PRESS RELEASE

Fraunhofer FFB study confirms: Sodium-ion batteries are close to market readiness

According to a recent study by Fraunhofer FFB and the University of Münster, sodium-ion batteries are on the verge of industrial mass production. Especially for applications with lower energy density requirements, they already offer a viable and sustainable alternative. Expected material optimizations could lead to sodium-ion batteries also being used in electric vehicles in the coming years.

Münster. Sodium-ion batteries are considered environmentally friendly, but often also underperforming. "Our results show that this blanket assessment falls short," summarizes study author Philipp Voß, a research associate at Fraunhofer FFB. The technology is more diverse than previously assumed. "Depending on the cell chemistry, the energy density and carbon footprint can vary considerably," explains Voß. The study confirms this differentiation for the first time through comprehensive modeling based on industrial production data on a gigafactory scale, with a focus on energy density and carbon footprint.

Sodium-ion batteries on their way to the mass market

Next-generation battery technologies play a key role in the energy and mobility transition. Sodium-ion batteries are considered a promising alternative to lithium-ion technologies, primarily due to the greater availability of raw materials and potentially lower environmental impact. The study exclusively examined cell chemistries and materials that are currently being pursued and further developed by commercial manufacturers.

Already competitive CO2 balance

The study results show that sodium-ion batteries currently store even less energy than lithium-ion batteries based on lithium iron phosphate, especially in terms of volume. According to the study authors, this gap can be reduced through targeted material optimization and even completely eliminated in individual cell chemistries. "Cells with layered oxide cathodes are among the most promising candidates among sodium-ion batteries. They achieve the highest energy densities among the cell types examined," explains Voß.

According to the study, many sodium-ion cell chemistries also already perform well in terms of their carbon footprint. The use of hard carbon as an anode material in particular shows advantages. Compared to the synthetic graphite used in lithium-ion batteries, whose production is particularly energy-intensive, hard carbon can be produced in a much more climate-friendly way. "The low energy consumption in the production of hard

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carbon not only reduces emissions, but also the cost of the anode material – a decisive advantage over lithium-ion technology," explains Simon Lux.

Hard carbon with development potential

However, there is a weakness in terms of energy density: while battery cell manufacturers use different materials on the cathode side, hard carbon is the dominant anode material. This currently has a significantly lower specific energy than the graphite in classic lithium-ion batteries. However, hard carbon still offers scope for performance improvements. According to the study, targeted material improvements could increase energy density and reduce emissions by up to 11 percent. "Hard carbon is still the bottleneck in terms of energy density today," says Lux. "But the development potential is great. With targeted optimizations, the gap to lithium iron phosphate can be closed in the foreseeable future."

Ready for the Gigafactory

Sodium-ion batteries are already entering the battery market, and several companies are pursuing plans for Gigafactory-scale production. Drop-in technology in existing lithium-ion battery production lines significantly lowers market entry barriers and accelerates production growth. "With sodium-ion batteries, we have the opportunity to become geostrategically independent from countries such as China," emphasizes Simon Lux. "To leverage this potential, targeted funding for research and development of sodium-ion batteries is essential."

Scientific method and approach

The study "Benchmarking state-of-the-art sodium-ion battery cells – modeling energy density and carbon footprint at the gigafactory scale" analyzed only cell chemistries and materials currently being pursued by commercial manufacturers. The evaluation is based on industrial-scale processes: from active material synthesis to cell production in the gigawatt hour range. The underlying production data comes from Fraunhofer FFB machines. Large-format cells on an industrial scale were considered. The study is freely accessible in the scientific journal "Energy & Environmental Science."

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