A cost and resource analysis of sodium-ion batteries

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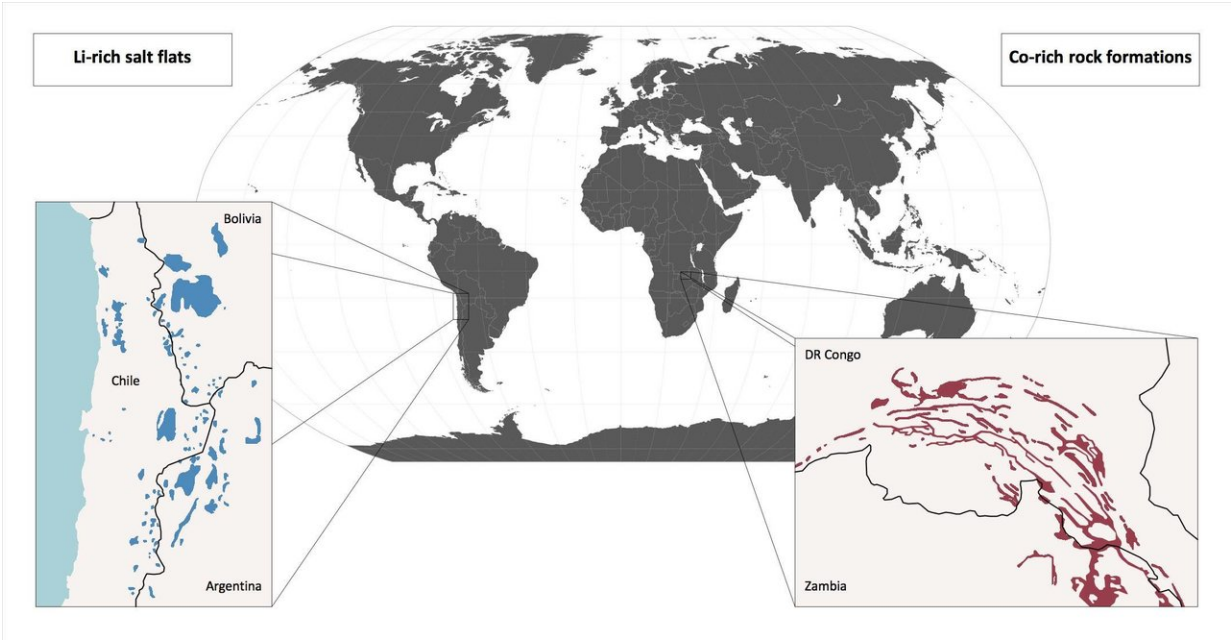

Regions with highly concentrated reserves: the 'lithium triangle' in South America and, for cobalt, the Copperbelt in Central Africa. Credit: Nature Reviews Materials

Lithium and cobalt are fundamental components of lithium-ion batteries. Analysis by researchers at the Helmholtz Institute Ulm (HIU) of the Karlsruhe Institute of Technology (KIT) shows that the availability of both elements could become seriously critical. Cobalt-free battery technologies, including post-lithium technologies based on non-critical

elements such as sodium, but also magnesium, zinc, calcium and aluminium, represent possibilities to avoid this outcome in the long term. These results are presented in *Nature Reviews Materials*.

Cobalt is a fundamental cathode component in lithium-ion batteries (LIBs), determining the high energy and power density as well as the long lifetime. However, as outlined in the article by Dr. Christoph Vaalma et al., cobalt is toxic and scarce. "In general, the rapidly growing market penetration of LIBs for electromobility applications, such as fully electric cars, will lead to an increasing demand for raw materials, especially with respect to lithium and cobalt," says Professor Stefano Passerini, who supervised the study together with Dr. Daniel Buchholz at the Helmholtz Institute Ulm.

Their scenario-based analysis of the applications of batteries through 2050 shows that cobalt shortages and price increases are likely to occur, since cobalt demand could be twice as high as today's identified reserves. In contrast, today's identified lithium reserves are expected to be much less strained, but the production will have to be strongly upscaled (possibly more than 10 times, depending on the scenario) to match the future demand. However, both elements are geographically concentrated in countries reported to be less politically stable. According to the researchers, this gives rise to concerns about a possible shortage and associated price increase of LIBs in the near future. "It is therefore indispensable to expand research activities toward alternative battery technologies in order to decrease these risks and reduce the pressure on cobalt and lithium reserves," says Daniel Buchholz. Stefano Passerini, HIU deputy director. "Post-lithium systems are especially appealing for electromobility and stationary applications. This is why it is both very important and urgent to unlock their potential and develop these innovative, high-energy batteries towards market maturity."

These results are further confirmed by the global scenario for battery

applications in the field of electromobility through the year 2050, recently developed at HIU and published as a book chapter. "The future availability of cobalt for the mass production of LIBs has to be classified as very critical, which is also evident from the price increase of cobalt higher than 120 percent within one year (2016-2017)," says HIU system analyst Dr. Marcel Weil. In addition, the establishment of a battery economy with a high rate of recycling would certainly be imperative to decrease the pressure on critical materials.

Both studies highlight the importance of new battery technologies based on low-cost, abundant and nontoxic elements, demonstrating the importance of further development in order to decrease the pressure on critical resources. To address this need, KIT and University of Ulm joined their efforts in the proposal for a Cluster of Excellence Energy Storage Beyond Lithium: New Storage Concepts For A Sustainable Future, focusing on the development of sodium-ion, magnesium-ion and other batteries based on abundant materials. The Centre for Solar Energy and Hydrogen Research Baden-Württemberg (ZSW) and the Justus-Liebig University Gießen are also involved in these efforts.

More information: Christoph Vaalma et al. A cost and resource analysis of sodium-ion batteries, *Nature Reviews Materials* (2018). DOI: 10.1038/natrevmats.2018.13

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