Where Are Lithium-Ion Batteries Cheapest to Manufacture? Insights from Four Major Markets

Alexander Kleiner, Omer Karaduman, Kuang Xu

Technical Report, Stanford Graduate School of Business[1]

Excel Model Link

This report provides a comprehensive overview of the production costs for NMC811 batteries in four key countries: the United States, Germany, China, and South Korea.[2] It supplements the accompanying Excel model, which breaks down costs across the battery production process. NMC811 batteries were selected for this analysis due to their widespread adoption in the electric vehicle (EV) market today (IEA, 2022).

The battery production process includes five main stages:
1) Mining and refining
2) Precursor production
3) Cathode production
4) Cell assembly
5) System integration (final battery)

Our model focuses on stages 2 through 5, as the initial mining and refining of key minerals—like lithium, nickel, manganese, and cobalt—typically occur outside these countries. These minerals are treated as global commodities, so we use spot prices plus shipping costs rather than delving into extraction details.

[1] Original: 6/5/24. Updated: 02/02/2026.
[2] NMC811 batteries were chosen for analysis because of their prevalent use in today's electric vehicle market (IEA, 2022).

For stages 2–5, we estimate production costs using country-specific data on factors like capital expenditures, labor, and energy. For stage 1, spot prices are adjusted with shipping costs for Germany and the USA, assuming comparable base prices in China and South Korea due to geographic proximity. We also assume tariff-free imports from South Korea to Germany and the USA (via free trade agreements), while imports from China incur tariffs.

Precursor Costs

To calculate precursor costs (a mix of nickel, manganese, and cobalt), we drew on Bloomberg New Energy Finance (BNEF) data for a typical U.S. plant, including capacity, lifespan, energy needs, and staffing. We used International Council on Clean Transportation (ICCT) data to determine material quantities per kilogram of precursor.

Capital expenditures (capex) for Germany, South Korea, and China were derived by applying ratios of cell production costs (excluding labor, energy, and materials) relative to the USA, based on Fastmarkets data. This assumes similar capex ratios between precursor and cell production across countries.

Labor costs were proxied using each country's minimum hourly wage for line workers, with managers earning four times that amount. Energy costs reflect industrial electricity rates in each nation. Finally, a uniform margin from a McKinsey study was added to arrive at the final precursor cost per kilogram.

Cathode Costs

Cathode costs were based on data from a real U.S. plant under construction, with capex for other countries extrapolated using the same ratios as for precursors. We assumed consistent operational years and utilization rates. Staffing numbers from the U.S. plant were applied across countries, adjusted for local labor and energy costs.

ICCT data provided lithium quantities per kilowatt-hour (kWh) in cathodes, combined with precursor costs. A margin was then added to yield the final cathode cost.

Cell Costs

Cell costs started with data from a U.S. cell plant under construction, with capex extrapolated for other countries. We assumed similar employee-to-manager ratios as in cathode production, using press release data for total staffing.

Key components like the cathode were cost directly, while ancillary items (anode, separator, electrolyte, etc.) were estimated at 50% of cathode costs, based on Fastmarkets data from China—assuming consistency across countries. Total cell costs aggregate all elements, including production expenses (capex, labor, energy). A margin was applied to project final costs per country.

System Costs (Battery)

The final stage assembles cells into modules, adds a pack, and integrates an energy management system for direct EV installation. Without detailed breakdowns, we used an ICCT-derived ratio of cell-to-system costs, assuming it's relatively uniform across countries, to estimate total battery system costs.

Key Findings

Based on the Excel model, China and South Korea offer the lowest overall battery system costs at approximately $101/kWh and $109/kWh, respectively, making them the most cost-competitive. The United States follows at $118/kWh, while Germany is the highest at $135/kWh, largely due to elevated labor and energy expenses.

Cost differences are most pronounced in cell production, where Germany's total (post-margin) reaches $105/kWh compared to China's $79/kWh. Without tariffs, manufacturing in the US is about 16% more expensive than importing from China (including minerals and associated costs). With tariffs, this premium narrows to less than 1%, and in some calculations (e.g., excluding minerals to emphasize production and logistics for finished goods), domestic U.S. production becomes cheaper. These disparities highlight potential trade-offs beyond pure costs, such as supply chain resilience and policy incentives, which may explain continued manufacturing in higher-cost regions.

Cost Difference Analysis

The Excel model highlights cost variations across stages, with China and South Korea generally the lowest-cost producers, Germany the highest, and the USA in between. Despite China's advantages, battery manufacturing persists in all countries, suggesting unmodeled factors like geopolitical risks, regulations, or logistics influence decisions.

Tabs 2 and 3 in the Excel file compare manufacturing in one country versus importing from another, with and without tariffs, at each stage. One approach isolates plant, energy, and labor costs; the other builds cumulatively, incorporating prior stages and minerals to capture broader factors like shipping complexities (e.g., higher costs for cells than raw minerals).

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