

INTERVIEW: Factorial Energy on the role of solid-state batteries in EVs

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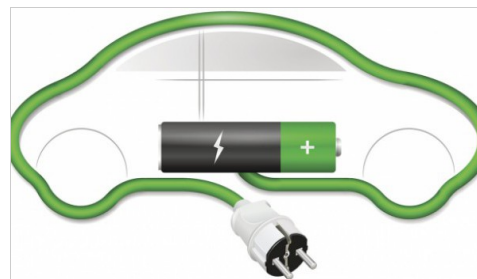
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Siyu Huang discusses solid-state batteries' potential in EVs, their benefits, and the importance of collaboration in the supply chain.

In this S&P Global Mobility interview, Siyu Huang, CEO and co-founder of Factorial Energy discusses the challenges and opportunities in the production and implementation of solid-state batteries (SSBs) in electric vehicles (EVs). Huang highlights the importance of collaboration and standardization to reduce costs and enhance sustainability in the supply chain.



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Huang explains that SSBs have the potential to address the limitations of current lithium-ion (Li-ion) batteries in EVs, such as range and cost. SSBs use advanced lithium anodes to pack more energy into smaller, lighter frames, increasing EV batteries' energy density and enabling longer driving ranges and faster charging capabilities. She further elaborates that their quasi-solid-state batteries combine the safety advantages of solid-state electrolytes with improved performance and manufacturability.

Huang also discusses the role of metallic anode material, such as lithium, in achieving higher energy densities in SSBs. She mentions that lithium metal as the anode can create cells with 50% higher energy density compared to lithium-ion batteries. The interview also covers the potential supply restrictions for battery raw materials, the charging rate of SSBs compared to conventional lithium-ion batteries, and the integration of solid-state technologies in today's batteries.

Key takeaways:

- Li-ion batteries in EVs are hitting their limits in range and cost due to the extra weight needed for more range, resulting in less efficient, heavier vehicles. Next-generation SSBs, using lithium anodes, offer more energy in lighter, smaller packages, improving energy density for longer range, quicker charging and less degradation. Factorial Energy claims its quasi-solid-state batteries merge the safety of solid-state electrolytes with enhanced performance and manufacturability, potentially extending EV range by up to 50% and reducing battery weight by over 200 lb compared to current Li-ion batteries.
- Integration of solid-state batteries requires close collaboration with equipment manufacturers for custom machinery and OEMs to overcome extensive development processes and strict regulations. While today's Li-ion batteries benefit from silicon anodes, the future is geared toward solid-state batteries with lithium metal, claims the supplier.
- Automakers are pushing the limits of higher energy densities with higher nickel and lower cobalt content, but they are hitting a wall, especially as lithium-ion batteries reach their theoretical limit and safety becomes an issue. Artificial intelligence (AI) and machine learning are being adopted for better fast charging. Past efforts to reduce battery costs have relied on economies of scale, but beyond 40–60 GWh factories, the returns diminish, and infrastructure burdens increase. This is where SSBs come in, says the company, breaking through the ceiling to achieve higher energy density and lower costs, promising to make EVs lighter and more efficient.

US-based [Factorial Energy](#) develops solid-state batteries. Its FEST® (Factorial Electrolyte System Technology) makes use of a solid electrolyte substance, which holds the promise of facilitating dependable and safe cell performance with high-capacity anode and cathode materials. The company has entered into joint development agreements with [Mercedes-Benz](#), [Stellantis](#) and

Hyundai.

The following is an edited transcript of the conversation.

S&P Global Mobility: Could you elaborate on the challenges related to the supply chain, specifically in procuring lithium metal for SSB, and how Factorial Energy is addressing these challenges?

Siyu Huang: There is a need for improved collaboration and standardization to reduce costs and enhance the sustainability of the supply chain. It has been a slow start, but it is finally picking up momentum. We work closely with our automotive partners, Stellantis, Hyundai and Mercedes-Benz, which share the same priorities and wield a huge amount of influence and purchasing power, to lead the charge toward a cleaner supply chain. Together, we are pursuing carbon neutrality by mid-2030, and working to secure several certifications related to how we produce and ship our batteries.

Lithium is not something we see as a limiting factor for several reasons, chiefly that it is naturally abundant and there is a growing industry for mining and refining around the world, especially in partner economies. That said, we are still developing robust end-of-life solutions as the Li value chain matures. Our FEST platform has a much higher utilization from recycling than traditional EV batteries, ensuring a better lifetime value chain. We have partnered with [Young Poong](#) to advance research on lithium-metal recycling for solid-state batteries, which is a new frontier, to enable more reusability.

As a US company, we are also working to build domestic battery manufacturing competency but there is work that needs to be done. While the Inflation Reduction Act (IRA) has been encouraging, more support is needed to break the EV industry's reliance on foreign material and equipment imports. We need local lithium suppliers and more investment in the piloting and scaling of next-generation innovations that provide the opportunity to leapfrog the incumbent lithium-ion industry, which is controlled by Asian battery cell makers.

Can you explain the advantages of SSB in addressing the range and charging time concerns for electric mobility, particularly in terms of the technology's reliance on solid material electrolytes?

EVs currently built with Li-ion batteries are hitting their physical limit in range and cost, as increasing vehicle range requires more battery weight. Additional batteries lead to a higher curb weight detracting from vehicle efficiency. This is why we are seeing EVs weighing hundreds to thousands of pounds heavier than similar-sized gas vehicles.

Next-generation SSBs use advanced and more efficient lithium anodes that allow the batteries to pack much more energy into smaller, lighter frames. Moving the anode to lithium, the lightest metal on earth with superior electrochemical potential, increases EV batteries' energy density — this enables longer driving ranges and faster charging capabilities without degrading the battery as quickly and with less concern about thermal runaway. Furthermore, due to their lower weight and more compact volume, SSBs have a smaller footprint than the heavier and bulkier batteries on the market today.

Our quasi-solid-state batteries combine the safety advantages of solid-state electrolytes with the improved performance and manufacturability of the cell. They have the potential to extend the driving range for EVs up to 50% and reduce battery weight by over 200 lb compared to lithium-ion

batteries in EVs today.

How does the use of metallic anode material, such as lithium, contribute to achieving higher energy densities in SSB?

Lithium metal is the lightest metal on earth and has the highest capacity as the anode. Lithium metal as the anode can create cells with 50% higher energy density compared with lithium-ion batteries. The high stability across a broad range of voltages enables the use of both a high-capacity cathode, such as 811, and a high-capacity anode, such as silicon or lithium metal. Traditional liquid electrolytes cannot be used with lithium metal anodes as they do not effectively inhibit the formation of dendrites and do not possess the correct chemical makeup to work with the metal, which can lead to short circuits and battery failure.

While all solid-state electrolytes offer improved resistance to dendrite formation, our proprietary FEST® system leverages a quasi-solid-state material that is also usable with lithium metal anodes. It combines the safety advantages of solid-state electrolytes with the improved performance and manufacturability of liquid electrolytes to achieve a 20–50% higher energy density over today's lithium-ion batteries.

Considering that polymer-based SSBs are already in use in vehicles, such as the Daimler eCitaro, what factors might drive the broader market adoption of SSBs, especially in the short term? And how do hybrid SSBs fit into the transition route?

We do not have enough information to comment on the use of eCitaro batteries, but we can share our major differentiator compared with traditional polymer-based SSBs. Traditional polymer-based SSBs would require higher temperatures to maintain operation. For our system, we do not require elevated temperatures but do reserve the high temperature stability. We also perform well at room temperature.

Another important differentiator for us is our compatibility with both high-capacity cathode and anode materials. Some technologies are not compatible with high-capacity cathode materials, such as 811 but are compatible with high-capacity anode materials, such as lithium metal. Some are compatible with lithium metal but not with 811, and therefore, can only operate with low energy density batteries, such as LFP.

We believe there will be potential supply restrictions for the battery raw materials in the medium and long-terms. How does this affect the SSB penetration that promises larger battery packs that use larger amounts of raw materials especially lithium?

We should be better positioned because we use less cobalt compared with traditional lithium-ion batteries by providing better safety with our high-capacity cathode. Our FEST® system also has a much higher utilization from recycling than traditional EV batteries, which will reduce the need for raw materials in the long run. Furthermore, our technology's improved safety profile reduces the need for vehicle-level thermal management systems, creating a lower overall cost, and its high energy density means OEMs will need less battery for the same mileage.

How do you evaluate the charging rate of the SSBs compared with the conventional lithium-ion batteries? In our customer surveys, the cost, long-charging speed and lack of charging infrastructure usually rank first as the biggest pain points of having an EV. How does SSB tackle these problems?

Conventional liquid electrolytes offer high ionic conductivity, ensuring efficient charge and

discharge processes, but they pose safety risks due to their high flammability. When it comes to SSB charging advantages, we are looking at speed and safety. SSBs have fast-charging capabilities without degrading the battery as quickly, and with less concern about thermal runaway.

SSBs are set to significantly mitigate range anxiety in EVs by providing a more energy-dense, yet lighter and smaller battery solution, enabling longer driving ranges and faster charging without the drawbacks of traditional lithium-ion batteries. However, many drivers may still have range anxiety due to the small number of charging stations available. As battery innovation improves EV performance, there also needs to be significant investment in reliable charging infrastructure — drivers need to see ample places to charge, with less broken chargers and waiting for public chargers to become available, to feel confident enough to buy an EV. Public investment will be key to ensure charging infrastructure is deployed equitably and prevents “charging deserts” that leave less economically advanced communities out of the EV future.

How do you envision the integration of solid-state technologies in today’s batteries, and what role might other technologies, such as silicon anodes play in this evolution?

The integration of solid-state batteries will require close collaboration with equipment manufacturers to develop machinery tailored to specific manufacturing needs and OEMs to overcome the lengthy development processes and strict regulatory requirements needed for progressing to commercial-scale production.

Silicon anode works for today’s technology and is good for lithium-ion batteries, but SSBs with lithium metal is the future.

Even if technology challenges are overcome, what uncertainties exist regarding the ability of SSB to bring down production costs in time for a rapid rollout of EVs?

New technologies always have challenges when it comes to production costs but when they scale, the costs come down. The fundamental cost of SSBs should be very competitive with lithium-ion batteries. The overall cost of vehicles should also be lower due to the benefits of the significantly reduced weight, up to 50%, from SSBs.

In addition, our production process is more than 80% compatible with lithium-ion batteries while the rest of our process remains comparable on cost. Uncertainties that exist remain around how we will be able to scale production in the US in a cost-effective manner.

Could SSB be limited to specific segments or applications if production costs remain high?

We believe EV batteries are the key to the commercialization of SSBs and their eventual adoption by adjacent industries, such as energy storage and aviation. As stated previously, we fully anticipate being cost-competitive once operations are fully scaled. That said, SSB costs need to go down significantly to make sense for energy storage applications for example.

At the initial stage of scale, any technology can be expensive, especially in the US, regardless of whether it is nickel-manganese-cobalt (NMC), lithium-iron-phosphate (LFP) or SSB. Therefore, when the initial scale is small, some high spec applications, such as aviation, could be potentially more price tolerant.

What role could SSB play in unlocking new possibilities and reimagining the future of transportation?

The battery industry has been awaiting disruption for 20 years. SSBs address persistent barriers to EV adoption, range anxiety and cost, and present an opportunity for the US to build its battery manufacturing competency and cement its leadership position in mobility.

Aside from SSB, are there alternative technologies being explored by automakers to achieve lighter, cheaper and faster-charging EVs?

Automakers are exploring higher nickel and lower cobalt content in cathode material to achieve higher energy densities, but they are reaching the limit of how high they can make the energy density while keeping the cobalt content close to zero. Safety is also becoming problematic as lithium-ion batteries reach their theoretical limit. To build better fast charging, various OEMs have adopted AI and machine learning.

To reduce battery cost in the past, automakers have looked to achieve economies of scale. However, beyond the 40–60 GWh factories, there are diminishing returns on the cost of batteries and added burden on the infrastructure for those factories. Hence, a new technology, such as SSBs, is needed to break the ceiling to achieve higher energy density (weight) while lowering cost. SSBs are set to make EVs substantially lighter and more efficient.

S&P Global Mobility comment:

The anticipation for the introduction of SSBs in the industry has been ongoing, but it's improbable that their arrival will be timely enough to alter the current discourse surrounding EVs. Initially, SSBs will carry a high price tag, likely making them exclusive to luxury brands and failing to meet the unmet EV demand at more affordable price points. According to the most recent predictions from [S&P Global Mobility](#), by 2034, EVs equipped with solid-state batteries will make up slightly less than 4% of total production. Further solidifying this narrative, it has been reported that Toyota's plans for large-scale production of solid-state batteries starting in 2027–28 will only result in an annual production slightly exceeding 10,000 units by 2030.

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