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Redox flow batteries have a reputation of being second best. Less energy intensive and slower to charge and discharge than their lithium-ion cousins, they fail to meet the performance requirements of snazzy, mainstream applications, such as cars and cell phones. There"s no such thing as a flow-battery Tesla.

But the companies at the International Flow Battery Forum in Prague in late June were adamant that flow batteries are now cheaper, more reliable, and safer than lithium ion in a growing number of real-world stationary energy applications. Flow-battery makers say their technology--and not lithium ion--should be the first choice for capturing excess renewable energy and returning it when the sun is not out and the wind is not blowing.

"Slowly but steadily, flow batteries are gaining their place in the energy storage space. It"s not about will it happen but how fast it will happen," said Kees van de Kerk at the start of the Prague forum. Van de Kerk is president of the industry group Flow Batteries Europe and managing director of the flow-battery firm Volterion.

In standard flow batteries, two liquid electrolytes--typically containing metals such as vanadium or iron--undergo electrochemical reductions and oxidations as they are charged and then discharged. Held in tanks that can be as big as shipping containers, the electrolytes release electricity when they are pumped over electrodes separated by an ion-exchange membrane. On charging, ions from one electrolyte move through the battery"s membrane to the second electrolyte.

Hundreds of flow batteries are already in commercial use. Almost all have a vanadium-saturated electrolyte--often a mix of vanadium sulfate and sulfuric acid--since vanadium enables the highest known energy density while maintaining long battery life. Vanadium in the anolyte, the electrolyte solution at the cell"s anode, switches between the +3 and +2 states of oxidation. In the catholyte, the electrolyte at the cell"s cathode side, vanadium switches between states +4 and +5.

The Anglo-American firm Invinity Energy Systems claims to be the world"s biggest vanadium flow-battery supplier; it has more than 275 in operation and a growing number of projects planned. The company builds its batteries inside 6 m long shipping containers, making them easy to transport and ready to plug in once on site.

The sweet spot for flow batteries is providing between 10 and 36 h of energy--a range known as interday--when power grids don"t have enough electricity to meet demand, Invinity"s CEO, Larry Zulch, said at the conference. This interday matchup of flow batteries with energy demand means "the killer app for flow batteries is wind," Zulch said. When paired with wind power, Invinity"s batteries can deliver power at 25-30% less cost than lithium-ion systems, he claimed.

By 2030, flow batteries could be storing about 61 MW h of electricity each year and generating annual sales for producers of more than $22 billion, Zulch said. "We have a big opportunity here. The numbers are staggering." Energy companies are obvious customers. Utilities such as wastewater treatment plants are also seeking energy security and want to avoid peak-time electricity tariffs.

Despite such projections, the flow-battery sector remains largely unknown. "We need to mainstream flow batteries," Zulch said. "People say, "Invinity, what do you do?" I say we make vanadium flow batteries. And they say, "What are those?" "

Several firms, including Enerox and Sumitomo Electric Industries, are also selling vanadium flow batteries in greater numbers worldwide, but the market is still small compared with lithium ion.

An inherent shortcoming of vanadium flow batteries is that they have an energy density of about 30 W h/L, about 10% of that of lithium-ion batteries. But big lithium-ion batteries need to be spaced far apart in case they catch fire, so they still take up a lot of room, said Thomas L?th, vice president of flow batteries at Voith Group, a provider of renewable energy services.

In contrast, flow batteries pose a minimal fire risk on account of the high water content in their electrolyte. As a result, they can be stacked on top of each other or even positioned safely inside a building, said Ellen Loxley-Sl?ttsveen, head of business development at Bryte Batteries, a Norwegian flow-battery producer.