Lithium battery cost breakdown

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Since 2010, the average price of a lithium-ion (Li-ion) EV battery pack has fallen from $1,200 per kilowatt-hour (kWh) to just $132/kWh in 2021. Inside each EV battery pack are multiple interconnected modules made up of tens to hundreds of rechargeable Li-ion cells.

Lithium-ion batteries (LiBs) are pivotal in the shift towards electric mobility, having seen an 85 % reduction in production costs over the past decade. However, achieving even more significant cost reductions is vital to making battery electric vehicles (BEVs) widespread and competitive with internal combustion engine vehicles (ICEVs).

2023 modeled cost of a 300-mile EV battery pack: $118/kWhRated ($139/kWhUseable); Cell - $100/kWhRated ($118/kWhUseable) The current cost estimate of $118 per kilowatt-hour of rated energy ($139/kWhUseable), is derived using the peer reviewed and publicly available BatPaC battery cost modeling software developed at Argonne National Laboratory.

Batteries are key for electrification -EV battery pack cost ca. 130 USD/kWh, depending on technology/design, location, and material prices [Jul 2021 figures] Cost breakdown of pack -Prismatic NCM 811 1) [USD/kWh]

The speed of battery electric vehicle (BEV) uptake--while still not categorically breakneck--is enough to render it one of the fastest-growing segments in the automotive industry.1Kersten Heineke, Philipp Kampshoff, and Timo M?ller, "Spotlight on mobility trends," McKinsey, March 12, 2024. Our projections show more than 200 new battery cell factories will be built by 2030 to keep up with rising demand. Overall, the market for cell components--comprising cathodes and anodes, separators, electrolytes, and cell packaging--is expected to grow by 19 percent per annum until 2030, reaching more than $250 billion.

This rapid growth opens a window of opportunity for cell component suppliers, start-ups, and new entrants, particularly in Europe and North America. Across both regions, industry and governments alike are strongly inclined to nearshore--or bring supply closer to home--in an effort to derisk supply chains and secure control over intellectual property. Despite this opportunity, however, current localized production would need to increase significantly to ensure supply meets demand by 2030.

This article is a collaborative effort by Jakob Fleischmann, Eugen Hildebrandt, Konstantin Huneke, Raphael Rettig, and Patrick Scott, representing views from McKinsey"s Automotive & Assembly Practice and McKinsey"s Battery Accelerator Team.

Suppliers in the battery component sector thus face challenges regarding commercial market entry, the necessity for substantial funding, and a rapidly evolving technological landscape. Moreover, local suppliers face a highly competitive market dominated by incumbent suppliers, mostly in Asia. And environmental and

regulatory factors pose risks that could disrupt production, increase costs, and create negative perceptions of the sector.

Cell component companies that seize the opportunity to meet the demand for local supply will place bets strategically from the start, build a backbone for success, and efficiently deliver on capacity additions.

Today, Asia leads the cell component market in annual production, measured in metric kilotons. The region produces 96 and 95 percent of cathode and anode active materials, respectively, and 90 and 95 percent of electrolyte and separator material, respectively (see sidebar, "An overview of the battery industry in Asia"). By contrast, Europe and North America have modest presences in the sector.

The battery industry has deep roots in Asia, particularly in China, Japan, and South Korea. In 1991, Sony introduced the first commercial lithium-ion battery in Japan. Japan and South Korea furthered technological development, laying the groundwork for rapid growth of the battery industry in Asia. In turn, China made substantial investments in the battery industry, catapulting it to global leadership. Today, China accounts for a dominant share of lithium-ion battery production.

According to the typical cost breakdown of a conventional lithium-ion battery cell system, cathode is the largest category, at approximately 40 percent (Exhibit 1). In most cases, the active material in cathodes is a transition metal (such as nickel, cobalt, manganese, or aluminum), oxide (NMC),2Lithium nickel manganese cobalt oxide. or lithium iron phosphate (LFP). Cathodes also contain lithium ions, which are then stored during charge in the graphite anode material.