

Turning Toxic Waste into Batteries

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The vanadium flow battery is a promising technology for energy storage at the grid and microgrid levels, but like any other storage device, it has flaws. Low power density, expensive materials, and instability at high temperatures have kept flow batteries on the fringe of the energy storage market. Over the past two years, Imergy Power Systems has made breakthroughs that could bring this technology into the mainstream. I spoke with engineers from Imergy Power Systems, who gave me the lowdown on their advances in flow battery technology.

Flow Battery Basics

A flow battery consists of two tanks containing liquid electrolytes and a chamber with electrodes separated by a membrane. As electrolytes are pumped into the electrodes, a chemical reaction generates electricity. In theory the electrolytes can be recharged an infinite number of times, making this an ideal rechargeable battery.

In vanadium flow batteries, vanadium is the electrolyte. Battery makers use high grade vanadium, which is about 99% pure, because impurities cause side reactions that reduce storage capacity. But high grade vanadium is expensive, making the batteries high priced compared to other battery technologies.

The Breakthroughs

Engineers at Imergy developed a process that allows them to use low grade vanadium, a waste product of abandoned oil wells and mines. By adding a patented masking agent to the low grade vanadium electrolyte, side reactions are suppressed, allowing the battery to achieve a higher state of charge. In addition, a stabilizer (also patented) is added to the electrolyte, increasing its viscosity and reducing stratification. Imergy's technology doubles the energy density of vanadium flow batteries and increases their high temperature stability. Where other vanadium batteries top out at around 30C (86F), Imergy's are stable up to 55C (131F) with no cooling required.

One Man's Trash Is Another Man's Treasure

The batteries' tolerance of low grade vanadium makes them less expensive than their high grade vanadium counterparts. Even better, vanadium, a toxic waste product found in slag, fly ash, and byproducts from diesel production, is removed from the environment and put to good use rather than taking up space in a chemical waste landfill. That's a pretty nice two-for-one deal.

Proven Technology

Imergy's flow batteries are operating at over fifty locations in India, China, Africa, South America, and Europe. In the US, Hawaii is adding Imergy batteries to its burgeoning photovoltaic industry, and the US Navy will be using them for its microgrids. In addition to their use in grid/microgrid storage, low grade vanadium batteries are replacing diesel generators as backup power in off-grid sites powered by renewable energy.

Imergy's batteries cost about \$500/kWh, making them a little more affordable than Li-ion batteries. With improvements in technology, materials, and manufacturing processes, the company expects that price to drop to \$300/kWh within the next year. Since 40% of a battery's cost is in the electrolyte and vanadium

has an infinite number of recharge cycles, the total cost of ownership could be considerably lower than for Li-ion batteries.

Powering the Future...

Flow batteries don't lend themselves well to electric vehicles, but that's not the market that Imergy is shooting for. They're out to capture grid storage and microgrid customers, but they also see a future behind the meter in residential markets. As power companies begin to charge higher rates for peak time usage, homeowners may see a benefit to buying and storing energy during off-peak hours and using stored energy during peak hours. Homes with renewable energy may be taking advantage of net metering, but there's no guarantee that net metering will always be an option. In Germany, PV customers have incentives to include on-site energy storage in order to ease the stress on the power grid. A low-cost, long-life battery is perfect for those applications, and low grade vanadium flow batteries might be the technology of choice.