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King Abdullah Petroleum Studies and Research Center

Is the Recent Price Spike in Electric Vehicle Lithium-Ion Battery Packs Temporary or the Start of a New Trend?

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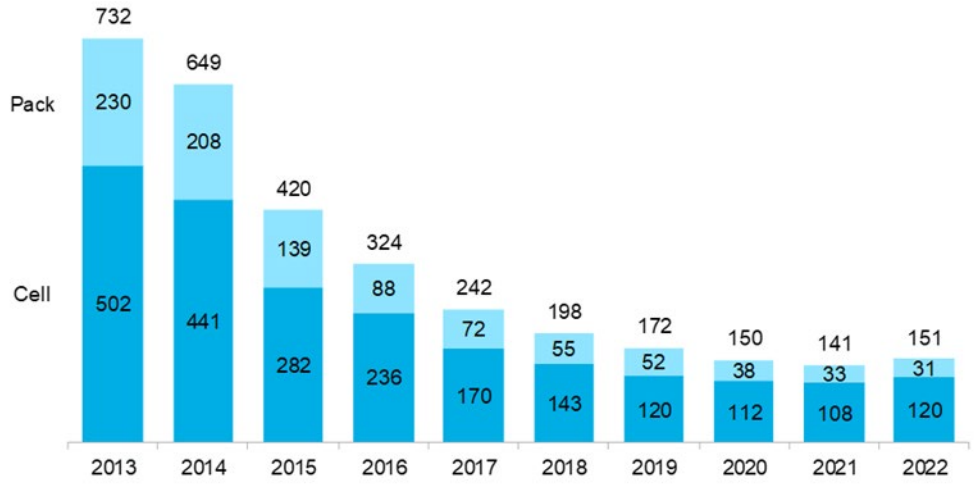
Most nations are evaluating vehicle electrification as a way to decarbonize their passenger car sectors (IPCC 2022). To make electric vehicles competitive with conventional vehicles for cost-conscious consumers, the upfront purchase price of electric vehicles needs to fall. The battery pack is the most expensive part of an electric vehicle, accounting for about 30% of the total cost to consumers (Boudway 2020). Thus, future battery pack price trends have major implications for the electrification of the passenger car sector. After an exponential decline for more than a decade, the average price of electric vehicle lithium-ion battery packs increased in 2022. As depicted in Figure 1, the volume-weighted average price across all sectors rose to $151 per kilowatthour (kWh) in 2022, a 7% increase from the previous year in real terms (BloombergNEF 2022). This development raises the question of whether this deviation is a temporary or permanent shift away from the trend of falling prices that had persisted for a while. It is possible that the recent price increase for lithium-ion battery packs is due to temporary factors that will eventually dissipate, leading to a return to falling prices. However, it is also possible that the price increase has been caused by structural changes in the market that could result in sustained or rising prices in the future.

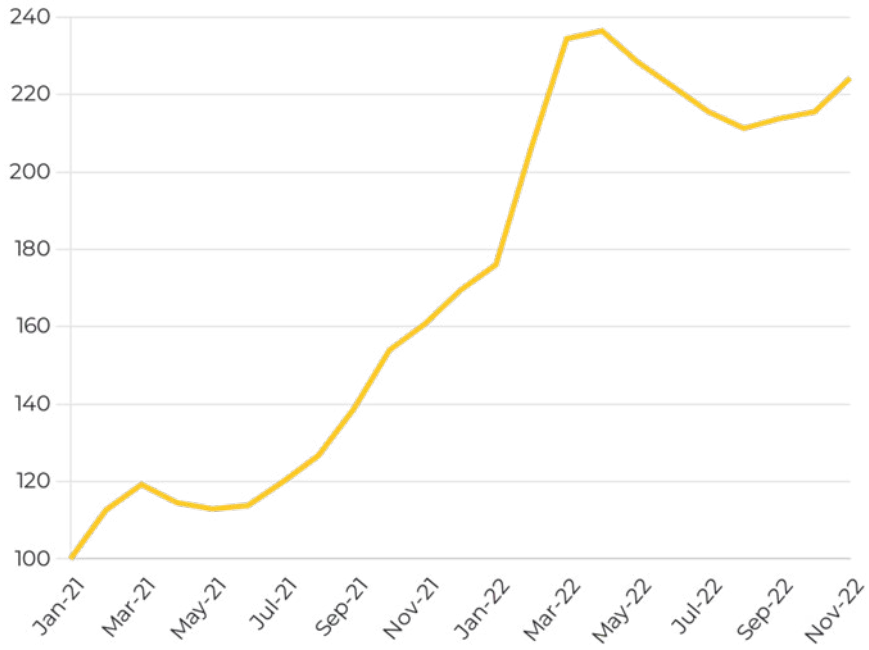
Figure 1. Volume-weighted average lithium-ion battery pack and cell price split, 2013-2022.
All values in real 2022 dollars.



Source: BloombergNEF (2022).

BloombergNEF (BNEF), which began tracking the prices of lithium-ion battery packs in 2010, attributes the 2022 price increase to rising inflation[1] and the prices of battery components and raw materials, such as cobalt, nickel, and lithium. This is despite the fact that BNEF itself reported in 2019 that battery pack prices are much less sensitive to commodity prices than is commonly believed, stating “Yes, contracts may fluctuate depending on the underlying commodity price but not by as much as you might think” (Goldie-Scott 2019). Despite recent falls in the prices of nickel and cobalt, and the possibility of a downturn in lithium prices, the prices of all three raw materials remain higher than in previous years. BNEF expects average battery pack prices to remain elevated in 2023 at $152/kWh (in real 2022 dollars). As a result of the high prices of these materials, which are used in cathode manufacturing, the price of li-ion battery cathodes, the most expensive component of a li-ion battery, has more than doubled since January 2021 (Imahashi 2022). Figure 2 shows the Benchmark Cathode Price Index, which tracks all cathode chemistries (Benchmark Mineral Intelligence 2022).

Figure 2. Benchmark Cathode Price Index.

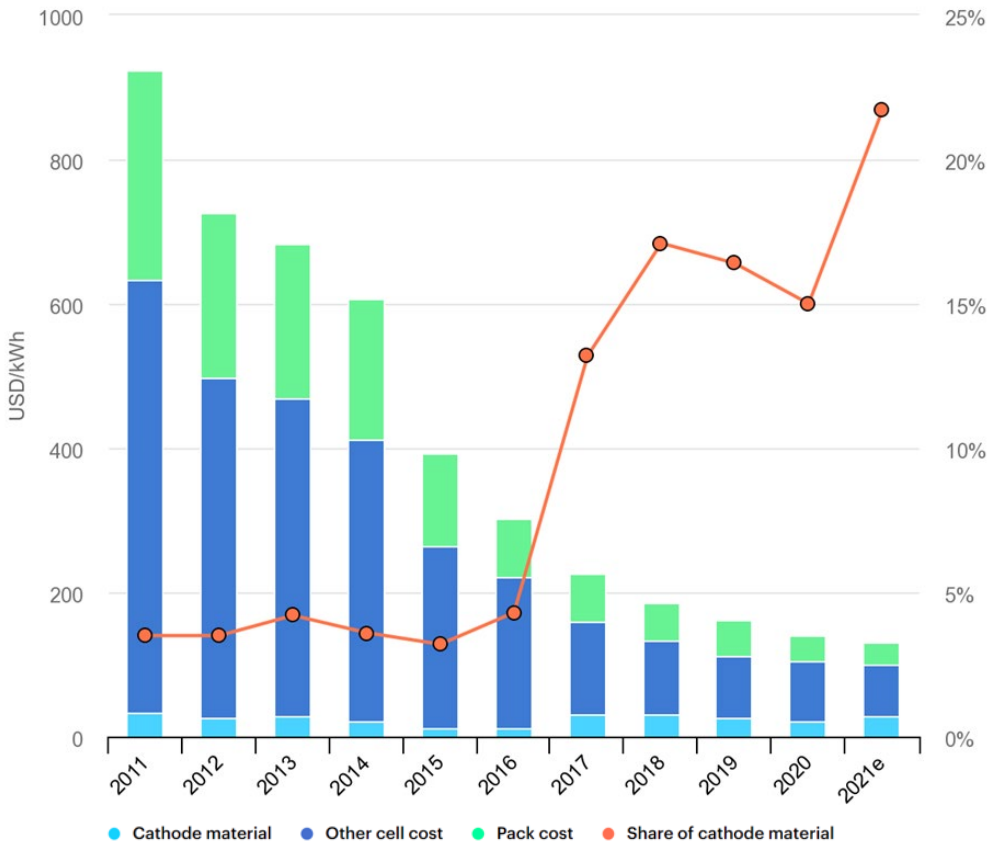


Source: Benchmark Mineral Intelligence (2022).

[1] The inflation effect has been accounted for in Figure 1, which depicts prices in real dollars.

In order to gain insight into the potential future evolution of battery pack prices beyond 2023, it is worthwhile comprehensively examining the factors that have impacted their historical price trend. During the first half of the 2010s, the market for plug-in electric vehicle (PEV) li-ion batteries was oversupplied, resulting in falling battery prices due to intense competition among manufacturers offering lower prices to secure the limited demand for these batteries (Curry 2017). Other contributors to the fall in battery pack and cell costs in the 2010s included economies of scale resulting from the construction of numerous gigafactories and technological advancements (Kim 2022). As the total cost of batteries has fallen over time, the raw material cost component share has increased. For example, as shown in Figure 3, the cathode material cost share of the battery pack price increased to nearly 25% by the end of 2021 from approximately 5% in 2011 (Kim 2022). The International Energy Agency (IEA) estimated that higher cathode material costs in 2021 increased the price of lithium-ion battery packs by roughly 5% compared to their 2020 levels. With the increase in lithium and other battery metal prices in 2022, the IEA anticipated a 20% increase in the price of lithium-ion battery packs in 2022 relative to their 2020 levels, which would likely have been offset by other measures to contain or reduce their overall costs (IEA 2022). If raw material prices continue to remain high, it is more likely that their impact will be felt in future PEV battery pack prices. In such a scenario, it is anticipated that future battery pack prices will be determined by the interplay between a rising raw material cost component and other cost components that may still be declining. If the rising cost of raw materials dominates, we may see a levelling off of battery prices around current values.

Figure 3. Average pack price of lithium-ion batteries and share of cathode material cost, 2011-2021.



Source: Kim (2022).

However, rising commodity prices drive future investment in production, which closes the supply-demand gap. Rising commodity prices also spur technological innovation that (i) reduces the commodity usage intensity in electrode manufacturing and (ii) promotes the use of cheaper alternative commodities. For instance, investment spending on non-ferrous metal production increased by 20% in 2021, and companies specializing in lithium development increased their spending by 50% to record highs (IEA 2022). That being said, bringing new capacity online can take six to ten years, as this involves a range of activities including exploration, permitting, construction, and commissioning (McKerracher 2022; Barrera 2022; BloombergNEF 2022). Furthermore, miners might also be hesitant to boost production for fear of what a glut of supply could do to battery raw material prices, as occured with lithium prices from 2015-2020, as shown in Figure 4. In that period, rising lithium prices encouraged miners to hike lithium production in anticipation of rapid electric vehicles sales growth in the immediate term (Lucas 2022). However, when the actual uptake of electric vehicles proved to be weaker than anticipated due to a lack of consumer interest in battery-powered electric vehicles and declining electric vehicle subsidies in China, lithium prices began to decline (Sifon-Arevalo 2019).

Figure 4. Benchmark Lithium Price Index.

Source: Lucas (2022).

Going forward, it could be argued that the current favorable lithium pricing environment and now well-established electric vehicle adoption trends are likely to make miners more inclined to ramp up future capacity, which could in turn suppress future prices. The increasing regulations mandating sales of zero-tailpipe vehicles, including the new energy vehicle policy in China, the zero emission vehicle (ZEV) mandate in California and other United States (U.S.) ZEV states, as well as stricter new vehicle fleet carbon

dioxide (CO2) emission standards in the European Union (EU) almost guarantee high demand for battery-powered electric vehicles. This guaranteed high demand is encouraging talks of creating an OPEC-like group among battery mineral-producing nations to help them have more control over battery raw material prices (Hui 2022; Campbell, Sugiura, and White 2022). Moreover, in the absence of significant investment in competitive backstop low-emission technologies other than battery electric vehicles, such as hydrogen-powered vehicles and the associated infrastructure, as well as CO2-neutral fuels, policies mandating the sale of zero-tailpipe emission technologies might be setting the stage for a bull run in the prices of electric vehicle battery raw materials. For instance, Albemarle, the world's largest lithium producer, anticipates that the exponentially increasing demand from the electric vehicle sector will lead to a supply-demand mismatch that persists for years, resulting in sustained high lithium prices even as they prompt a rush to expand supply (Dempsey 2022b).

Increasing deglobalization has the potential to alter the previously declining battery pack price trend, particularly as the West reduces its reliance on China (Ouerghi 2022; Campbell, Sugiura, and White 2022). Globalization is commonly believed to have contributed to the previously declining prices of 'green' technologies. For instance, a recent 2022 paper published in the journal *Nature* indicates that the globalized supply chain saved countries $67 billion in solar panel production costs between 2008 and 2020 (Helveston, He, and Davidson 2022). This is because networks of cross-border trade, knowledge and investment keep costs down and encourage learning and innovation (Goldthau and Hughes 2020; Helveston, He, and Davidson 2022). The rising trend of localization is especially evident in the recently enacted inflation reduction act (IRA) in the U.S. and the EU's recent battery regulation. The U.S. IRA connects the electric vehicle tax credit to local battery material procurement and manufacturing (Ewing 2022). The EU battery regulation requires economic operators that manufacture batteries for the EU market to develop and implement a so-called "due diligence policy" to address the social and environmental risks linked to sourcing, processing and trading raw materials and secondary raw materials (European Parliament 2022a). In other words, the EU battery regulation intends to implement stringent environmental, social, and governance (ESG) standards to enable EU-based battery manufacturing companies to compete upon factors other than price alone (European Parliament 2022b). This policy was implemented in an effort to prevent repeating the EU's costly mistake in solar photovoltaic production: it focused solely on price competition and allowed non-EU companies to gain an advantage in the space (European Parliament 2022b). As stated by the European Federation for Transport and Environment (2022),

> "the law will ensure products made by new European players cannot be undercut by imported batteries made with coal-heavy energy and with little regard for human and workers rights."

Experts, supported by recent research, anticipate a potential increase in EV battery pack prices as a result of increasing levels of localization (Campbell, Sugiura, and White 2022; Helveston, He, and Davidson 2022; Smialek and Swanson 2022a). Even now, U.S. and European prices for li-ion battery packs are 24% and 33% higher than the Chinese battery pack price, respectively, with the difference attributable in part to higher production costs in western markets (Dempsey 2022a). That being said, many OECD countries are hoping that 'friend-shoring,' moving supply chains to allied countries, will limit the impact of deglobalization

on costs. Moreover, the extension of EV tax credits under the U.S. IRA, which had previously been discontinued for automakers who had reached the cap imposed on electric vehicle production of 200,000, is likely to contribute to a long-run decrease in the cost of EVs and their components, such as battery packs. Finally, outside of the U.S. and EU, the full costs of battery production, particularly environmental costs, may not be accounted for, implying the possibility of falling battery pack prices, albeit at a slower rate than before due to reduced access to manufactured batteries for the U.S. and EU markets.

All of these structural shifts in market dynamics, including policy-mandated exponentially rising demand affecting the prices of battery raw materials, and geopolitical shifts affecting supply and promoting localization, suggest that last year's anomalous rise in battery pack prices may not be a blip.

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