



REPORT SAMPLE

ESS Price Forecasting Report

Q1 2024



ESS Price Forecasting Report

Ongoing supply chain issues, changing global market dynamics, and the rising demand for energy storage solutions are leading to challenges for buyers of energy storage system (ESS) equipment. To navigate this complex landscape, companies need a reliable tool to predict future cost and pricing trends. This is the driving force behind Clean Energy Associates' ESS Price Forecasting Report (PFR).

Released quarterly, the ESS PFR offers a comprehensive four-year cost and pricing outlook for Lithium Iron Phosphate (LFP) and Nickel Manganese Cobalt (NMC) battery containerized systems. This report is grounded in leading technology and material platforms, and it incorporates vital data on input material price and supply outlooks, market bottlenecks, and demand analysis to support its cost and price forecasts.

The ESS PFR is a crucial resource for decision-makers aiming to make well-informed choices in the ever-evolving energy storage industry. With detailed insights into containerized system price stacks, including forecasted "all-in" pricing and baseline price outlooks tailored to specific markets, subscribers are equipped with the knowledge they need to stay ahead.

In this report you will find:

- **Cost & Pricing Outlook:** Four-year forecast for battery cell, DC container, and lithium pricing
- **Market Analysis:** Insights into supply, demand, and market bottlenecks.
- **Cost and Price Stacks:** Detailed "all-in" cost and pricing breakdowns.
- **Data-Driven Accuracy:** Proprietary methodologies backed by CEA expertise.

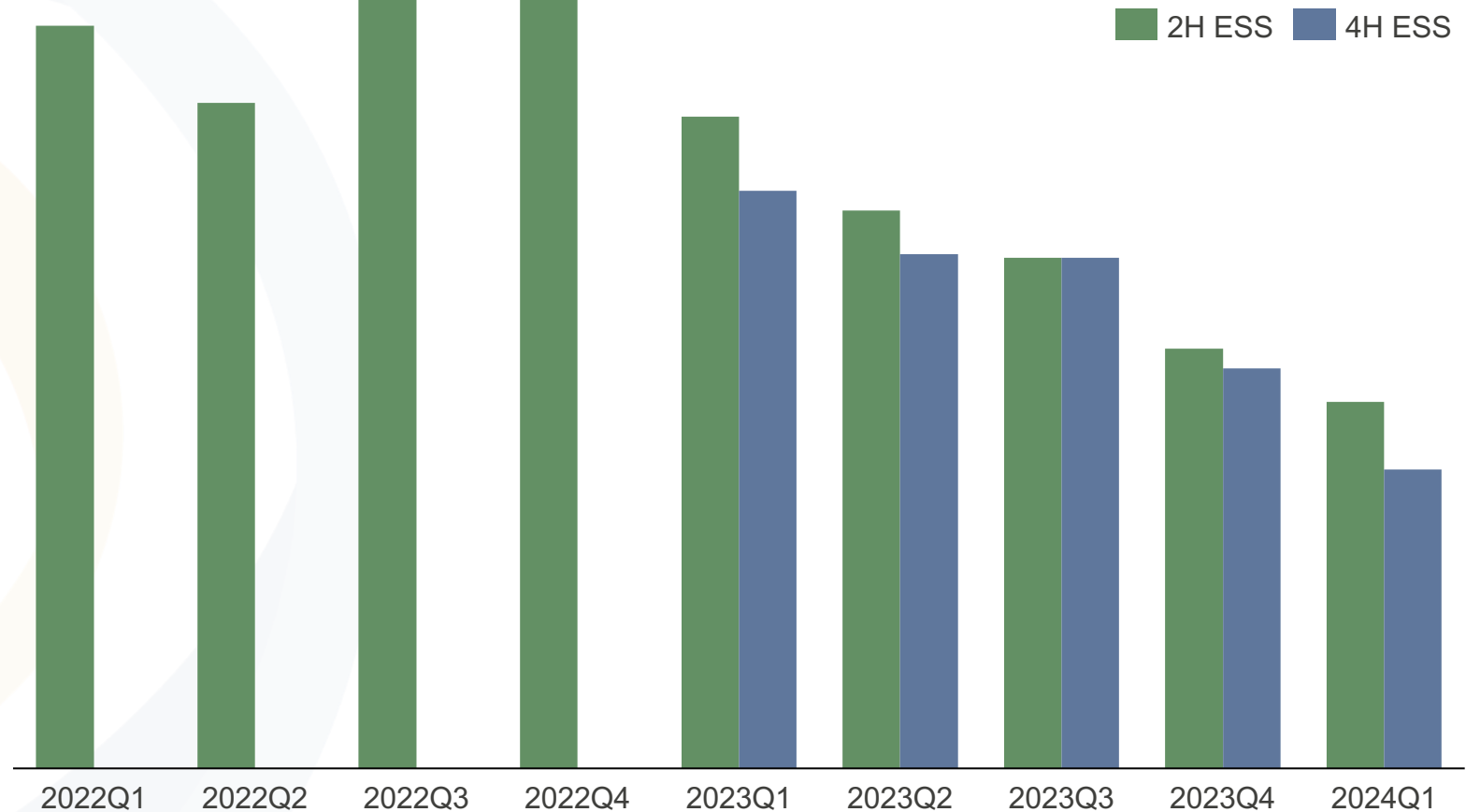
China ESS prices continue downward trend

Declining raw material prices, intensified competition, and technological innovation

What changed?

- ESS-related companies in China are proliferating, with 17,000 domestic energy storage-related companies registered in Q1/2024.
- The core driver of this proliferation is that most Chinese provinces mandate that wind and solar projects be paired with BESS to accommodate increasing levels of intermittent renewable energy.
- Despite the well-intentioned mandate, Woodmac reported in Q2/2024 that the utilization rate of grid-scale Chinese BESS projects in 2023 was only about 30% of designed hours.
- As is common in many maturing markets, there is a fundamental issue with public policy mandates having unintended consequences, and this appears to be the case in the Chinese BESS sector.
- Developer buying criteria in China is often price driven, but in this case, a lack of a viable power market redesign plan will hamper revenue generating opportunities for BESS installations
- The result is fierce competition, resulting in a rapid reduction in prices reported in public bids.

China 2H and 4H DC ESS quarterly weighted average price (US\$/kWh)

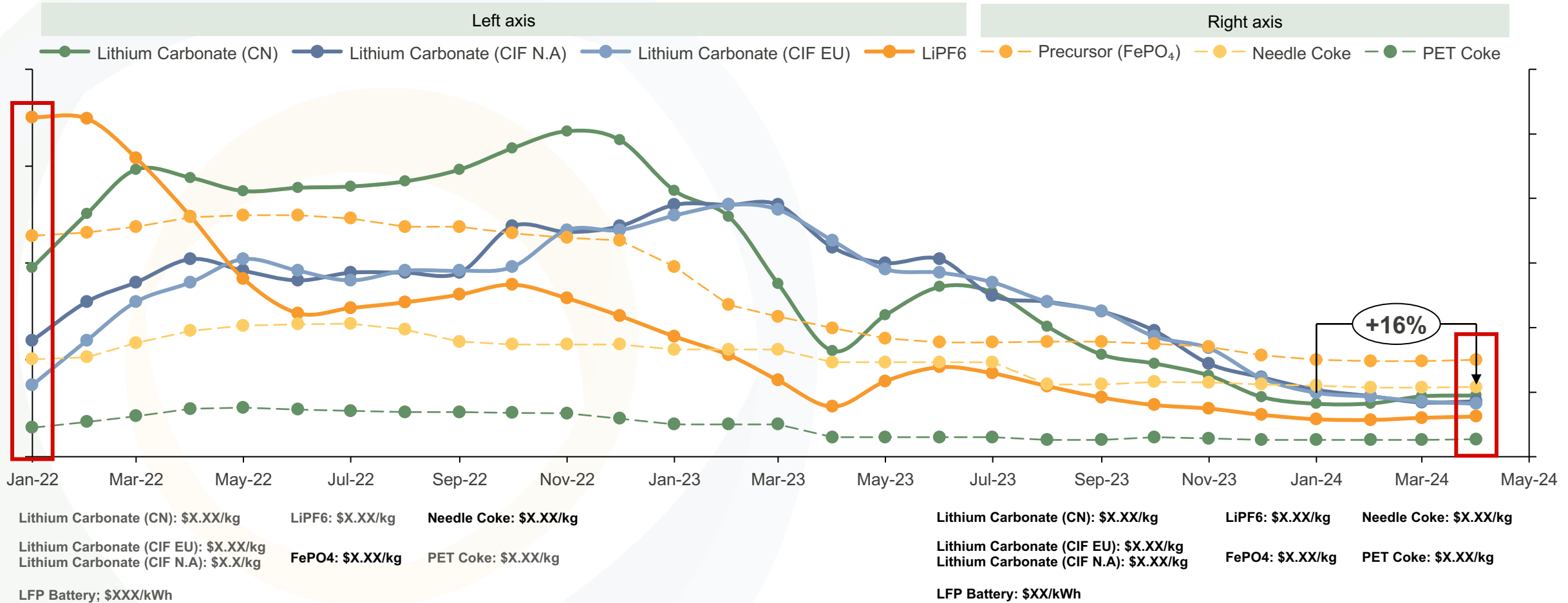


Notes | Scope of supply includes DC container price for the Chinese market.

Upstream raw material prices reach lowest levels since 2021

Q1 2024 lithium rally was short lived, signs point to continued price weakness

China LFP battery upstream material price, and US and EU lithium carbonate prices (\$/kg)

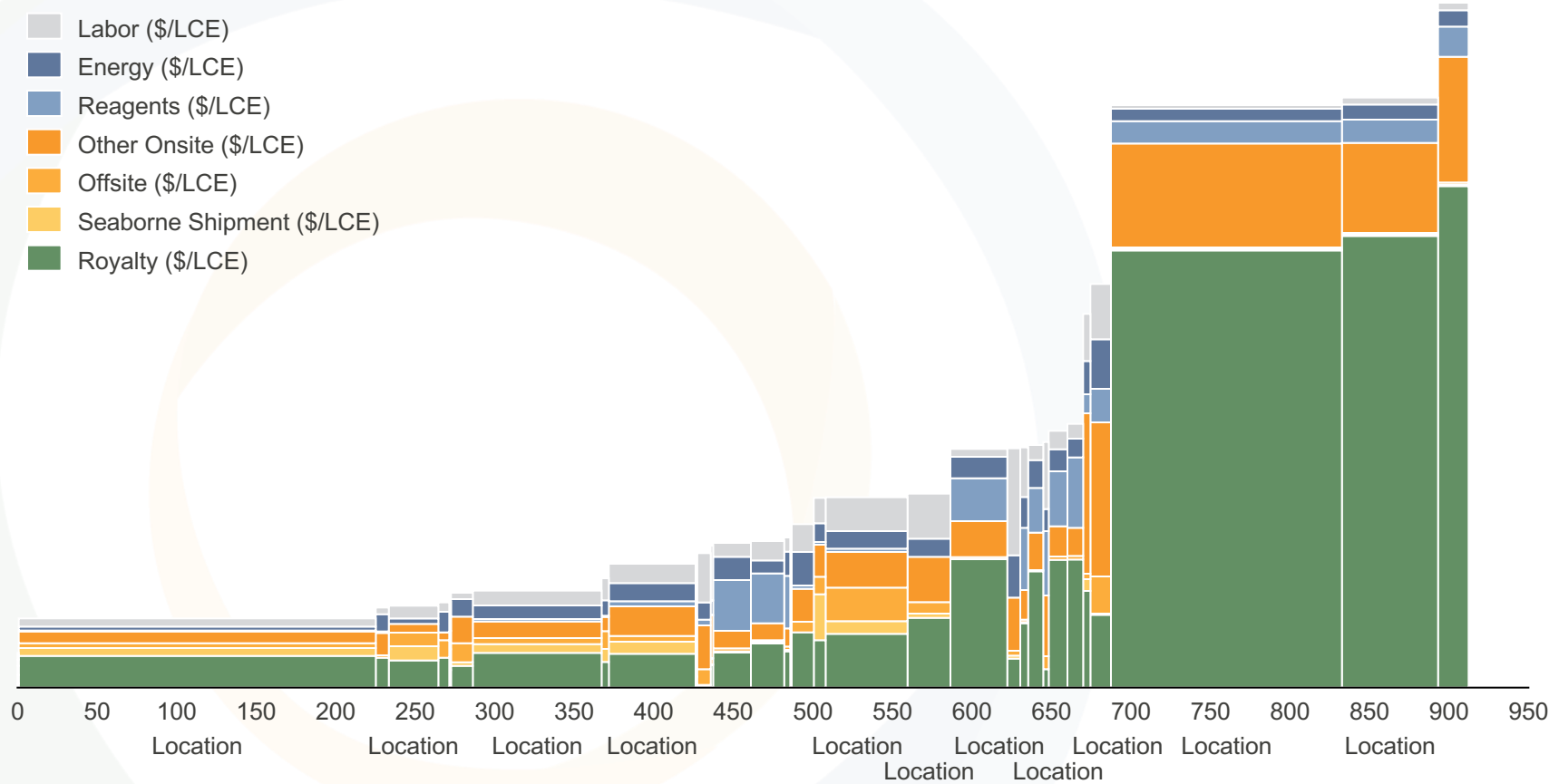


Notes | The spot prices are observed from SMM. Lithium Carbonate prices (CIF Europe) and Lithium Carbonate prices (CIF N.A) provided by Benchmark Minerals

The weighted cost of lithium in 2023 was \$9.72 /kg LCE

Utilizing salt lakes for lithium extraction necessitates substantial royalties

2023 lithium supply stack (,000 t v \$/kg)



- Lithium mine expansions in Australia have the potential to dramatically increase production with projects like Wodgina and Pilgangoora planning long-term capacity outputs of up to 1 million tons per year.
- Benchmark Minerals and S&P Global have stated that African lithium mine capacity will increase dramatically in 2024, with projects like Bikita adding more low-cost supply to the market.
- The lithium industry chain is transforming global to local. The US and the EU have implemented localized battery supply chain requirements. To meet these demands, significant investments are being made in new mine excavation.
- Despite the current surplus, the lithium industry remains optimistic. competition has intensified, resulting in lower gross margins for lithium producers.

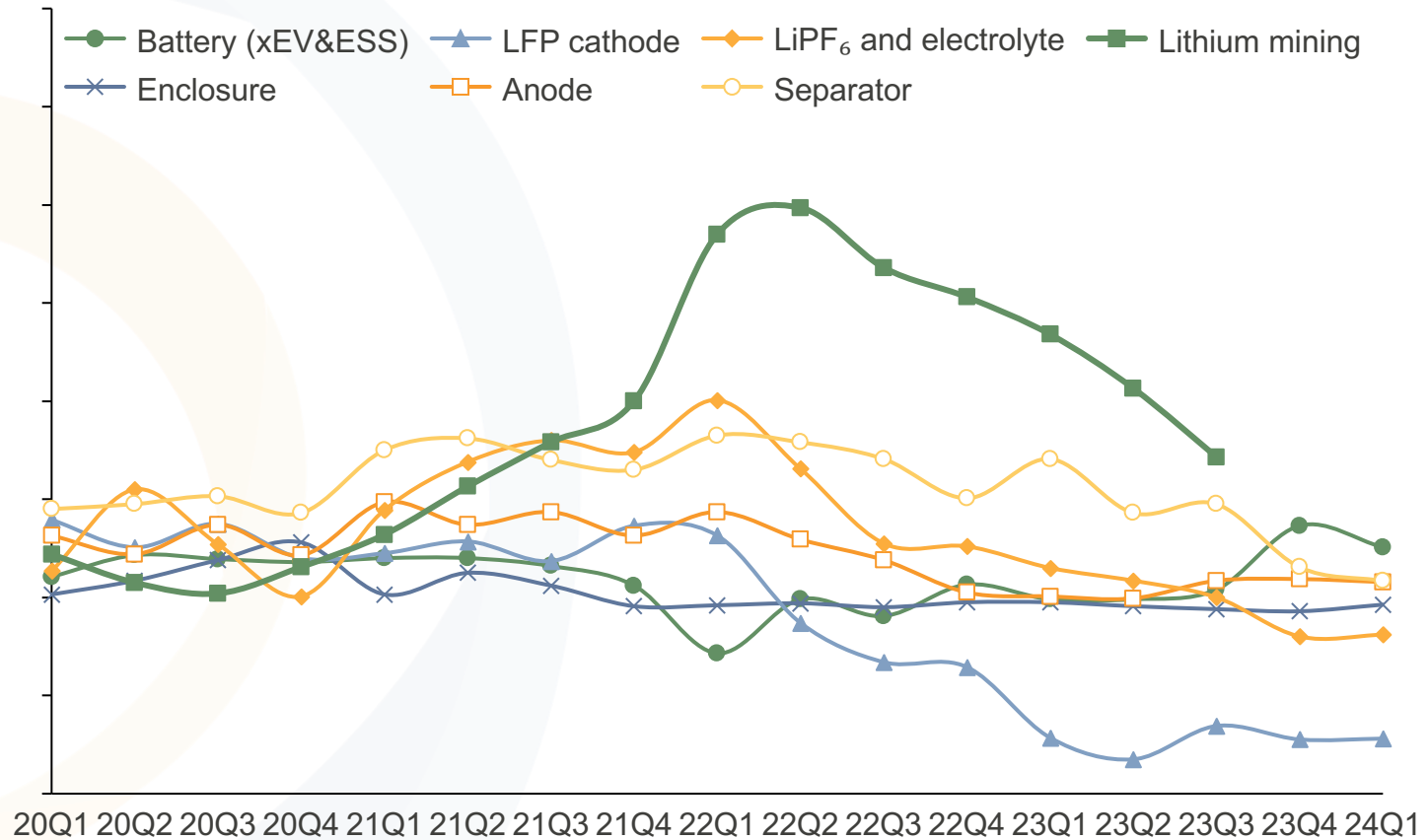
Notes | Data derived from S&P Global Mine Economics

Gross profit decline is the main trend of the lithium industry chain

Midstream and downstream supply chains are facing serious overcapacity

- Structural long-term demand for lithium remains intact, though margins are down YoY, they are still well above 2020 levels.
- Capacity ramping occurred most rapidly in the LFP cathode active materials (CAM) and anode active materials (AAM) sections of the upstream value chain, and oversupply has become extreme.
- It is feasible that chemical converters lose all pricing power and turn towards cost/plus tolling agreements similar to what is done on the PV wafer market.
- The downstream supply chain has maintained margins as a result of increased buyer power.
 - CATL, BYD and LG have commanding positions and make up over 65% of global LIB cell market share alone.
 - Battery suppliers able to beat down overextended midstream supply base.
- The separator market is far more difficult to crack with technology differentiation limiting margin compression.

BESS supply chain gross profit margin (%) trends (2020-2023)



- Battery -X.XX%pts
- Enclosure -X.XX%pts
- LFP cathode -X.XX%pts
- Anode -X.XX%pts
- Electrolyte -X.XX%pts
- Separator -X.XX%pts
- Lithium mining -X.XX%pts

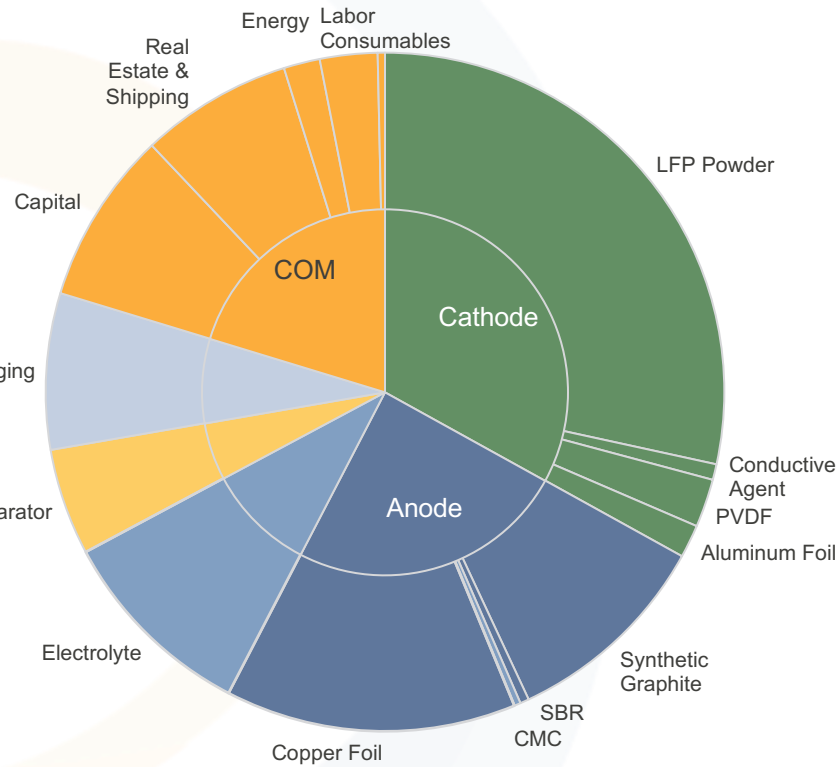
Notes | The gross profit margin for the lithium battery supply chain is derived from the weighted average of financial reports provided by major publicly listed companies.

LFP and NCM pricing converging following lithium price collapse

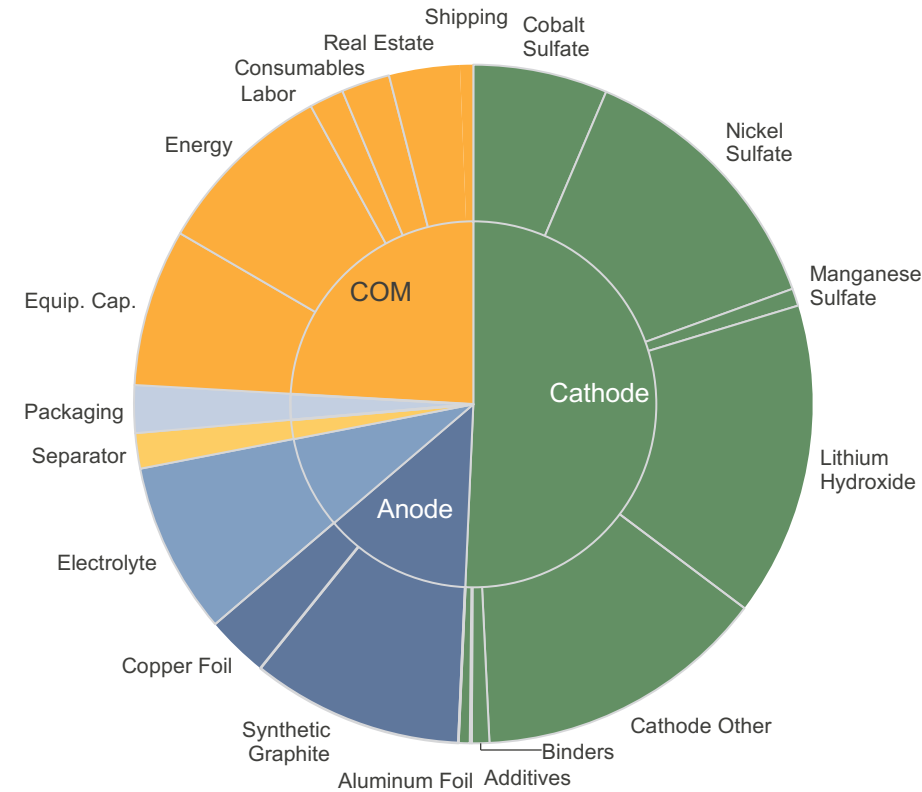
Cobalt markets have also weakened, contributing to lower NCM prices

- LFP batteries are safer, cheaper and boast a longer life span compared to NMC, making them ideal for ESS.
- NCM traditionally boasts a price premium on a US\$/kWh basis given its higher energy density and exposure to both lithium and cobalt markets.
- However, the convergence of lithium carbonate (LFP powder) and lithium hydroxide prices, along with a collapse in global cobalt prices has contributed to a price convergence among the two technologies.
- A lingering lithium surplus coupled with a desire to reduce/eliminate the use of cobalt in LIBs will likely maintain the limited price differential between LFP and NCM cells.

China LFP battery cell cost, 2024 (\$/kWh)



China NCM 523 prismatic battery cell cost, 2024 (\$/kWh)

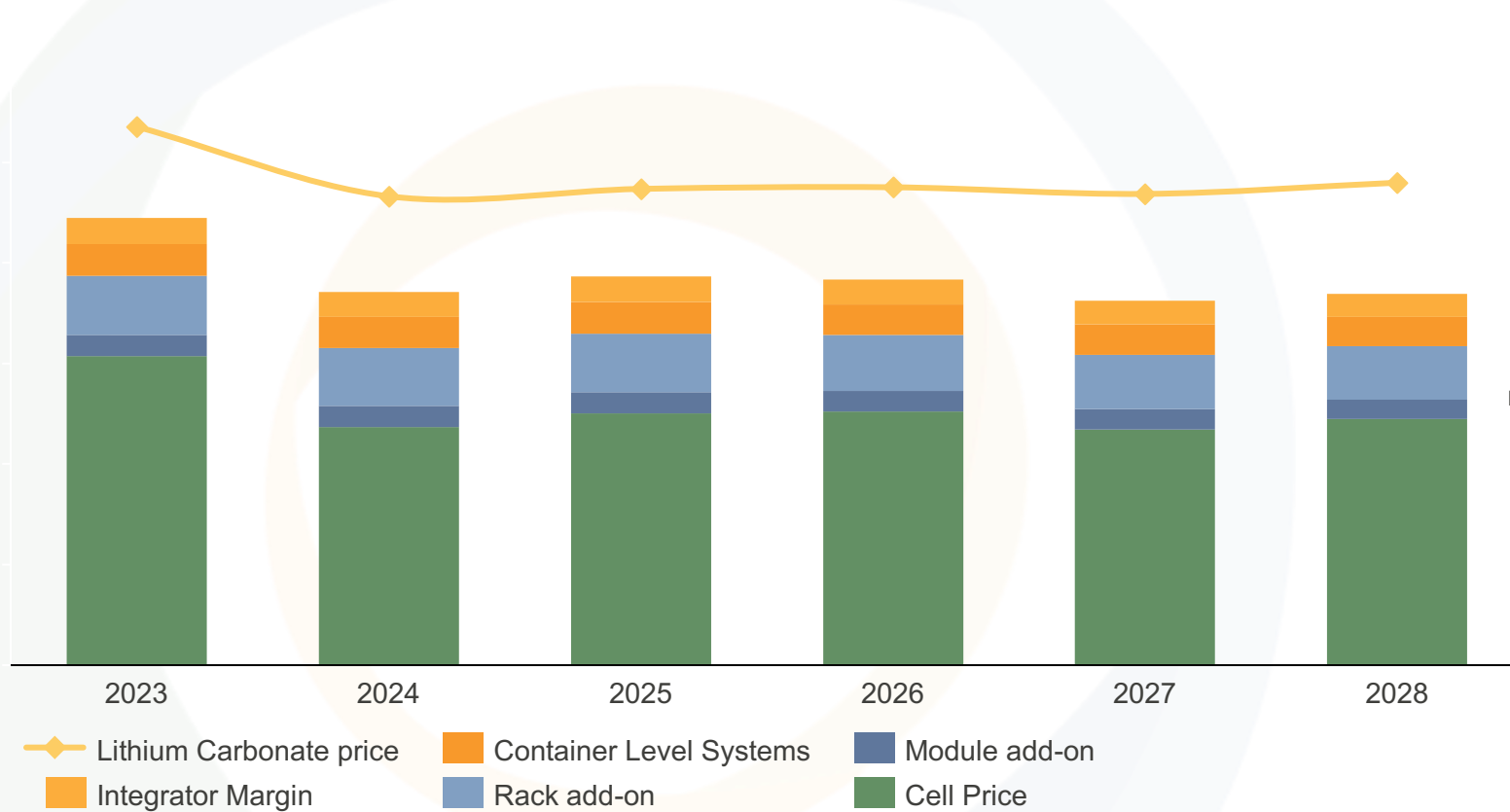


Notes | Data derived from CEA's in-house cost-to-price forecast using E-Source's Battery Cost Model
Cell pricing assumes 320 Ah prismatic LFP and NCM cells rated at 3.2V and 3.7V, respectively.

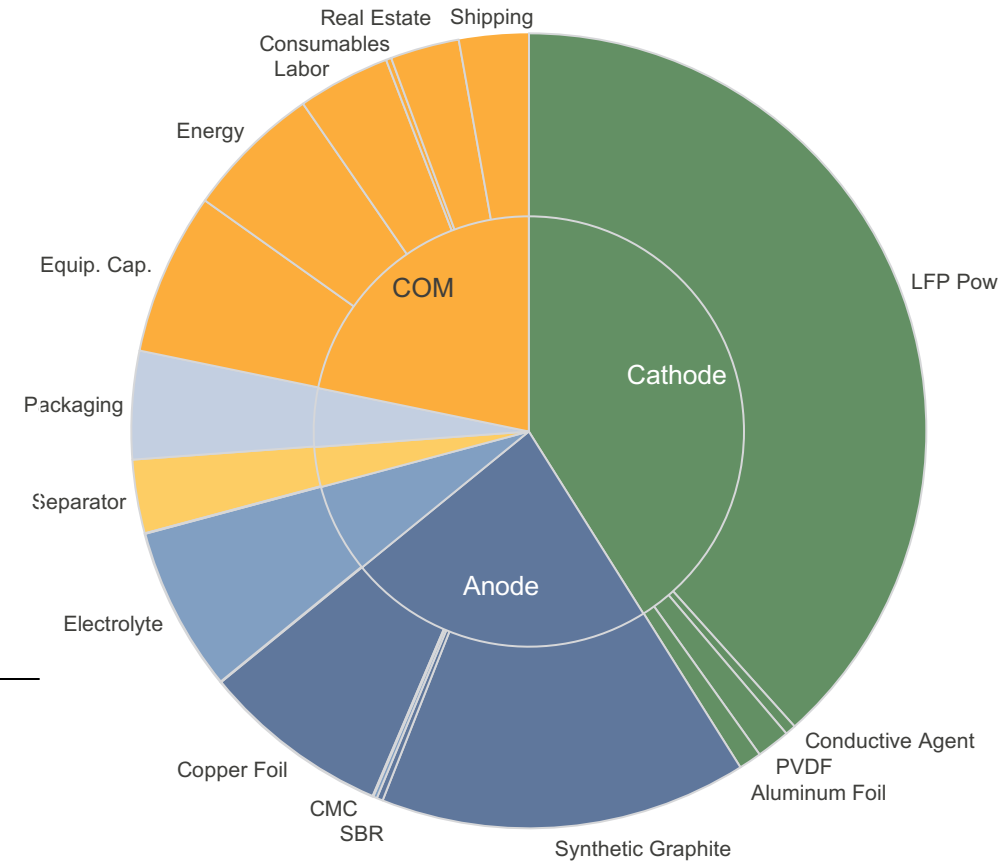
EU-made LFP cell costs are higher than China and US

High cost mainly due to the supply chain, energy cost and labor cost

EU manufactured DC container price, 1.25kW/5kWh, (US\$/kWh) and lithium carbonate price (US\$/kg) outlook



EU LFP battery cell cost, 2024 (\$/kWh)



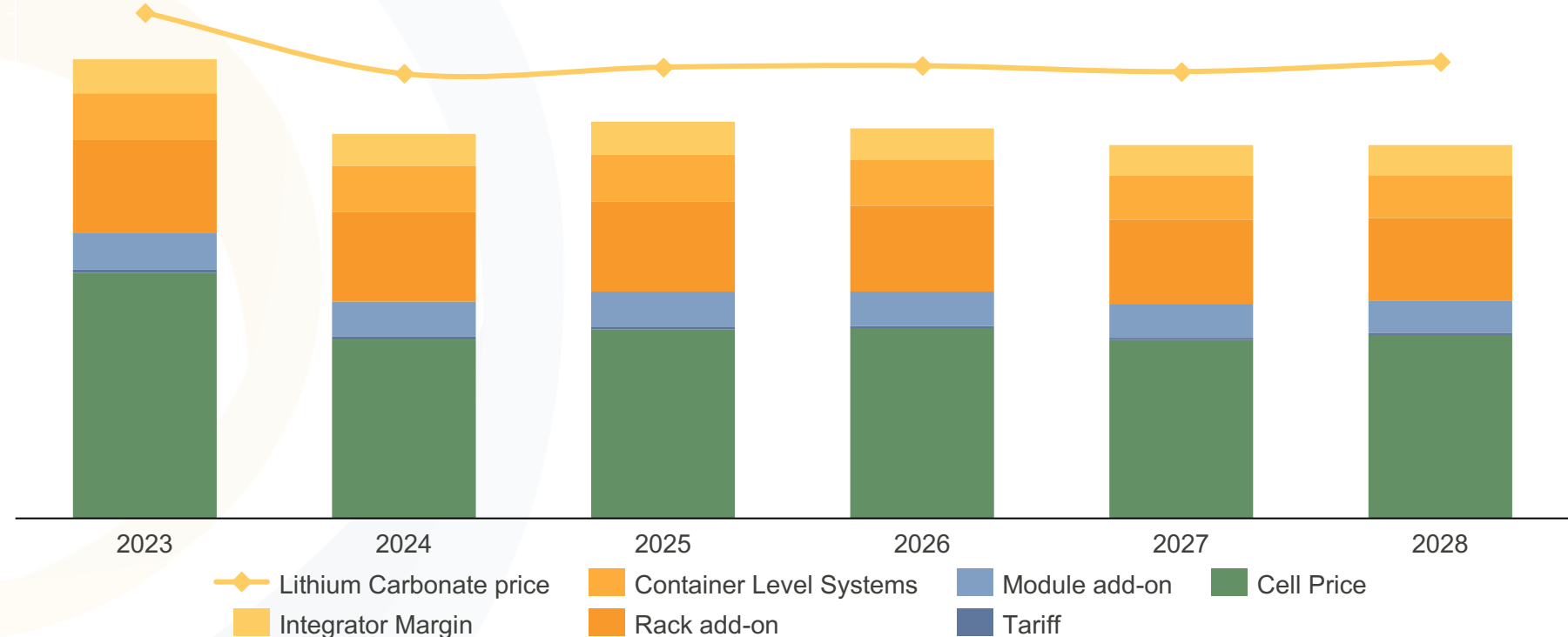
Notes | Data derived from CEA's in-house cost-to-price forecast using E-Source's Battery Cost Model, Cell pricing assumes 320Ah prismatic LFP cells rated at 3.2V. Cells are manufactured in the EU.

EU integrator can benefit from the current low tariff

The EU battery localized requirement potentially will increase the tariff

- EU BESS integrator who use China imported LFP battery benefit from a low tariff, resulting in reduced overall costs versus a like strategy in the U.S. where tariffs are substantially higher.
- However, a potential challenge looms as the EU aims to localize its battery supply chain, increasing the likelihood that tariffs could increase in the future.
- Additionally, stricter environmental, social, and governance (ESG) requirements could add cost if upstream value chains need to be modified to lower GHG emissions attributable to imported cells from China.
- Due diligence obligations are also imposed on economic operators regarding raw material sourcing which could negatively impact availability of supply

EU manufactured DC container price, 1.25kW/5kWh, (US\$/kWh) and lithium carbonate price (US\$/kg) outlook (with China imported LFP 320AH cell)

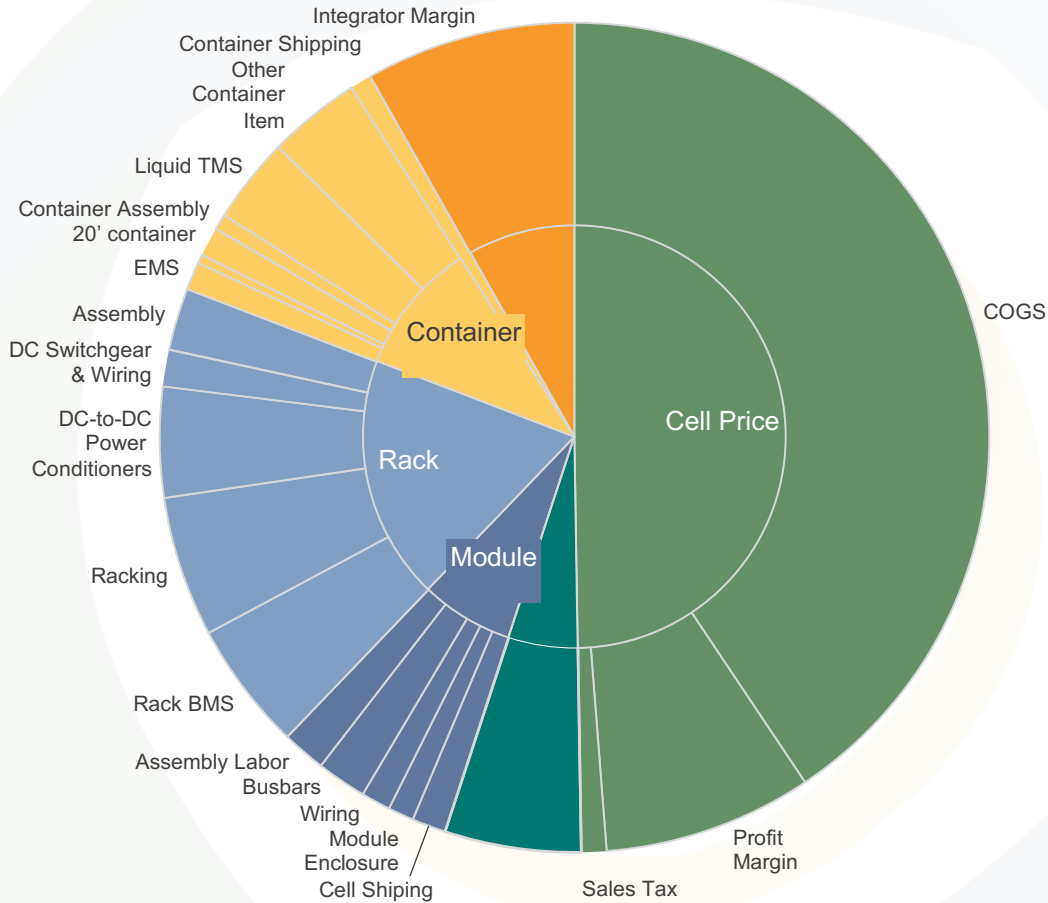


Notes | Data derived from CEA's in-house cost-to-price forecast using E-Source's Battery Cost Model
Cell pricing assumes 320 Ah prismatic LFP cells rated at 3.2V

BESS container price driven by cell COGS and vendor margins

Strong investment increasing capacity and competition

U.S. DC container price composition, 1MW/5MWh, DDP from China, CY2024 (US\$/kWh)



Category	Key commodity	Price outlook	Commentary
LIB cell COGS	Lithium carbonate	↔	Lithium markets stabilizing, with global surplus production forecasted annually thru 2028
	Synthetic graphite	↑	Well publicized Chinese export bans have done little to impact pricing and/or supply availability, though we do see moderate price increases for 2025
DC racking, container and enclosure	Steel	↔	The global steel market still faces oversupply, although demand is improving. Near-term pricing flat, with slightly higher pricing likely by years end
Busbars & cabling	Copper	↔	Prices spiked to 20-year highs recently, and opinions abound as to whether the trend has finally hit a short-term ceiling.
Switchgear and power conditioners	Power electronics	↔	Price producer index for electronics manufacture stabilized in 2023 following steep increases from 2021-2022.
BMS/EMS	Software	↑	The cost of industrial controller manufacturing as well as software programmer costs remain on the rise
Assembly labor	Electronics manufacture	↓	Higher levels of automation expected while hourly labor costs in China continue to drop, albeit slowly
Profit margins	N/A	↓	Increasing competition will force margins lower to levels on par with automotive sector.

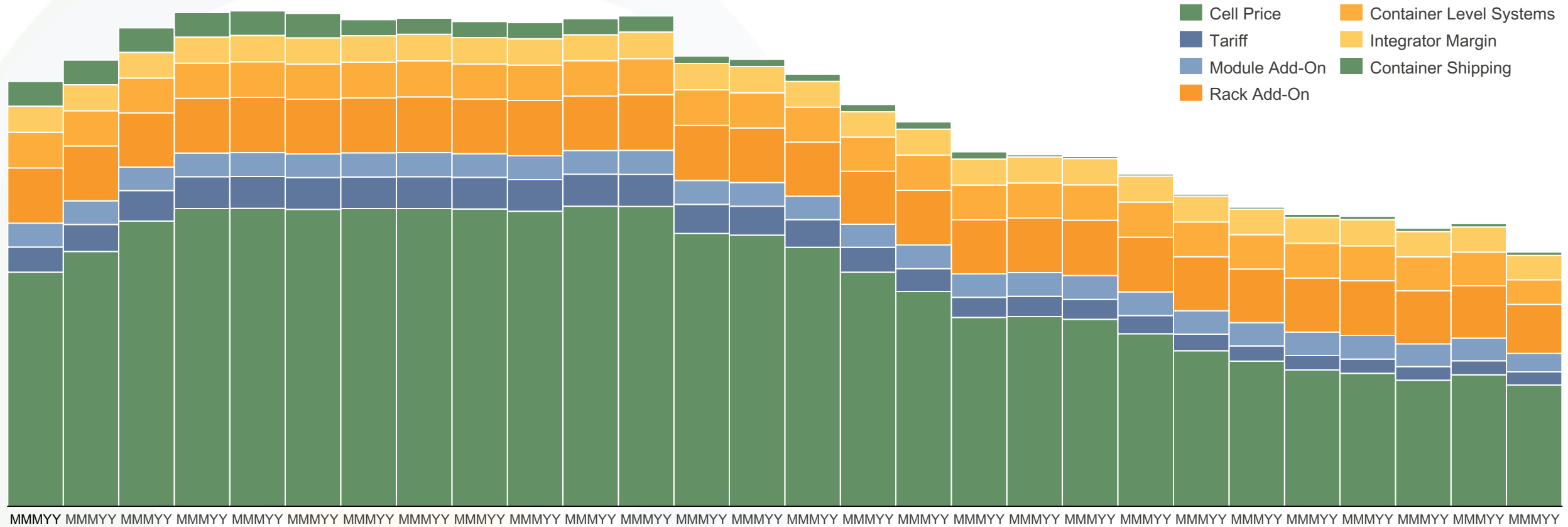
Notes | BESS DC container price derived from E-Source's cost model. Lithium carbonate prices data from CEA, E-Source, and Global Lithium.

20ft shell (China), 14 racks, 320 Ah prismatic LFP cells rated at 3.2V with 4-hour capacity, liquid cooled, and BOS components fully sourced and integrated in the U.S.

Container prices historically have been closely tied to LIB cell prices

ESS prices have transitioned from volatile fluctuations to gradual reductions

U.S. DC container price composition, 4hr, DDP from China, 2022-2024 (US\$/kWh)



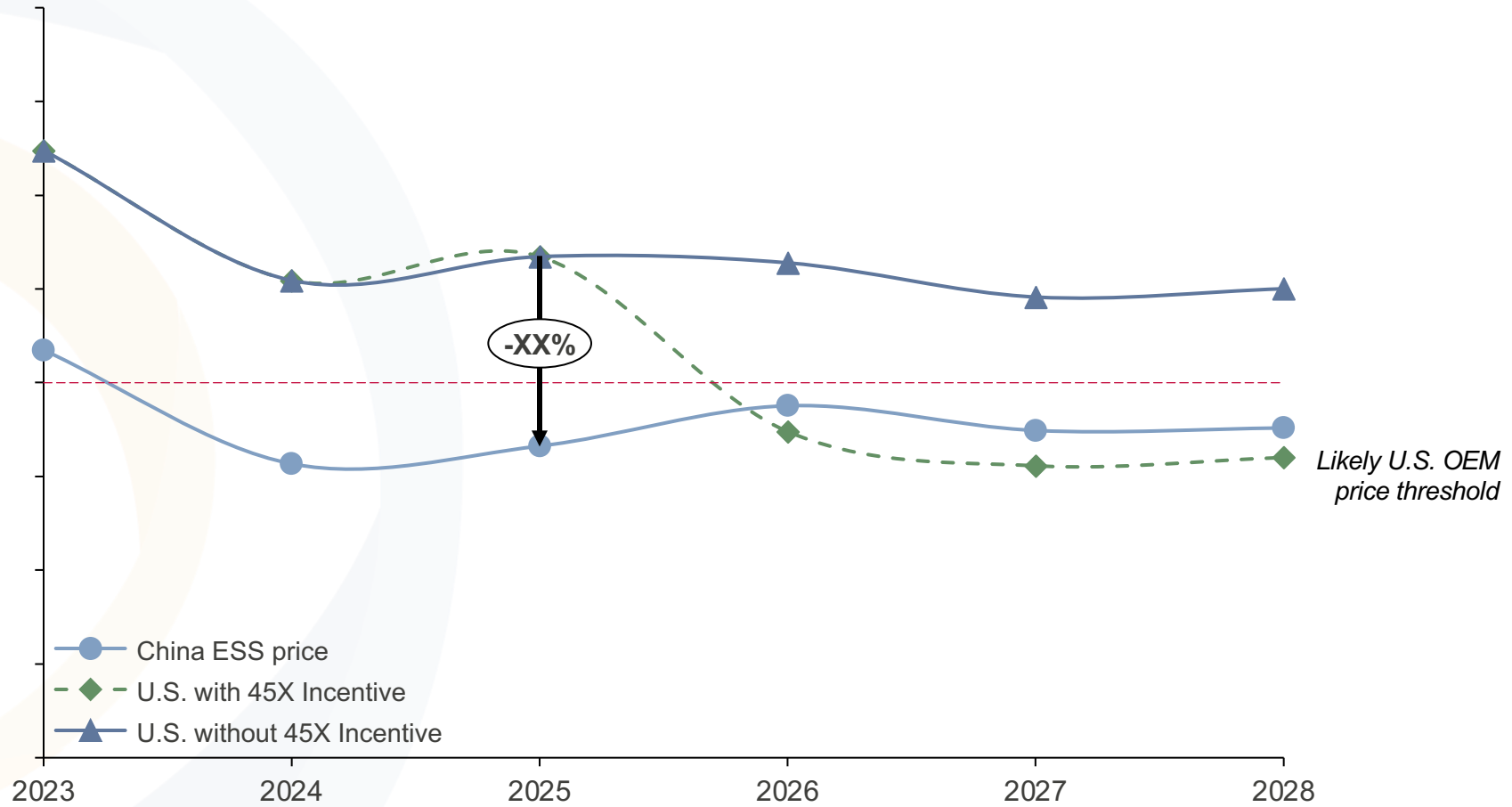
Notes | Data derived from CEA's in-house cost-to-price forecast Battery Cost Model. Assumes full container solution, 20ft shell, 14 racks, 280 Ah before A-24, 20Ah after, prismatic LFP cells rated at 3.2V with 4-hour capacity, liquid-cooled, and BOS components sourced from China

The IRA can enhance the competitiveness of U.S.-made ESS

IRA incentive is leveling the playing field with China

- U.S.-made lithium battery energy storage systems are currently more than 20% more expensive than Chinese imports. However, with IRA subsidies for local systems, U.S.-made energy storage systems can become competitive with China on price.
- The U.S. expansion progress for energy storage capacity is slower than previously expected. The capacity is expected to be available by 2025, but according to current planning and progress, most of the capacity to meet local requirements will likely come online around 2026.
- Japanese and South Korean enterprises with local production capacity in the United States have been able to enjoy subsidies. However, their existing capacity is primarily used for electric vehicles (EVs), and there is still a shortage of energy storage batteries to meet subsidy requirements in the short term.

Domestically produced ESS price outlook, U.S. and China, 2023 – 2028 (US\$/kWh)



Notes | Data derived from CEA's in-house cost-to-price forecast using Battery Cost Model. Cell pricing and comparison assume 320 Ah prismatic LFP cells rated at 3.2V.

Report Contents: 50 Pages of In-Depth Reporting

CEA's **Price Forecasting Program** is the leading source of price data and analysis in the solar and storage industry. We leverage the expertise of our PV industry experts and analysts, our network of lab partners, independent industry experts and raw material suppliers, and our access to proprietary, trade association and public databases to report on current trends and anticipate changes that will transform the renewable energy landscape.

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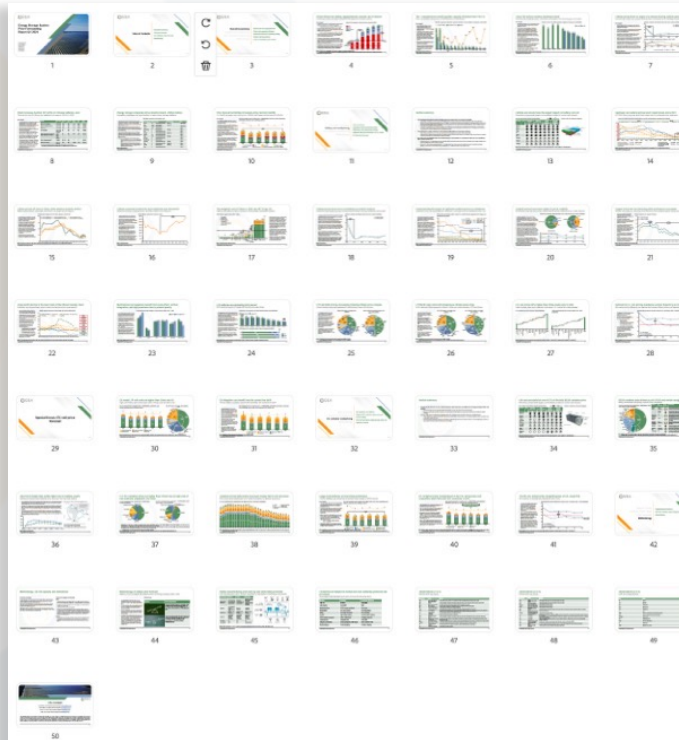


Table of Contents Q1 2024

- Executive Summary
- Cell Price Forecast
- DC Container Price Forecast
- Methodology



Thank You

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