UltraCell: A Portable Power Plant

Lawrence Livermore Natl Lab
University of California, Berkeley (UC Berkeley)

After Hurricane Katrina ripped up the United States' Gulf Coast in August 2005, countless hospitals, clinics and nursing homes were left without electricity for days and even weeks. In the city of New Orleans alone, some two dozen hospitals had to be evacuated because of the loss of power, water and sewage service, according to a 2006 report by the Urban Institute. While portable power generators pumped electricity to critical care areas, many people died sweltering in temperatures that exceeded 100 degrees Fahrenheit.

Natural disasters such as Katrina revealed just how much we depend on energy during an emergency. They also demonstrated the need for making energy last longer, and for portable devices that can go where they're most needed.

A company called UltraCell in Livermore, Calif., is working to address these needs. UltraCell is making the world's first micro-scale fuel cells, which run on clean energy — methanol — and due to their compact size, are highly portable.

While these innovative fuel cells currently can power computers, they're being developed for larger applications, such as power generators, that could make a big difference in future Katrina-like disasters.

A Small Energy Solution for Big Energy Problems

A fuel cell is an electrochemical energy conversion device that produces electricity quietly and effi ciently, without pollution. Unlike power sources that use fossil fuels, the byproducts from a hydrogen fuel cell are benign — heat and water.

The UltraCell technology is a high-power, high-energy-density fuel cell system for portable electronics applications, ranging from military to laptop computing, to police and industrial use.

Demonstrating a preproduction device at an Intel Developers Forum in 2006, UltraCell Chief Executive James Kaschmitter said, "Our fuel cell systems literally cut the cord to electrical dependence."

While fuel cells have been around for a while, UltraCell has managed to address one of the major stumbling blocks associated with their widespread use: energy density. An interdisciplinary team at Lawrence Livermore National Laboratory in Livermore, Calif., figured out how to get the most bang for the buck in fuel cell technology — reducing the size of the cell while at the same time increasing the amount of energy it can store.

The project that led to the development of these micro fuel cells began in the Chemistry and Materials Science and Energy Directorates of the Lawrence Livermore National Laboratory, with funding from the U.S. Department of Energy. While many years of work had gone into the use of hydrogen in fusion, in the 1990s researchers at the lab began looking into developing hydrogen as a source of fuel. Right away it was clear they needed to create smaller-scale devices.

"Fuel cells had always been very large in scope and size," said Alan Jankowski, one of the inventors of the technology and now a professor of mechanical engineering at Texas Tech University in Lubbock. "You could power a bus with a fuel cell, but the fuel cell would be about as big as the bus."

With a background in materials science, Jankowski had been working on creating thin fi lm coatings for application in fuel cells, trying to develop the cells on a smaller scale. When he began collaborating with Jeff Morse, an electrical engineer at Lawrence Livermore with a specialty in microelectromechanical systems (MEMS) and nanofabrication, the results were revolutionary.

"When people started looking at smaller fuel cells, they were looking at taking a large (90 watt) device and making it smaller," Morse said. "We decided to take MEMS and microscale approaches and blend them together to create a new paradigm."

In other words, instead of using existing technology to take something big and scale it down, Jankowski and Morse decided to start — and stay — small.

"People were trying to minimize the real estate of a fuel cell with traditional machining," Morse explained, "but if you want to work on the scale of cubic centimeters, you need MEMS."

Teamwork Leads to Commercialization

The team of inventors made their first invention disclosure to the Lawrence Livermore Office of Technology Partnerships and Commercialization in 1997. The group, led by Jankowski and Morse, included chemists and chemical

engineers, mechanical engineers, materials scientists and energy experts, as well as doctoral and postdoctoral students from the nearby University of California, Berkeley. This group worked collaboratively for five years to miniaturize the components of a hydrogen fuel cell. Although the bench top devices were demonstrated, they still didn't have a commercial product.

Then came Kaschmitter, a former Livermore staff engineer and serial entrepreneur with a background in energy storage, who saw a real need for the new, small-scale fuel cell technology.

> *As soon as the concept had been sufficiently proven, he wanted to bring it to market.*

"I wanted to take an interesting technology and make a product that people would really use," Kaschmitter said. "Jeff and his group had proved the viability of the technology. We saw the potential to turn it into a product."

Kaschmitter says collaboration was critical to the success of the project. "Scientists at the lab are working in basic research, they're not thinking about the market, so they needed practical information, which I could bring."

He worked with the researchers for several months and when it became clear it would work, formed the company UltraCell, which licensed the technology in 2002. The company recently opened a plant in Vandalia, Ohio, and is expected to generate more than 300 jobs in the region.

Aside from offering a clean source of energy, hydrogen fuel cells offer a safer, better way to store energy, especially as compared with lithium batteries, according to Kaschmitter.

"Cell phone and laptop lithium-ion batteries have reportedly exploded or caught fi re, and if you try to put more energy into them, it could create a safety hazard," he said.

The number one advantage of fuel cells over batteries, according to Kaschmitter, is that they are lighter weight, and offer more energy. Batteries in today's cell phones and laptops last only three or four hours. He says soldiers in the field today routinely carry up to 30 pounds of batteries on missions that can last a week or more.

He's heard anecdotal evidence from military leaders — stories about batteries going dead in the middle of an air strike, for example. "Today's soldiers increasingly rely on portable electronics, such as GPS systems and radios, so portable power can be a critical life-protecting component for them," Kaschmitter said.

The military is the company's first customer, and it's a good place to start, according to Kaschmitter. "The military provides field testing with very high standards, plus it gives us a higher price point during production startup," he says. "Now, we're going from military to industrial markets, to provide portable power that will run for a long time."

While UltraCell technology is currently geared toward small devices, such as laptops and portable telecommunications equipment, Kaschmitter says it may one day have larger-scale uses. These include providing power at remote construction sites, or backup power for homes, apartment buildings and hospitals. UltraCell could also be used in the rental power market, which provides electricity for concerts and other large public events.

And, as mentioned earlier, UltraCell technology could be a vital resource in disaster relief efforts. It's a small-sized solution for large-scale problems.

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