

The Critical Mineral Supply Chain: Evolution and Revolution as New Battery Technologies Emerge

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Abstract

Energy storage is the key to widespread adoption of renewables, and the resulting exponential growth in battery production creates demand for raw materials. Currently, this critical mineral supply chain resides mainly in China. Those few minerals with significant extraction in other countries are largely processed to industrial grade in China prior to shipment to battery manufacturers, of which 75 percent are in China as well. The lead time on design specifications for most materials is 3-5 years, so the use of the lithium ion battery, and the supply chain behind it, is baked into the production of batteries for electric vehicles for the coming decade. But what about the advent of new technology, including the use of new metals? Current research is in place to substitute aluminum for lithium, copper foam for liquid electrolyte, and iron fluoride plus polymer for cobalt- or nickel-based cathodes. Companies who mine platinum-group sulfides are researching ways to use them in batteries and replace the declining auto-catalyst market. Many reformulations rely on chemical and physical properties at the nano scale. In addition to metal substitutions, redox flow batteries (RFBs) create charge from excess renewable energy to draw electrons from one tank to another. Return to steady state generates electricity from the stored solutions. These batteries are large and not very portable, but have the advantage of separating power from energy, and are thus safer and easily scalable. Vanadium, iron, chromium and zinc are common metals used in RFBs, while non-aqueous RFBs use polycyclic aromatic hydrocarbons to improve energy density. Concentration of solar-voltaic energy in either silica or salt, to be released later in the form of light or heat, is another storage mechanism reliant on mineral raw materials. The latter has been commercially deployed, while the former is in testing. As each of these

battery technologies becomes cheaper and scales, the supply chain to support production will evolve. Miners in Bolivia and Australia are beginning to repatriate the value-adding segment of industrial processing. Common factors such as social licensing, recycling, zero-carbon mining and site restoration will add complexity as well as profitability to the evolving critical mineral supply chain.