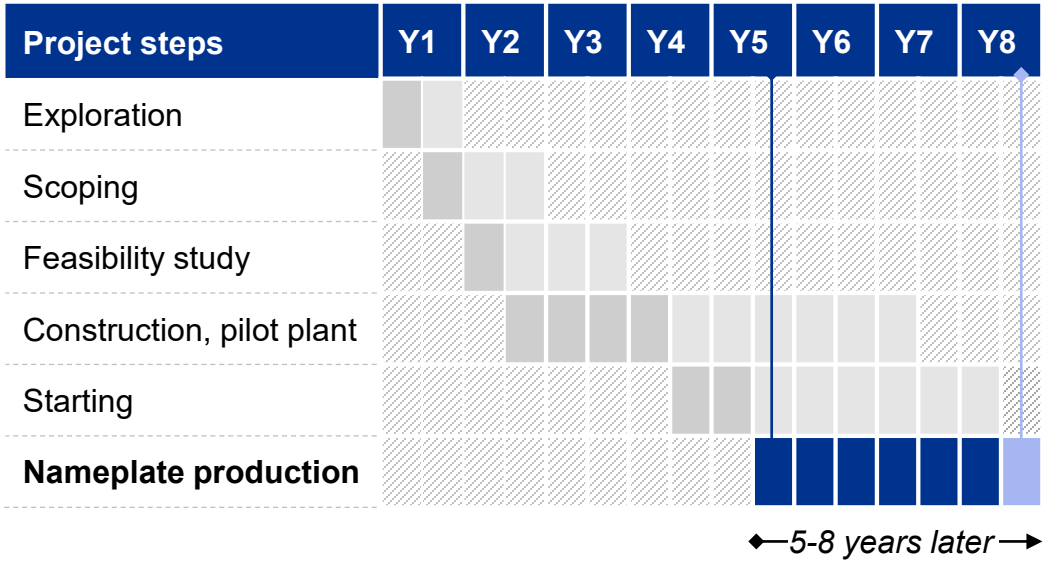
Production concentration
- Lithium extraction and refining geographically concentrated
- Limited number of companies converting lithium products

Price volatility
- Delayed planned expansion projects for smaller companies
- Simultaneous boom of supporting battery sales

Stricter environmental regulation
- Increased need to address lithium mining hazards
- Increased need to track carbon footprint of batteries

Global logistics dependence
- Limited possibilities for integrated players in the supply chain
- Higher trend towards domestic battery manufacturing

New mining projects take time before operation



Delayed mining projects will lead to sourcing strains

- In 2030 mining will remain heavily concentrated in **Australia** with ~40% of global lithium extraction (**world's largest lithium ore deposit**) and **Latin America's** 'lithium triangle' accounting for one third of raw lithium production (**world's largest lithium brine deposit**)
- **Delayed new exploration projects are bound to worsen the supply shortage** with a 5- to 8-year gap between early-stage development and mining operation, possibly culminating in the failure to achieve a 100% increase in lithium production for 2030

Sources: S&P Global, desk research, KPMG analyses

From a supply perspective, BESS manufacturers should anticipate potential refined lithium shortages and remediation strategies

Potential upcoming lithium scarcity increases risk of BESS price surge

- Up to **40% of total BESS CapEx is linked to battery cell cost**
- The anticipated future strain on lithium, the primary component of battery cells, could **prevent BESS prices from stabilizing** and **potentially drive costs up**

> "There might be a **refined lithium bottleneck**, due to geopolitical concerns"
>
> **Head of ESS project development at TotalEnergies**

Expected consequences

BESS development is tied to ability to maintain low costs

- Since BESS are a common driver across various applications, **an increase in BESS prices could significantly hurt their future rollout**, despite the fact that they are needed to integrate more renewables
  - According to our model, a **5% increase in CapEx might result in a 14% drop in yearly total additions of generation supporting BESS**

> "The market **will boom as soon as BESS costs are low enough**"
>
> **CEO of Advanced Battery Concepts**

Lithium will be prioritized for EVs where its properties may be most needed

- The **technical properties of lithium**, such as **volumetric and gravimetric energy** paired with performance, make it an ideal candidate for EV, with few alternatives currently available
- **Lithium will mainly supply the EV market** due to higher volumes (~3TWh in 2030 vs 0.4TWh) and a lack of substitutes

> "In **a high EV demand** scenario, we will need to **prioritize the allocation of lithium**"
>
> **Director of CHR Metals**

The lithium shortage will translate into opportunities for other technologies, challenging the current overdominance of lithium

Sources: desk research, expert interviews, KPMG analyses

Consequently, battery manufacturers have numerous opportunities in this transforming market

Some are technology-agnostic…

Develop integrated systems to serve the market with turnkey solutions

Demonstrate value compared to established technologies (e.g., lithium) via demonstrators or use cases

Offer sustainable solutions, while securing the supply of raw materials

Forge strategic partnerships for large-scale production deployment

…while others are technology-specific…

3 Li 6.9

Benefit from the development of the sector from EV (e.g., supply chain) to **continue to grow BTM & FTM**

82 Pb 207.2

Develop **Behind-the-Meter** applications (particularly **EV infrastructure**) and in **emerging economies**

11 Na 23.0

Compete with lithium batteries FTM and BTM due to similar properties, higher availability of materials, and superior safety

23 V 50.9 30 Zn 65.4

Benefit from increasing need for long-term storage and from favourable policies in China **to develop generation support applications**

…and need to overcome challenges

Secure raw material sourcing and lower LCoS

Decrease LCoS through R&D (e.g., cycle life extension, DoD)

Enter development phase, extend cycle life and lower LCoS

Secure a sustainable supply of vanadium, or develop flow batteries relying on other materials

Sources: desk research, expert interviews, KPMG analyses

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

Geographic 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**

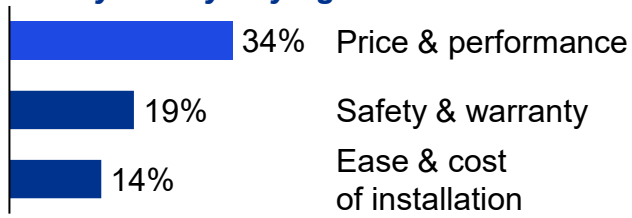
Leverage recyclability

- **~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

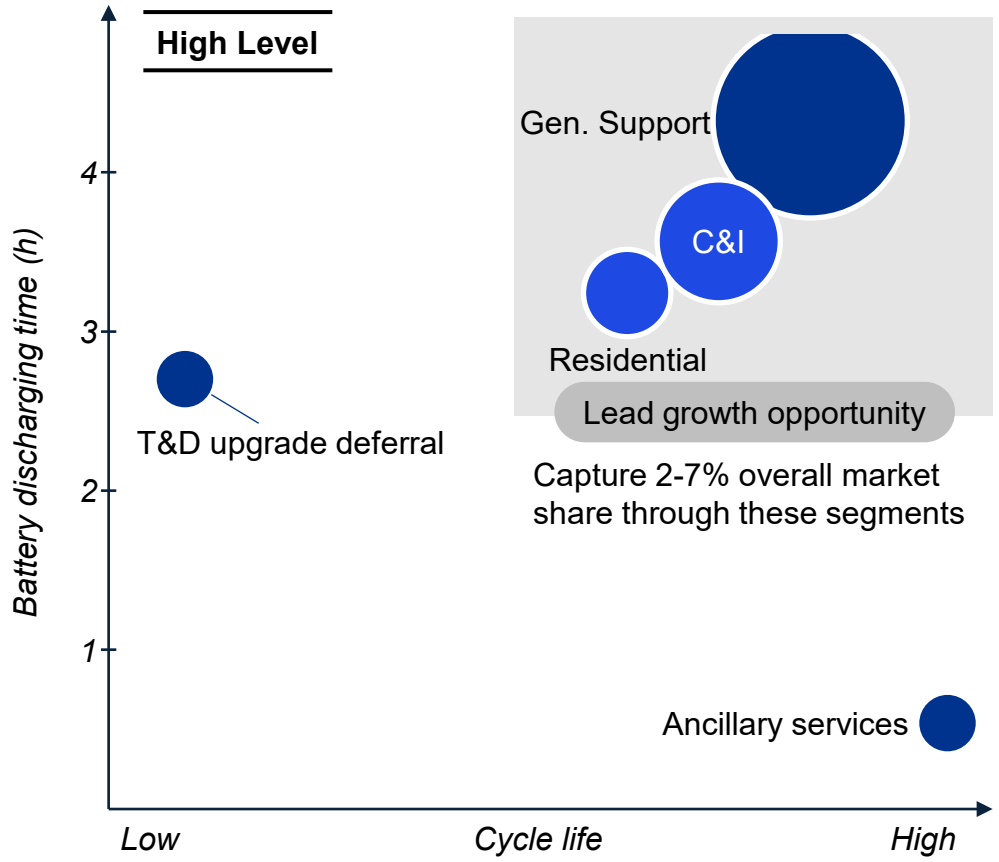
> "**Customers are simply looking for** solutions that foster **profitable projects**"
>
> **Director of Hoppecke**

Sources: McKinsey, desk research, expert interviews, KPMG 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



Capture 2-7% overall market share through these segments

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

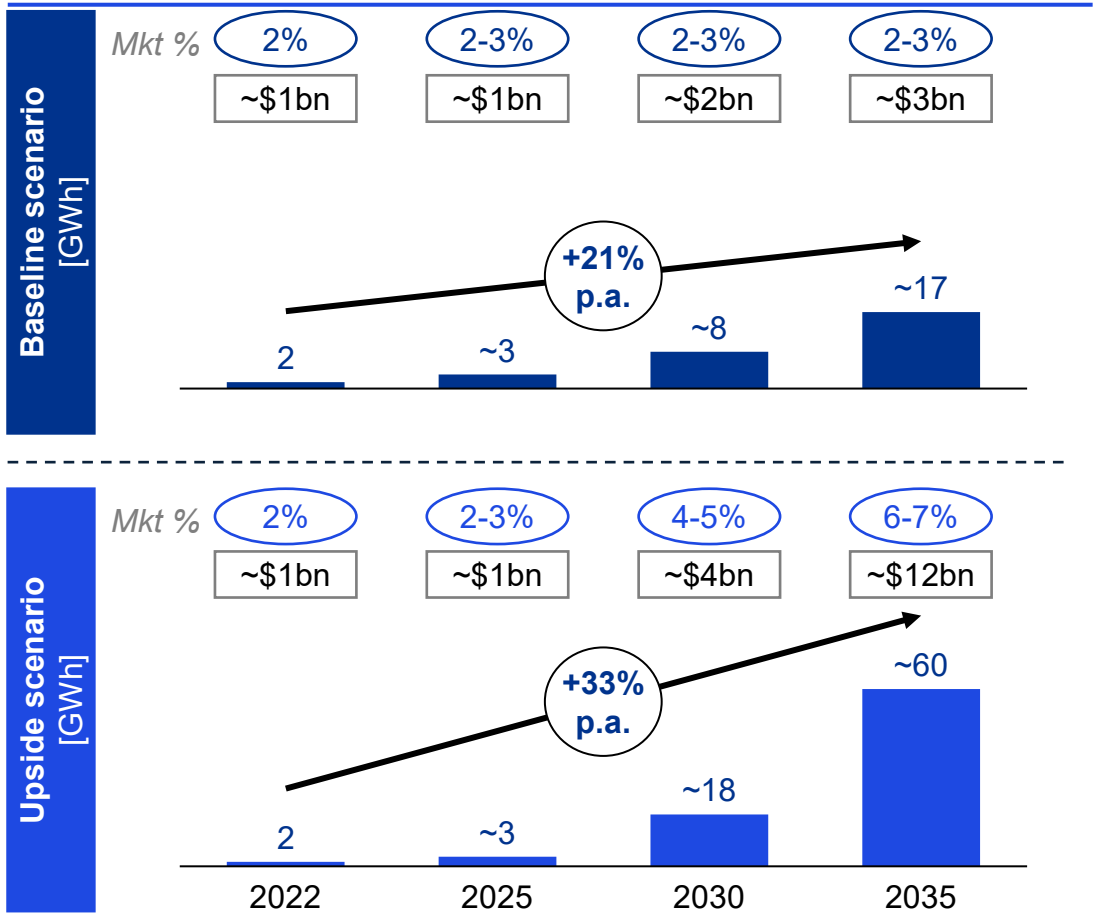
Sources: desk research, KPMG analyses

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 key markets:
  - **Behind-the-Meter,** particularly in **EV infrastructure**, lead batteries can take their place as genuine market competitors. By 2035, lead batteries could secure up to 30% of the EV infrastructure market, and has the potential to secure more than 30% of yearly new additions in other BTM applications in emerging economies
  - In **emerging economies**, particularly India, lead batteries can be adopted to support the deployment of **utility-scale** RE against a backdrop of rising temperatures
- 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 analyses

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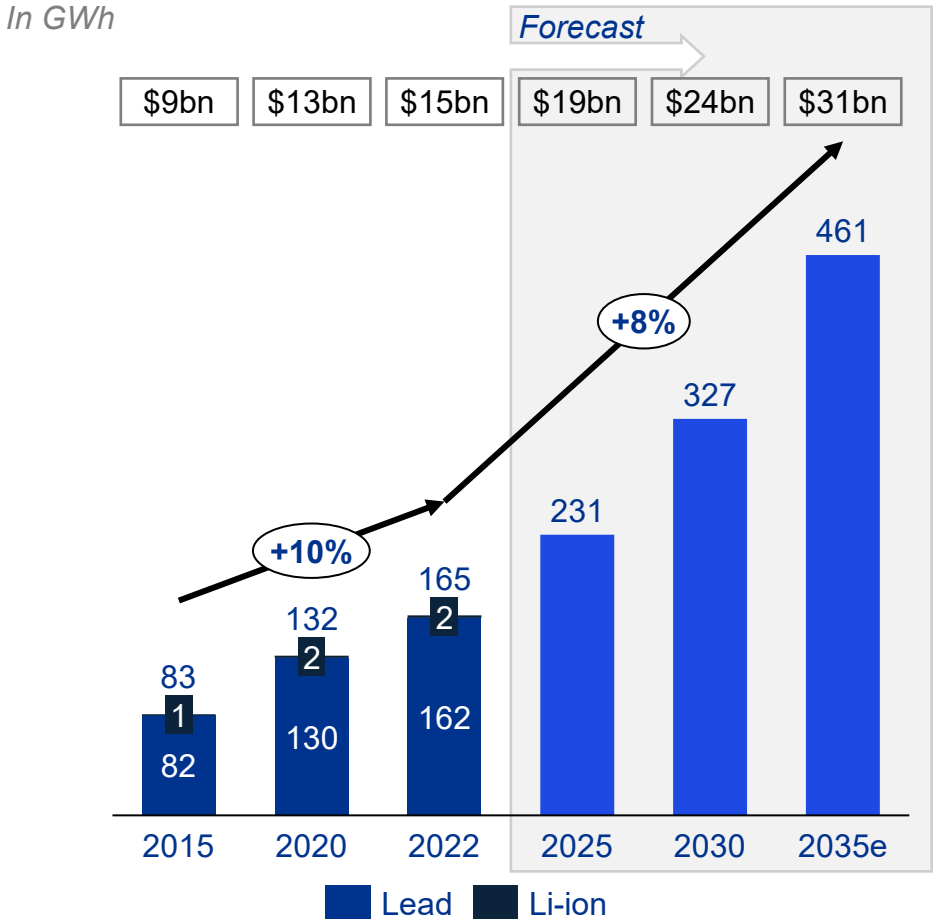
Behind-the-meter, residential UPS-inverters: a mature market, mostly comprising lead batteries in India

Residential ESS forecast according to Avicenne (incl. UPS-inverter)



Sources: Avicenne, KPMG analyses

KPMG insights

- In addition to the BESS capacities modelled in this study, the stationary energy storage market can be linked to the domestic UPS-inverter segment, with batteries serving the sole purpose of backup power
  - According to a report for CBI by Avicenne, **the UPS-inverter market is already mature**, with more than 82 GWh installed in 2015, mostly comprising lead batteries in India
  - **We expect the market to continue developing** in regions with high electrification needs and poor grid quality, although some capacities will be replaced by BESS
- In this report, **we excluded the UPS-inverter market from the definition of BESS for several reasons**
  - **Lack of consensus** regarding the definition of BESS and its overlap with UPS-inverters
  - **Limited use cases:** BESS tend to have multiple functions, whereas UPS-inverters serve only one application
  - **Difference in market maturity:** the BESS market is emerging while the UPS-inverter market is already mature

Across geographies, regulatory bodies act in four main areas

Market structuring

- **Regulating electricity transmission & wholesale**
- Fostering **fair, effective competition**
- **Approving** and **inspecting projects**
- Protecting **system reliability**
- **Monitoring** & **investigating energy markets**
- **Enforcing regulatory requirements** (e.g., exacting civil penalties)

Support for R&D

- Granting **government subsidies** (e.g., loans, investment programs)
- Undertaking **demonstration programs** to test and validate the efficiency of BESS technologies
- Entering into **partnerships** to accelerate the dissemination of technologies

Energy policy strategy & development

- Decisions related to the **energy mix** (e.g., development of renewable energy projects versus fossil-fuel projects)
- Setting up **national** or **state-level objectives** in **energy storage installation**
- **Strategic plans** and **funding to structure domestic production and enhance national competitiveness**

Safety & environmental regulations

- Establishing **performance** and **safety standards**
- Establishing **environmental standards** (e.g., waste management, battery recycling)

Sources: desk research, expert interviews, KPMG analyses

Regulatory frameworks stem from national economic and geopolitical challenges

Overview of the regulatory frameworks of key geographical areas

China

- As the **global leader in energy storage,** a position under threat from the US and EU's quest for independence, China has **actively enacted regulations** anticipating tensions (e.g., supply of critical raw materials) that could slow down the country's capacity to meet its **major installation targets**
- Central institutions (e.g., National Development and Reform Commission) shape the regulation, while **local governments implement** and adapt it **with a notable degree of freedom**

European Union

- Having to **catch up with superpowers** in an era of climate change, the EU rolled out multiple regulations and initiatives to strengthen its supply chain and overcome its dependence on critical materials, while aiming for **leadership on environmental topics**
- EU-level regulatory bodies (e.g., the European Commission, ECHA) are the key players that enact regulations, while Member States are responsible for implementing and adapting them within the **limits of the single market principle**

United States

- Faced with the challenges of **climate change** and **geopolitical competition** with China, the US made significant adaptations to its regulatory framework over the last decade
- Key regulatory bodies are the following: federal and state-level commissions, governments, environmental agencies, national labs – with **federal entities setting the minimum requirements** and state entities being free to implement more ambitious policies (e.g., California)

India

- Having to catch up with superpowers to ensure **national development**, India rolled out several regulations and initiatives to develop its energy storage manufacturing capacity and strengthen its position in the supply chain to overcome its dependence on critical materials
- Key regulatory bodies at central level (e.g., electricity authorities, ministries) are **harmonizing legislation while empowering states** to set stricter regulations (e.g., State Pollution Control Boards)

Glossary

Abbrev.	Definition
ACC	Advanced Chemistry Cells
aFRR	Automatic Frequency Restoration Reserve
BESS	Battery Energy Storage System
BTM	Behind-the-Meter
C&I	Commercial and Industrial
CAGR	Compound Annual Growth Rate
CAPEX	Capital Expenditure
DoD	Depth of Discharge
ES	Energy Storage
ESS	Energy Storage System
EU	European Union
EV	Electric Vehicle
FCR	Frequency Containment Reserve

Abbrev.	Definition
FERC	Federal Energy Regulation Commission
FTM	Front-of-the-Meter
KPI	Key Performance Indicator
LCoS	Levelized Cost of Storage
mFRR	Manual Frequency Restoration Reserve
PV	Photovoltaic
R&D	Research and Development
RE	Renewable Energy
RES	Renewable Energy Source
T&D	Transmission and Distribution
TSO	Transmission System Operator
US	United States
vRE	Variable Renewable Energy