What goes up must come down: A review of battery energy storage system pricing

Pricing | Despite geopolitical unrest, the global energy storage system market doubled in 2023 by gigawatt-hours installed. Dan Shreve of Clean Energy Associates looks at the pricing dynamics helping propel storage to ever greater heights

The Crimson BESS project in California, the largest that was commissioned in 2022 anywhere in the world at 350MW/1,400MWh

Credit: Axium Infrastructure/Canadian Solar Inc

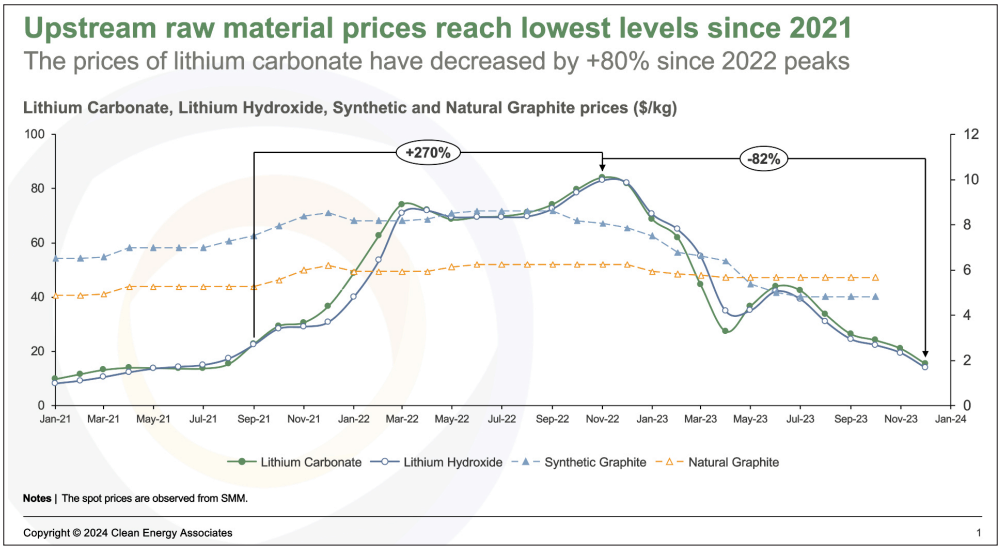
2023 is in the books, and early indications are that the global energy storage system (ESS) market may very well have doubled again in terms of gigawatt-hours (GWh) installed. This is a remarkable feat, especially in the face of geopolitical tumult, elevated interest rates and impossibly crowded interconnection queues. The market has shown reliance and is, indeed, poised for further growth, with a fourfold increase in annual installs possible by 2030. The reason why is simple: pricing.

As a start, CEA has found that pricing for an ESS direct current (DC) container — comprised of lithium iron phosphate (LFP) cells, 20ft, ~3.7MWh capacity, delivered with duties paid to the US from China — fell from peaks of US$270/kWh in mid-2022 to US$180/kWh by the end of 2023.

The primary price driver is universally recognised as a frothy lithium market that suddenly lost its fizz. Lithium carbonate pricing is down more than 80% from its 2022 peak. Supply/demand imbalances are to blame; or rather, how third-party estimates regarding those imbalances developed over the past three years (Figure 1).

To illustrate, in December 2021, S&P Global forecasted 2023 global lithium supply to top 762,000 tons, with a small surplus of 9,000 tons over demand. By the end of 2022, supply estimates for 2023 had grown to 864,000 tons, surpluses were nil and long-term shortages were expected. The market shifted dramatically in 2023, and S&P's latest estimate pegged global lithium supply at 968,000 tons, corresponding to a market surplus of 95,000 tons. A longer-term lithium carbonate surplus is now the industry consensus.

To be clear, the supply swing caught the entire market by surprise. Most industry pundits misjudged the pace of supply expansion from existing lithium mines, the dwindling electric vehicle (EV) demand dynamics, and the apprehensive buying behaviour in this still-youthful commodity segment.



Source: CEA

Figure 1. Upstream raw material prices since 2021

For example, although supply/demand imbalances drove price volatility from 2021 through 2023, the magnitude of those price excursions was exacerbated by stocking and destocking within the lithium-ion battery value chain. EV battery cell suppliers, especially those in China, have been locked in a heated battle for market share for years. Fears of critical raw material shortages at a time when global EV demand was achieving growth rates of +60% stoked irrational buying behaviour.

The result was a 270% increase in lithium carbonate costs from Q3 2021 to Q4 2022. The removal of China's New Energy Vehicle incentive in 2023, lingering range anxieties among Western consumers and a global increase in interest rates cast a pall on the EV market, resulting in a "disappointing" YOY growth rate of 31%. As demand slipped, suppliers were left sitting atop mountains of inventory and thus moved aggressively on price to bring their balance sheets back in order.

Savvy ESS developers recognise the critical importance of monitoring the broader EV sector alongside their own market. EVs represent around 80% of global lithium-ion battery demand, and the knock-on impacts to the ESS segment in terms of raw material pricing are meaningful as DC container suppliers generally apply raw material index pricing to their proposals.

Consequently, ESS developers and integrators should be mindful of near- to mid-term EV downside demand risk as they could be leaving money on the table. The next wave of EV adopters will need a rollback of interest rates, rollout of lower-cost EVs and an expansion of charging infrastructure, all of which will take time. BNEF just downgraded its global EV forecast (again) for 2024 by 775,000 vehicles.

Just when you thought it was safe… pricing falls to new lows

ESS market participants entered 2024 with enthusiasm and confidence, under the impression that market conditions had settled down and that they would finally be able to ink purchase orders. That euphoria was dashed by the time Intersolar North America 2024 took place as US$20/kg lithium carbonate pricing fell to US$14/kg. This left many to wonder where the floor for lithium really is. Interviews with ESS developers by CEA at the event revealed pricing for DC containers had dropped again, with average pricing at

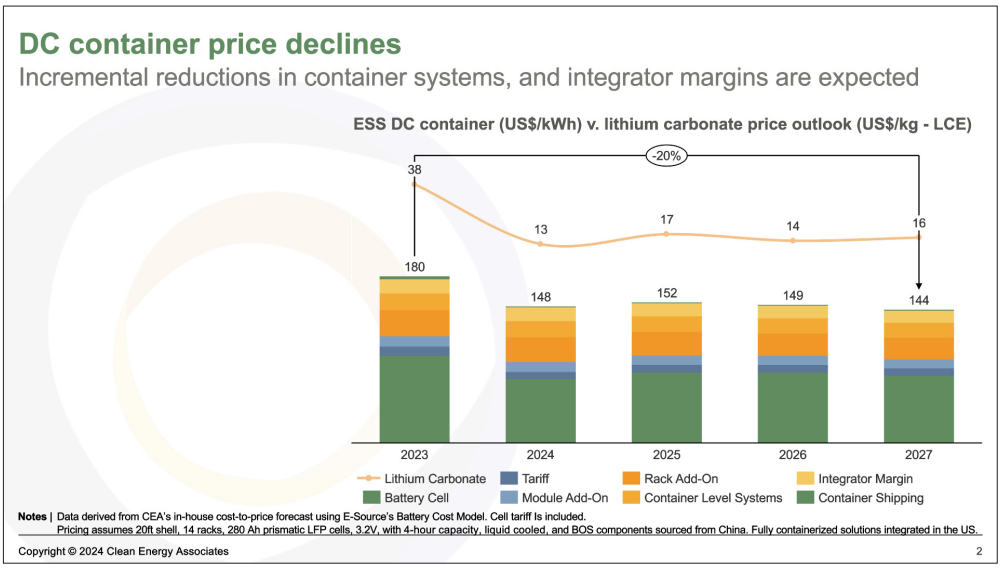


Figure 2. DC container pricing, 2023-27

US$150/kWh. Aggressive bids from Tier II/III suppliers seeking to gain a foothold in the US were even lower, which raises the question as to whether current pricing is sustainable.

Lithium's impact on ESS system pricing has been established but does not fully explain the extent of current market pricing. In fact, the lithium impact is diminishing mightily, as lithium carbonate within the battery cathode constitutes only around 5% of DC container system cost at current market pricing. CEA has been advocating for months that ESS developers and integrators begin to evaluate other price drivers for their DC container buy, including the impact of anode active materials costs, increased battery module manufacturing efficiencies, battery cell technology advancements and supplier margins in general.

Anode active materials (AAM) costs, most notably synthetic graphite, have been in the spotlight lately because of China's export regulations pertaining to that material. Concerns regarding an outright ban on graphite exports proved to be ill-placed, however, as Chinese officials have already provided export licences to chemical providers outside of China such as South Korea's Posco. Pricing impacts were also negligible as more than 90% of AAM production resides in China, where capacity remains grossly oversupplied. In fact, pricing has the potential to push lower as AAM producers introduce lower-cost feedstocks such as higher-sulfur petroleum coke versus needle coke from coal.

In terms of production efficiencies, the market continues to move along the same path as the solar photovoltaic market, pushing to increase the level of automation applied at gigafactories. In the case of batteries, operational scale has enabled producers to introduce automation to handle tasks such as cell sorting, cell stacking, busbar installation and welding of electrical connections. Battery module balance of system component integration and cell/module testing likewise are being automated to increase production throughput. These capital investments have a meaningful impact and can lower DC container production costs by more than US$10/kWh.

Similarly, supplier value chain integration investment is continuing in an effort to reduce margin stacking. Client-facing system integrators must do their utmost to gain control over as much of their bill of materials as possible. Companies with end-to-end supply capability are already well-positioned. And third-party integrators able to qualify multiple battery cell vendors can also be quite competitive if they can attain sufficient scale to manufacture their own battery racks. Module assembly automation may be more challenging for integrators looking to gain buying power by diversifying their cell supply, as different cell types could complicate production processes.

Technology advancement in the ESS sector will also contribute to a steady downward price trajectory for DC battery containers. The ESS value chain remains focused on evolutionary advancements to the ubiquitous prismatic LFP battery cell, as evidenced by the mass market transition from 280Ah to +300Ah battery cells. This is largely the result of battery manufacturers increasing electrode active material loading while reducing electrode

thickness, without sacrificing battery performance. This evolution in energy density will yield incremental cost reductions from the current 280Ah architecture in large part thanks to balance of system savings at the container level.

Pricing paranoia sets in…

Pricing paranoia is beginning to set in as procurement professionals shrug off the good news regarding price declines and instead debate the probability of a battery container pricing rebound, when it may occur and to what extent. Their concern is a valid one, especially given the price volatility the ESS market has experienced since the COVID-19 pandemic. Nevertheless, most market indicators point toward a period of relative tranquility, although geopolitics can upset the apple cart.

For starters, despite the roller coaster ride of the past 24 months, the likelihood that lithium markets fall into a structural supply deficit is unlikely. Lithium exploration and extraction ventures continue to make headlines, with new reserves being proven across North America, Western Australia and South America. Oil and gas giants are entering the space with new technologies such as Direct Lithium Extraction.

Risks remain, especially given the mass of junior miners that entered the sector when prices topped out at US$80/kg lithium carbonate equivalent. However, underfunded ventures with strong natural resource claims will be quickly snapped up by established mining conglomerates seeking to expand their global footprint.

On the demand side, a dramatic increase in EV adoption seems unlikely without a correspondingly dramatic increase in charging infrastructure deployment. The 2021 Infrastructure Investment and Jobs Act (IIJA) already earmarked $7.5 billion in funding for electric vehicle charging infrastructure, so additional funding is unlikely to move the EV adoption needle. Similarly, ESS is poised for tremendous growth, but in major markets like the U.S., permitting and clogged interconnection queues limit growth trajectories, not funding. Thus, as far as upstream supply/demand dynamics are concerned, imbalances are likely to be short-lived and impart a lesser impact to global lithium prices.

The ESS downstream supply chain continues to expand, and with it the sophistication of production processes and quality of Tier I/II manufacturers. Consequently, as with other renewable energy technologies, the story is one of continued cost reduction, as battery cell manufacturers make incremental tweaks to cathode (lithium iron phosphate to lithium manganese iron phosphate) and anode (graphite silicon) chemistries to further increase energy density and lower DC container costs. Margins are also likely to be held in check, as gross oversupply at a global level already is in place. And with no signs of the pace of investment slowing, the situation will only get worse. ESS pricing dynamics are ebbing ever closer to PV pricing dynamics.

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It's Super Bowl season… time to toss the political football

When ranking relative risks to battery pricing and project profitability, CEA handicappers offer the following as the most likely drivers:

1. US trade policy
2. US general elections

CEA's top concern in terms of resource availability and pricing is the expansion of the Uyghur Forced Labor Prevention Act (UFLPA) into the ESS sector. UFLPA enforcement upended the US solar market in 2022 and would create an even larger disruption to the ESS market given the exceptionally complicated supply chains supporting DC container production. Unravelling the origins of critical raw materials flowing through those supply chains to the satisfaction of US Customs and Border Protection (CBP), officials would take months or maybe longer.

Forward-looking developers and manufacturers are beginning to work through traceability programmes in advance of any government action. Nevertheless, substantial battery or DC container detainments under UFLPA would immediately create supply/demand imbalances both in the US and abroad. This would result in a substantial price premium for battery vendors able to deliver a CBP-compliant solution. As a reference, pricing for UFLPA and Antidumping and Countervailing Duties compliant PV modules with existing US import tariffs from Southeast Asia is 10% higher than global pricing for Chinese-made modules.

The IRA is not bulletproof

The Inflation Reduction Act (IRA) is central to current US energy transition plans, and any changes to its structure or the value of its incentive mechanisms could have detrimental impacts to both the domestic ESS and EV sectors. A new administration could hinder its implementation through executive action by withholding loans and grants, or even revising Department of Treasury guidance for rules that have not been finalised. A new Congress could potentially revisit the Investment Tax Credit, Production Tax Credit or the New Clean Vehicle Credit.

A repeal of these provisions would affect pricing and demand for battery cells, modules and DC containers in the US. ■

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