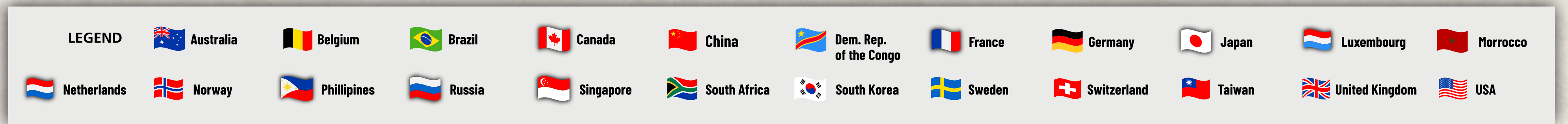


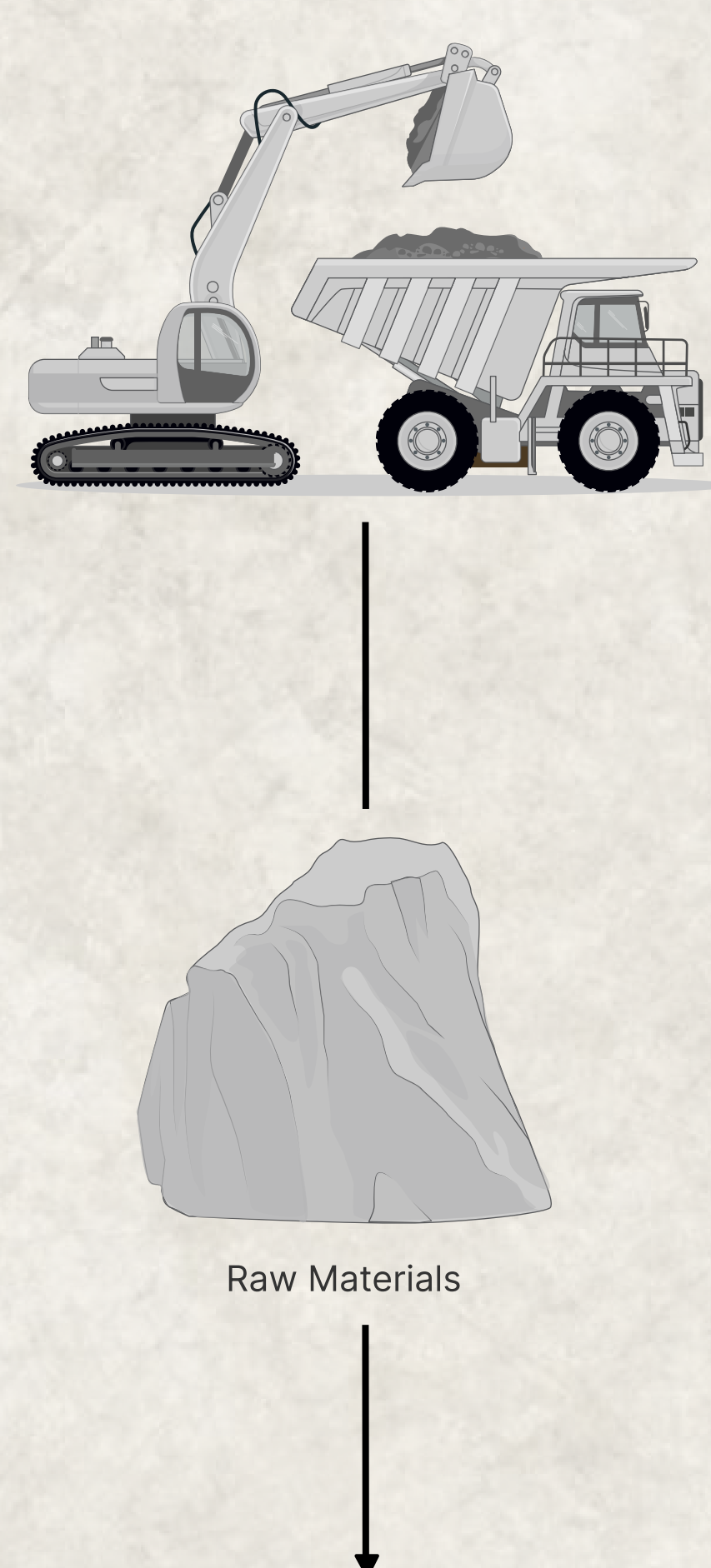
The Companies Behind the EV Battery Supply Chain

Lithium-ion (or li-ion) batteries are a type of rechargeable battery widely used in consumer electronics, energy storage, and electric vehicles (EVs). As electric motors, li-ion batteries represent an alternative to fossil fuels and are at the center of the clean energy transition. Since 2016, demand for li-ion batteries in the automotive sector has exploded, roughly doubling every two years. Going forward, experts project an impressive 20 to 30 percent yearly growth until 2030. Meeting this demand is no simple task. It requires the coordination of a complex, globe-spanning, and still often highly concentrated supply chain, filled with chokepoints and geopolitical tensions. This graphic presents a list of the key companies at each step of this supply chain—from mineral extraction to EV manufacturing—with a special focus on China's footprint. More than any other country, China finds itself at the epicenter of the lithium-ion battery revolution. Not only is it the world's largest market for EV batteries, but Chinese companies dominate nearly every stage of the production.

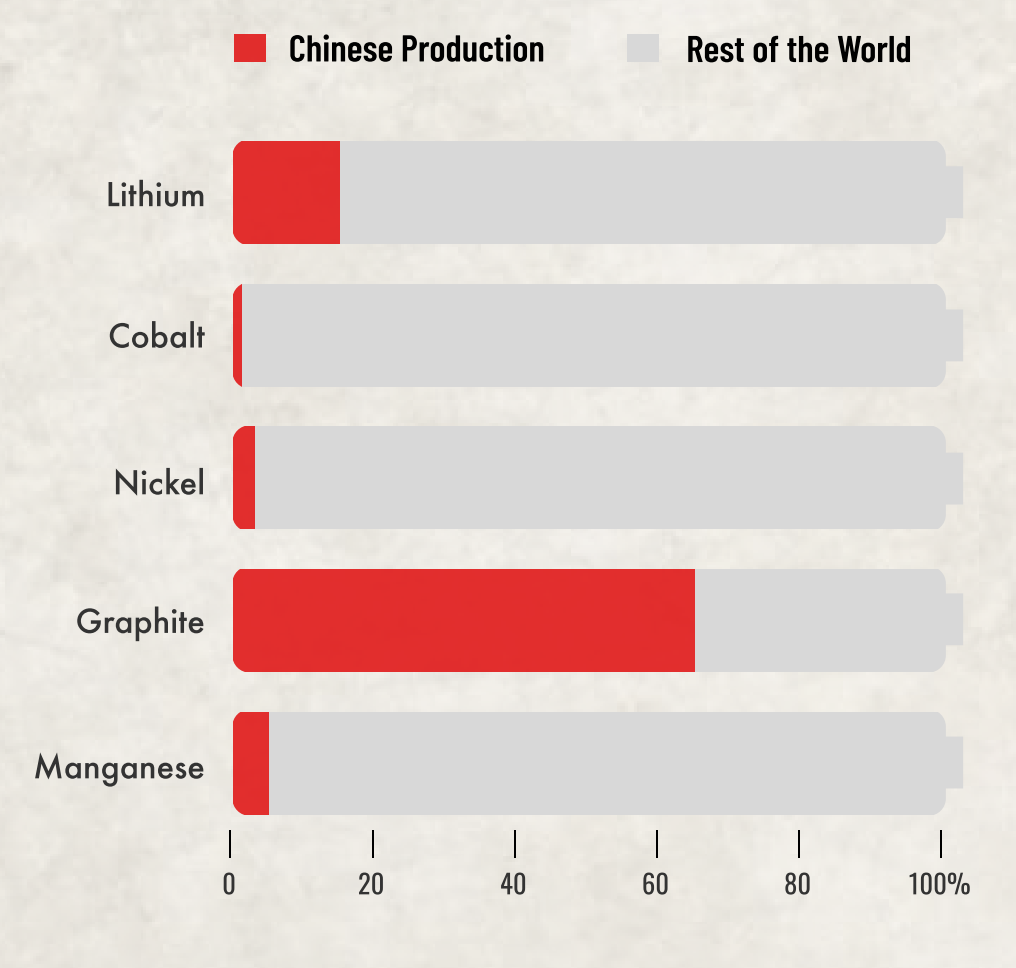


MINING

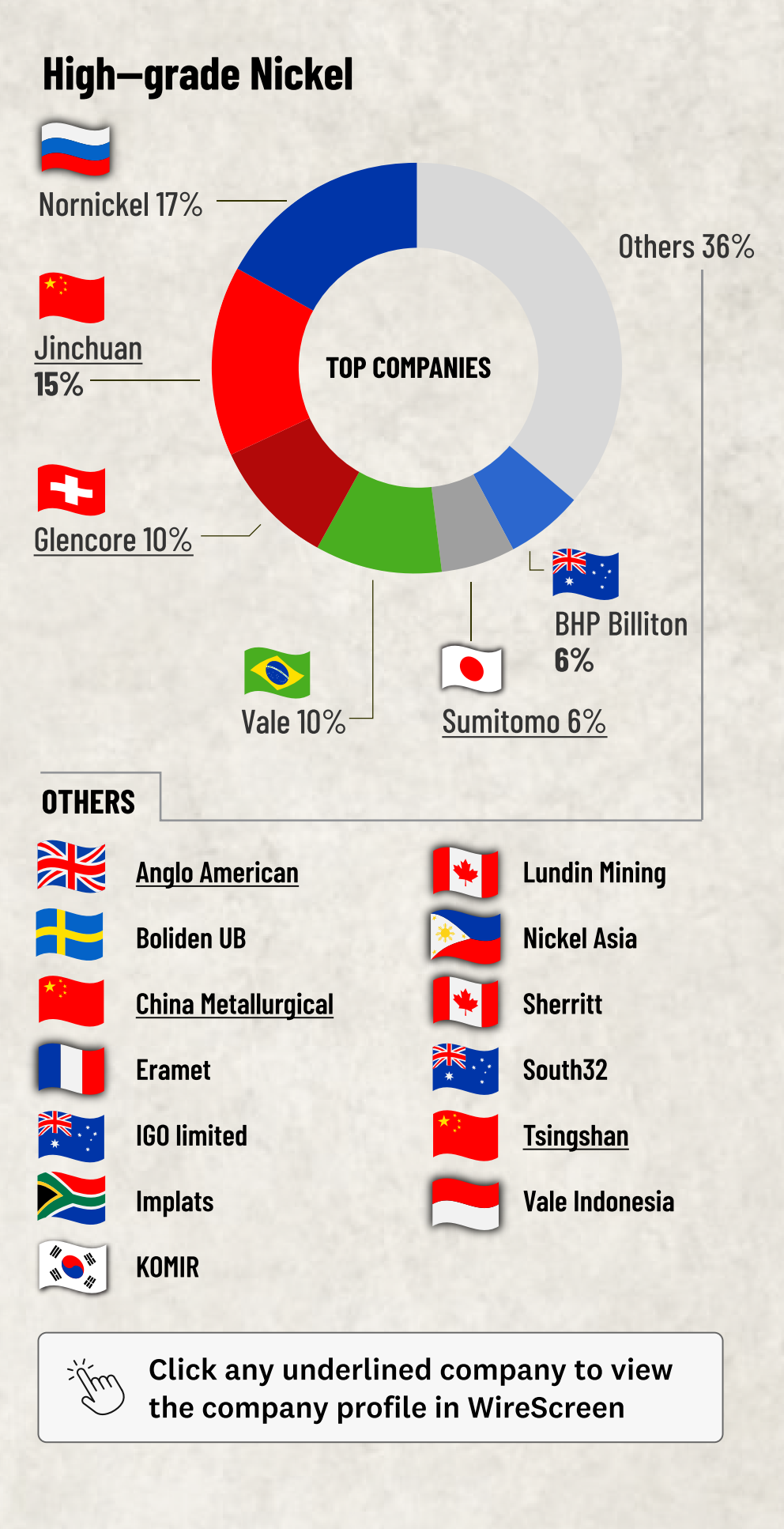
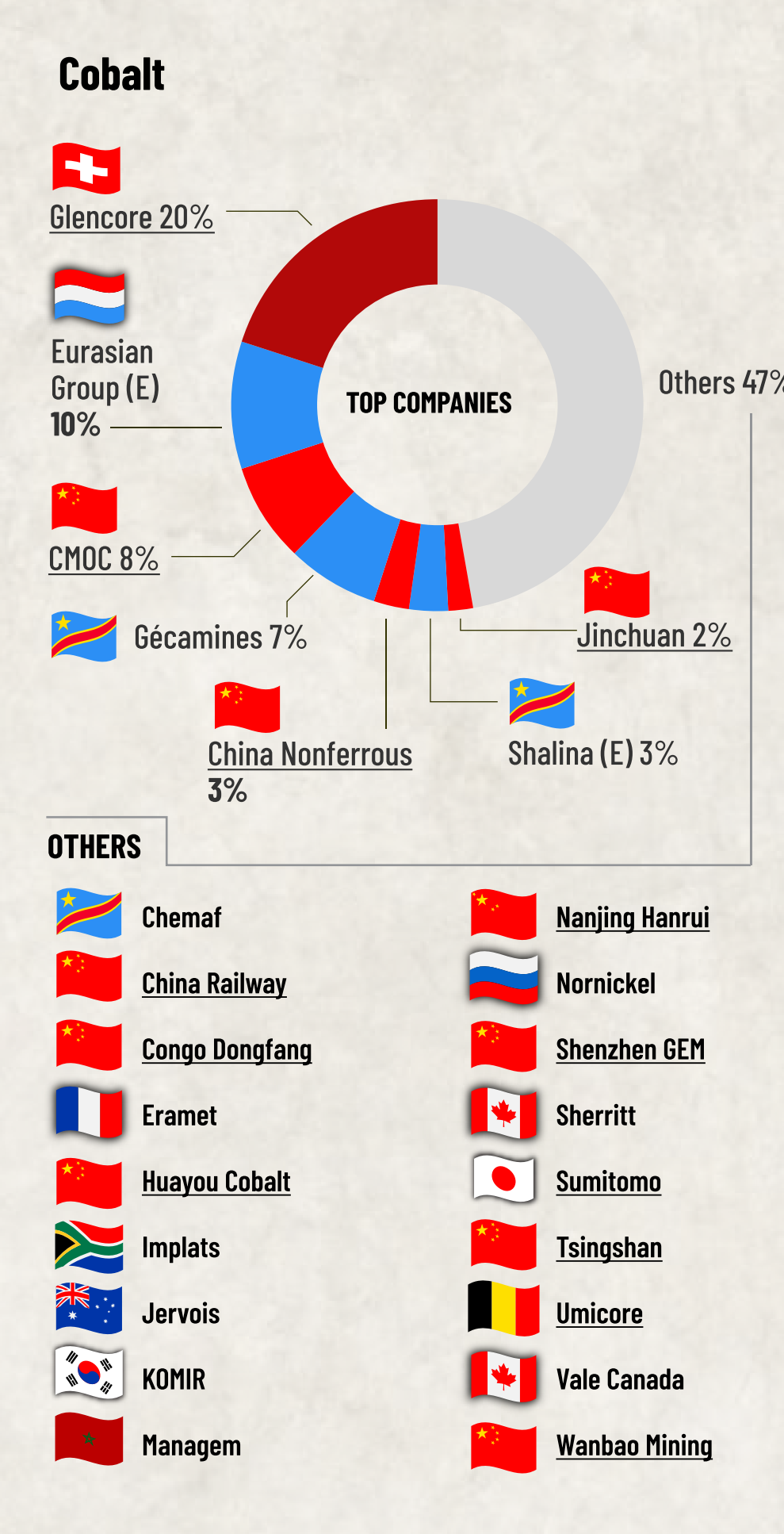
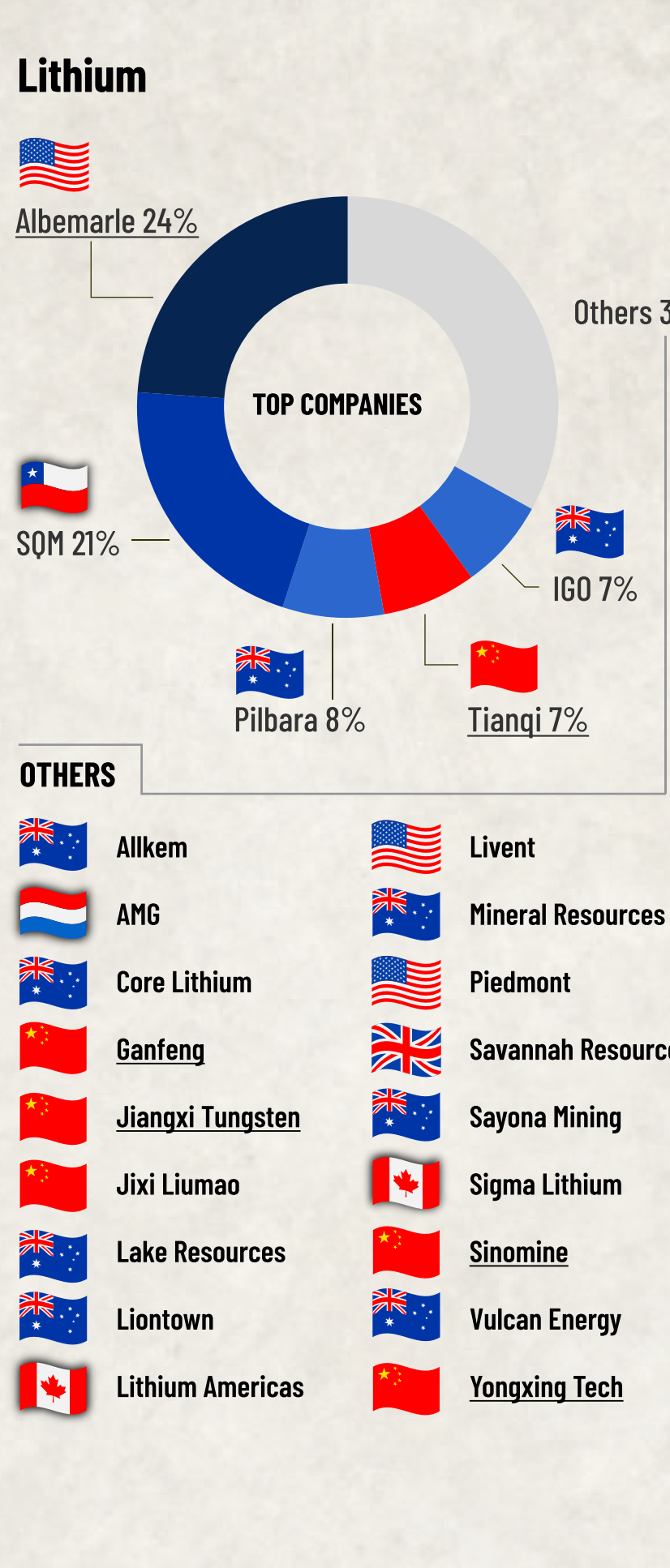
Mining companies collect the raw minerals needed in batteries. Large upfront costs and long lead times keep industry concentration high, with a handful of companies often responsible for the majority of world production.



CHINA LEADS THE EV BATTERY SUPPLY CHAIN
Chinese companies dominate nearly every stage of battery production. Though core minerals come from mines outside of China, Chinese companies control important rights to their supply. And once mined, most minerals are sent to China, which dominates the remainder of the supply chain, from processing to EV sales.

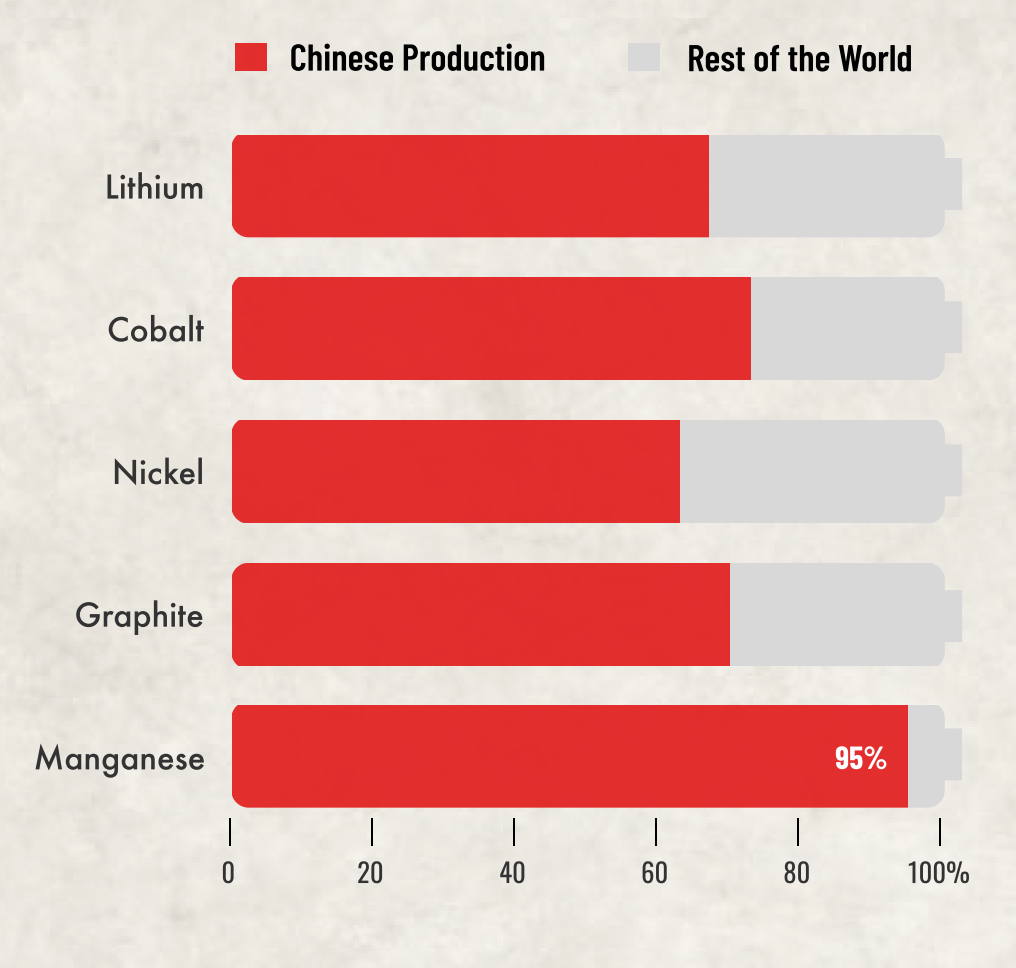
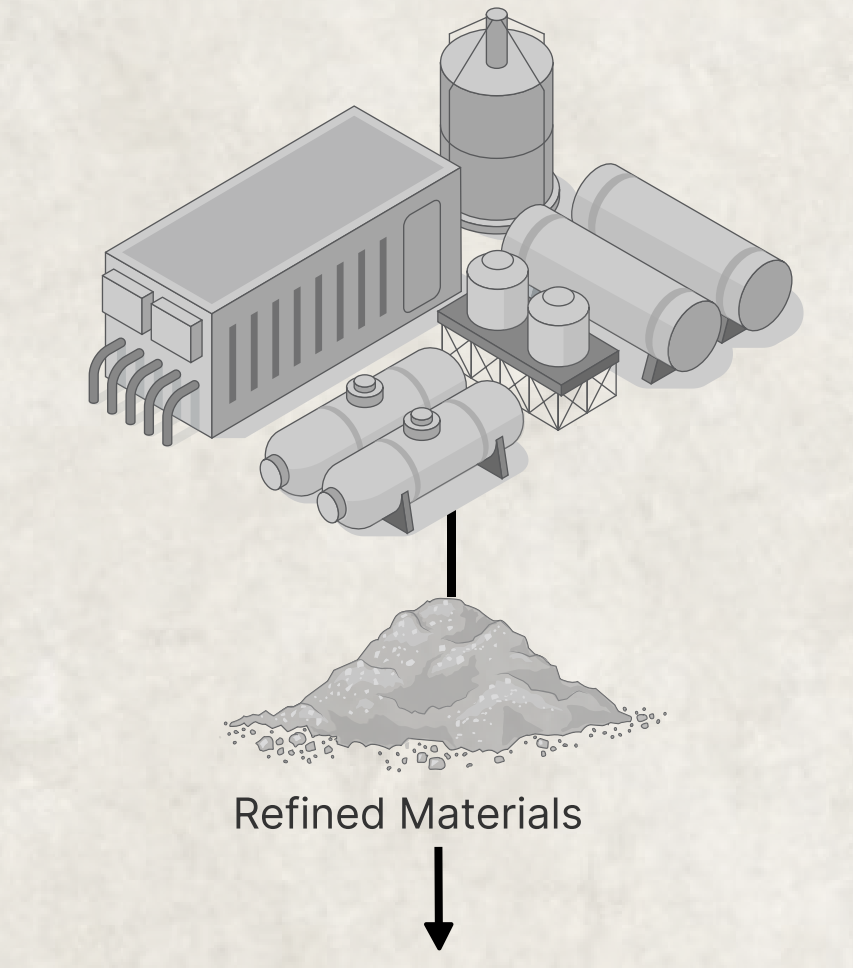


SHARE OF GLOBAL PRODUCTION, 2022



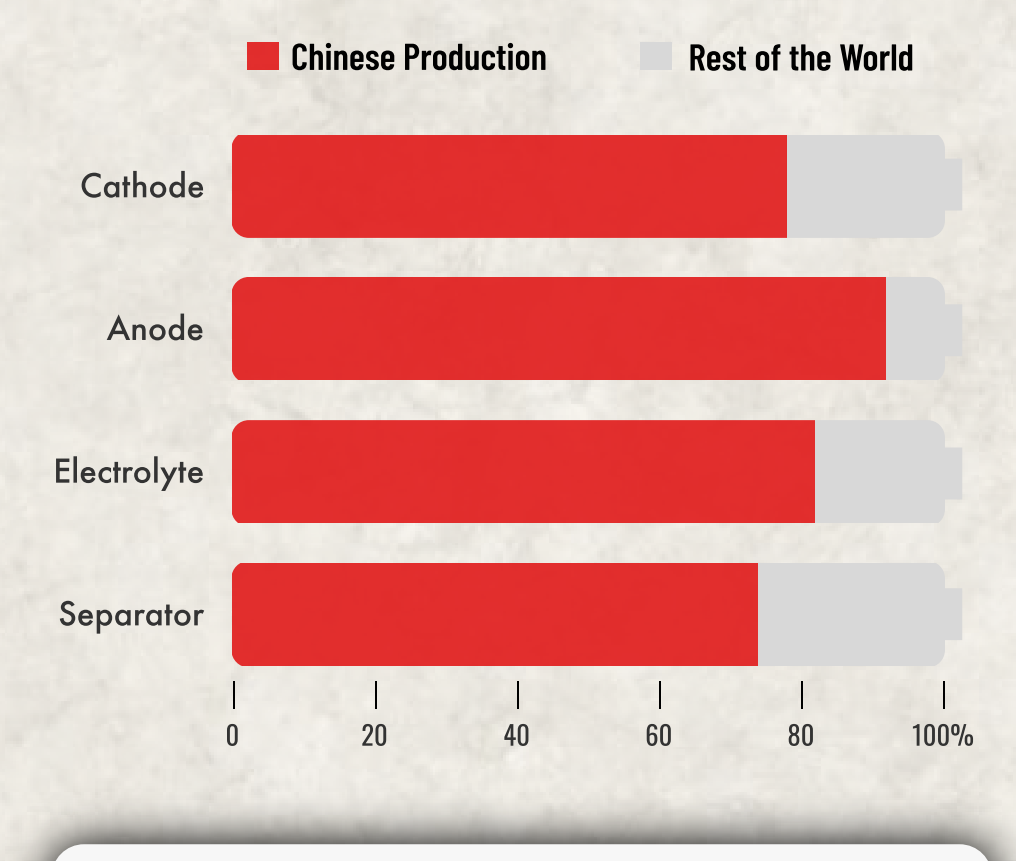
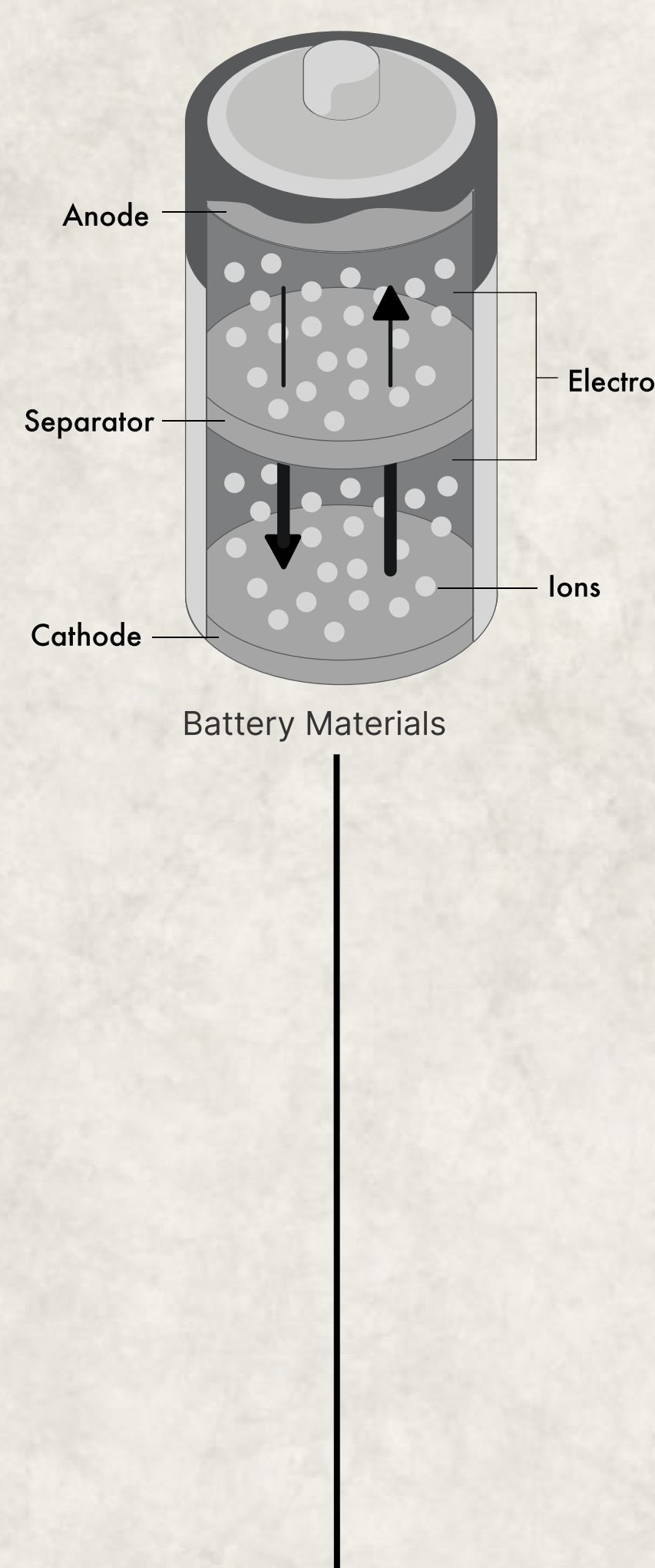
PROCESSING

These companies process the raw minerals taken from the earth to produce refined materials. This is a crucial step: battery performance is tied to the purity of the minerals used to make it.



BATTERY COMPONENTS

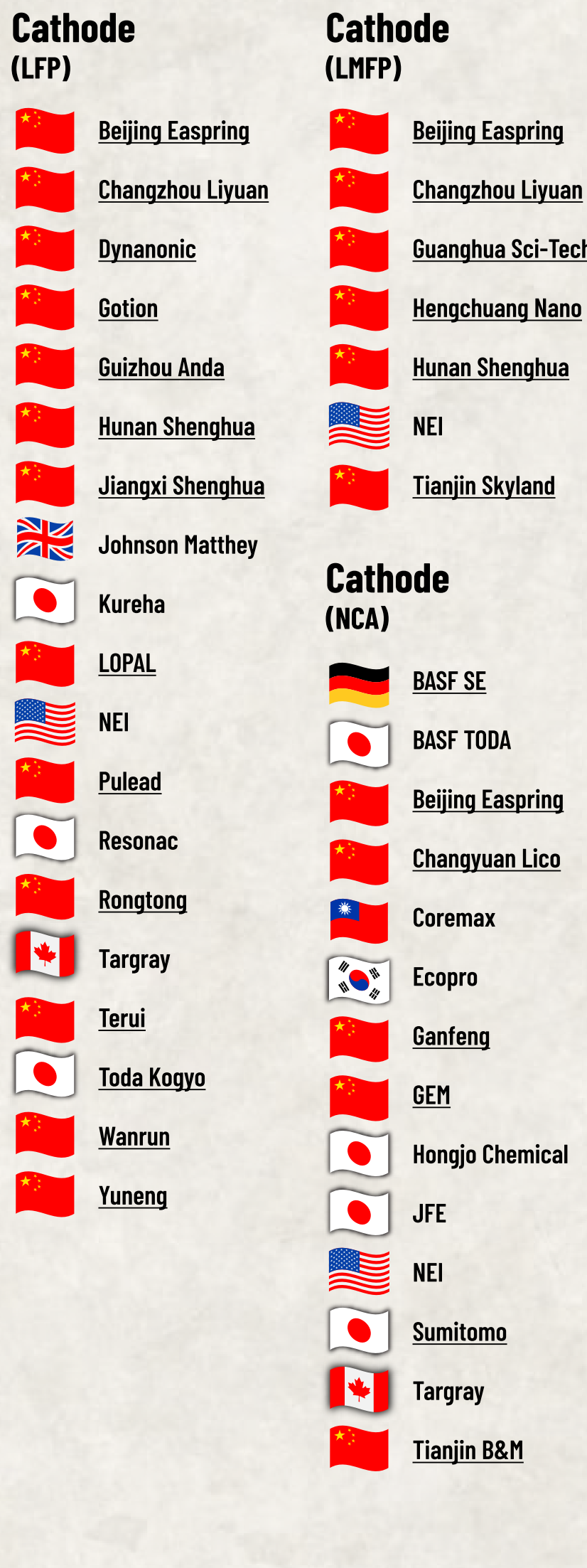
These companies produce the active materials used in a battery's chemistry. Cathode materials are the most crucial for performance so the sector is represented in more detail. (See the Battery Primer for more information.)



Li-ion Battery Primer

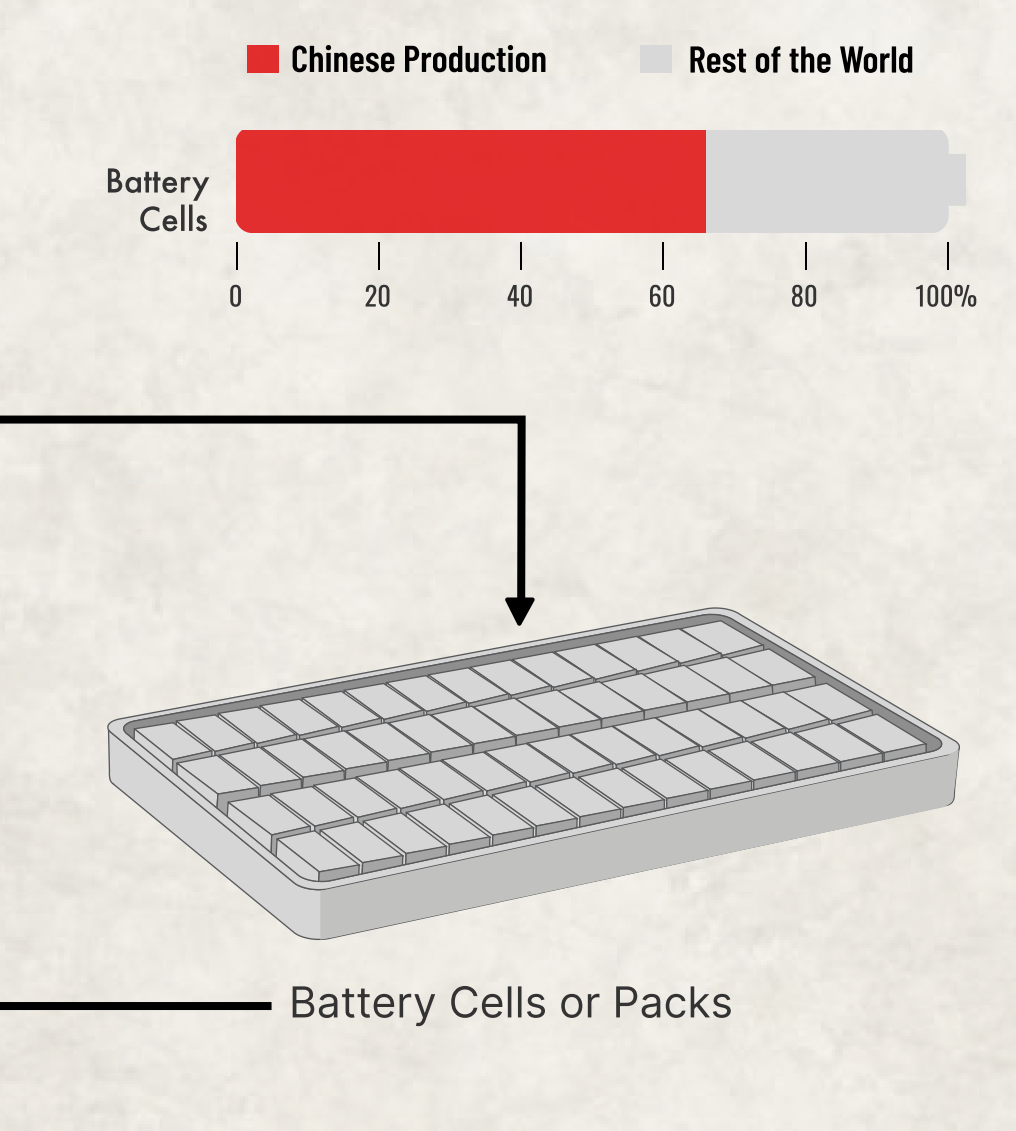
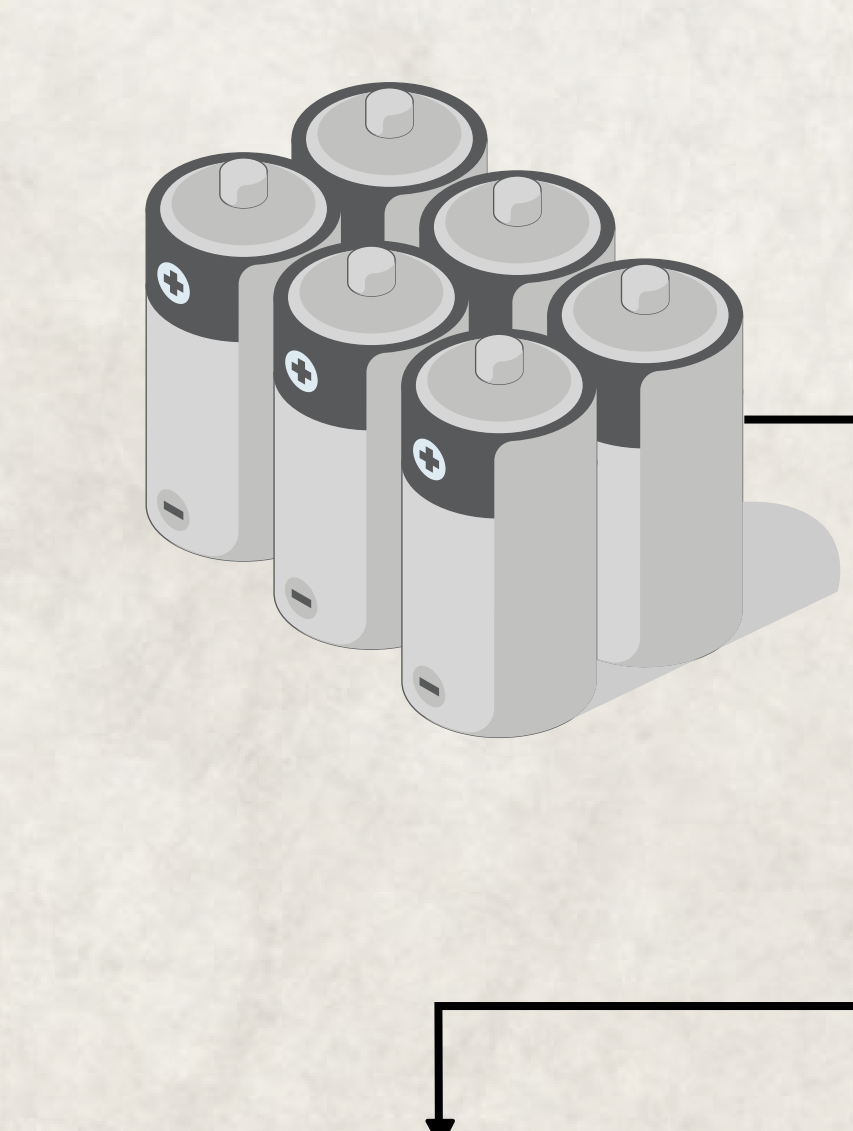
EV battery packs are a combination of many battery cells, each made up of four main components: the cathode, anode, electrolyte and separator. During use, the lithium-ions in a cell flow from the cathode (positive electrode) to the anode (negative electrode), discharging the battery and powering the vehicle. The electrolyte carries the lithium-ions from one to the other and the separator lets ions through while keeping the two electrodes apart.

While the anode is typically made of a single active material, graphite, the cathode is central to the battery's performance and can be made using a variety of materials. The most popular types of chemistries are Lithium-Iron-Phosphate (LFP) and Nickel-Manganese-Cobalt (NMC). The choice of chemistry comes with tradeoffs, each one having different costs, energy density, and safety characteristics.



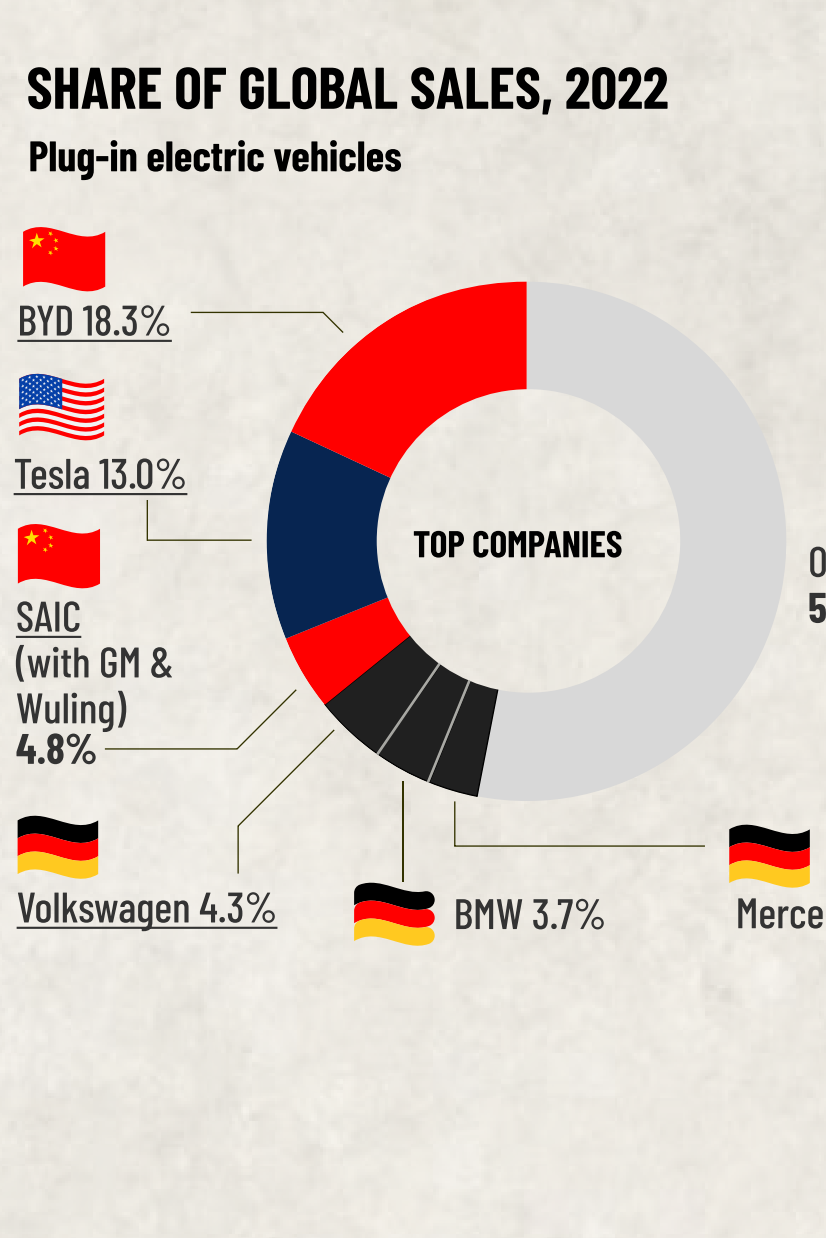
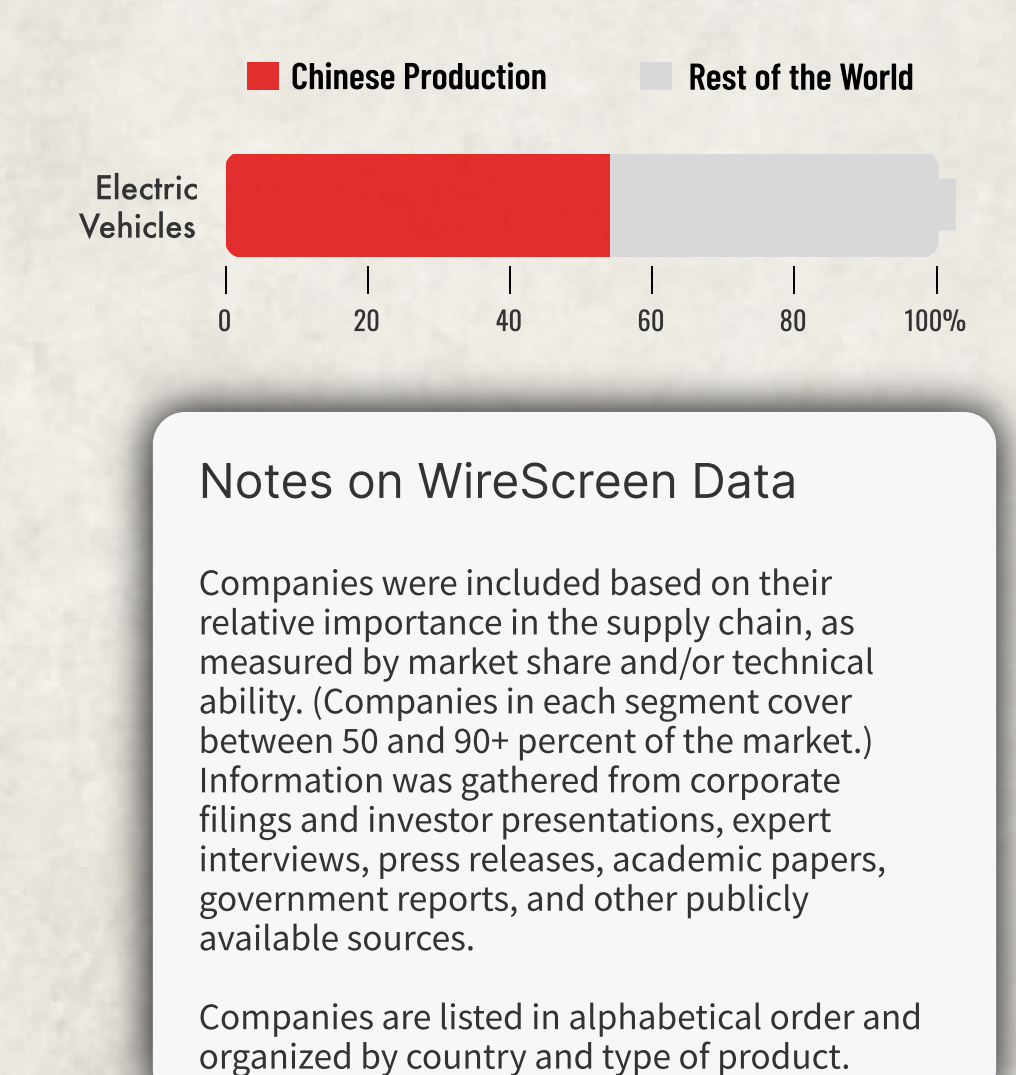
BATTERIES

Battery companies take the various battery materials as inputs and produce the final EV battery, either as a battery pack or as individual battery cells to be put together by auto manufacturers.



EVs (ELECTRIC VEHICLES)

Many legacy car-makers are transitioning to electric vehicles, but the world's leading EV manufacturers are pure-play EV firms Tesla and BYD. Relatively unknown until recently, BYD has become China's EV champion.



Recycling companies break down old batteries and extract their useful chemicals. Currently only a small percentage of li-ion batteries are recycled, but battery manufacturers expect a boom and are investing heavily in this sector.

