Green

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Saving Electricity on a Philadelphia Subway Line

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Septa

On the Market-Frankford subway line of the Southeast Pennsylvania Transit Authority, batteries will capture some energy that is generated when a train brakes, and hold it until it is needed.

Science

Subway trains need a lot of electricity to get going, turning electricity into kinetic energy, the energy of movement. When they pull into a station, many of them can do the opposite: generate electricity from their momentum. They turn their motors into generators to slow the train, producing current.

But in many systems, some of that energy goes to waste because of a bottleneck: the third rail, which carries current to the train, cannot handle as much energy as the train is

generating during deceleration. Too much current pushes up the voltage, and when the voltage gets too high, the electricity is dissipated by running it through a piece of metal that converts it into heat.

But in Philadelphia, on the Market-Frankford line of the Southeast Pennsylvania Transit Authority, a new company called Viridity Energy will install batteries to capture a lot of that electricity and hold it while the train is in the station. Then it can deliver the power when the train starts up again or store it for a time of day when it is needed more.

“Economically, it will identify what’s the best thing for Septa to do, based on hours and prices in the market,” said Audrey Zibelman, the founder, president and chief executive of the company, which is based in Conshohocken, just west of Philadelphia.

Yet the batteries are fairly small. The whole installation stores only about 400 kilowatt-hours, which a house with central air conditioning could consume in a week or maybe less. But it can accept or discharge energy fast, at a rate of about 800 kilowatts — enough to run about 800 window air conditioners going full blast.

For short periods the battery pack can handle 1.5 megawatts. That’s about half of the theoretical maximum that a train could put out while it was braking, according to Kevin Morelock, director of the project. (The other half would go on the third rail system.) The amount of electricity the batteries will capture during each deceleration is small, 2 to 4 kilowatt-hours.

The trick is that Septa has thousands of train stops a year, so the system will empty and refill quite frequently. They will hold less than a dollar’s worth of electricity in each cycle but should save $135,000 a year for the transit authority, Ms. Zibelman said. The energy savings should reach 1,500 to 1,600 megawatt-hours a year, she said, enough to run 1,000 suburban houses for a year.

The batteries, to be built by Saft, a major manufacturer, will sit by the side of the tracks in a box that looks like a shipping container. Beyond capturing electricity, they will perform a second function: help keep the alternating current of the regional electric grid working at exactly the right rate.

The system is nominally 60 cycles, meaning that the electrons reverse course 60 times per second, but in practice that varies from 59.999 to 60.001. When it strays from that range, someone has to add or subtract energy, a service that the grid operators will pay cash for.

For technical reasons, frequency control is becoming more of a challenge; because natural gas-fired plants and wind turbines generally do not regulate the frequency of the grid as well

as old-fashioned coal plants do, some experts say, the job is getting harder. In New York, one company recently opened a plant that does this regulation work with flywheels.

Viridity, which plans to go into operation by the end of this year, will be hooked up by computer to the operator of the regional power grid, PJM. (The letters used to stand for Pennsylvania-Jersey-Maryland, but the system now sprawls from Delaware to Ohio and beyond, covering parts of 14 states.) Every few seconds, it can add energy or subtract it from the subway system's third rail network. That will change Septa's demand on the regional grid in a way that helps keep the grid at the proper frequency.

A third company, Envitech of Pointe-Claire, Quebec, will supply the electronic control system.

The project will cost $1.6 million, part of which will come from the Pennsylvania Energy Development Authority. Viridity says it will demonstrate that such projects can pay for themselves in savings.

Saft

Batteries manufactured by Saft of France will sit in a box near the train tracks.