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Next Stop: Ultracapacitor Buses

A U.S.-Chinese venture is out to prove the benefits of quick-charge buses.

By Tyler Hamilton on October 19, 2009

Municipal transit agencies have tried to reduce the carbon footprint of their bus fleets using a range of options over the years, from biofuels and hydrogen to batteries and hybrid-electric diesel. Now a Chinese company and its U.S. partner say that ultracapacitors could offer the greenest and most economical way of powering inner-city buses.

There's just one catch: the best ultracapacitors can only store about 5 percent of the energy that lithium-ion batteries hold, limiting them to a couple of miles per charge. This makes them ineffective as an energy storage medium for passenger vehicles. But what ultracapacitors lack in range they make up in their ability to rapidly charge and discharge. So in vehicles that have to stop frequently and predictably as part of normal operation, energy storage based exclusively on ultracapacitors begins to make sense.

Sinautec Automobile Technologies, based in Arlington, VA, and its Chinese partner, Shanghai Aowei Technology Development Company, have spent the past three years demonstrating the approach with 17 forty-one seat municipal buses on the outskirts of Shanghai. On October 21, the two companies will offer a one-day demonstration at American University in Washington, DC, where an 11-seat minibus running on ultracapacitors will spend the day shuttling people around campus.

The trick is to turn some bus stops along the route into charge stations, says Dan Ye, executive director of Sinautec. Unlike a conventional trolley bus that has to continually touch an overhead power line, Sinautec's ultracapacitor buses take big sips of electricity every two or three miles at designated charging stations, which double as bus stops. When at these stations, a collector on the top of the bus rises a few feet and touches an overhead charging line. Within a couple of minutes, the ultracapacitor banks stored under the bus seats are fully charged.

"It's a brilliant concept," says ultracapacitor expert Joel Schindall, professor of electrical engineering and computer science at MIT. "It's not well suited for electric-only cars, but it is practical to stop a bus every few city blocks."

The buses can also capture energy from braking, and the company says that recharging stations can be equipped with solar panels (although this is mainly to further the perception that the vehicles have a lower carbon footprint). Ye says the buses use 40 percent less electricity compared to an electric trolley bus, mainly because they're lighter and have the regenerative braking benefits. They're also competitive with conventional buses based on fuel savings over the vehicle's 12-year life, based on current oil and electricity prices. Sinautec estimates that one of its buses has one-tenth the energy cost of a diesel bus and can achieve lifetime fuel savings of $200,000.

"The ultracapacitor bus is also cheaper than lithium-ion battery buses," says Ye. "We used the Olympics (lithium-ion) bus as a model and found ours about 40 percent less expensive with a far superior reliability rating." Ye adds that the environmental benefits are compelling. "Even if you use the dirtiest coal plant on the planet, it generates a third of the carbon dioxide of diesel when used to charge an ultracapacitor."

Credit: Sinautec Automobile Technologies

Tagged: Energy, renewable energy, battery, transportation, ultracapacitors, fuel, carbon dioxide emissions, lithium-ion batteries, renewable fuel

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Buses in the Shanghai pilot are made by Sunwin Bus, a Chinese joint venture company with Volvo of Sweden, and uses ultracapacitors manufactured by Shanghai Aowei. Foton America Bus, based in Germantown, TN, will be manufacturing the ultracapacitor buses that will be sold in the United States. The ultracapacitors are made of activated carbon and have an energy density of six watt-hours per kilogram. (For comparison, a high-performance lithium-ion battery can achieve 200 watt-hours per kilogram.) Clifford Clare, chief executive of Foton America, says another 60 buses will be delivered early next year with ultracapacitors that supply 10 watt-hours per kilogram.

“The ones in Shanghai right now have been on the road for three years without incident, without failure whatsoever, which in the bus industry is phenomenal,” says Clare, who adds that his company is in talks with New York City, Chicago, and some towns in Florida about trialing the buses. “It will end up being a third generation of the product, which will give 20 miles [of range per charge] or better.”

Sinautec is also in discussions with MIT’s Schindall about developing ultracapacitors of higher energy density using vertically aligned carbon nanotube structures that give the devices more surface area for holding a charge.

“So far we’re able to get twice the energy density of an existing ultracapacitor, but that’s not enough,” says Schindall. “We’re trying to get about five times.” Schindall says that this would create an ultracapacitor with one-quarter of the energy density of a lithium-ion battery.

“Right now the [Foton] buses can only go every other stop, a range of about 5 or 10 city blocks, and that’s okay for some routes, but here in the Boston area that would be too far [between charging spots],” Schindall adds. “If they could double that, or even quadruple that, it would increase by an order of magnitude the numbers of routes for which it could be a technical solution.”

There are some other important limitations. The 41-passenger buses, based on current technology, lose 35 percent of their range when air conditioning is turned on (from about 5 miles to about 3 miles), and have weak acceleration. But even under these conditions, they could still prove practical for municipal,

campus, airport, and tourist buses.

“We want to replace a large portion of the diesel fleet in the United States,” says Ye. “We do need to have charging stations throughout various points of the network, but as energy density goes up, the number of stations will go down.”

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