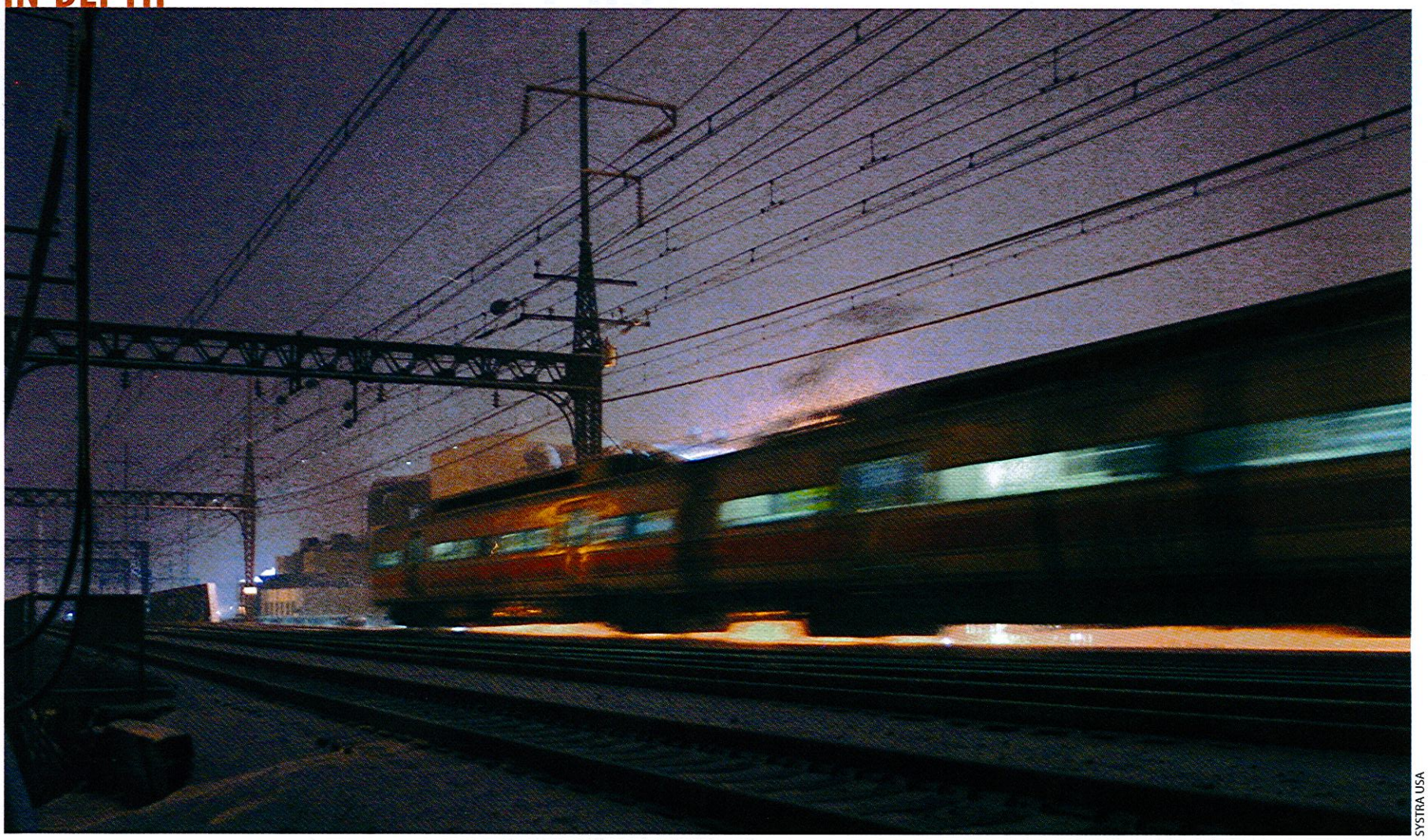

SYSTRA USA

Smart Grids and Wayside Energy Storage

Opportunities for Transit

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The emergence of "smart grid" technologies and systems for monitoring and controlling electric power flows will have important implications for rail transit agencies, including the potential to significantly impact the way agencies purchase electric power, typically one of the largest items in their budgets. As rail transit is a large local user of electricity, agencies may be called upon to acquire and install new equipment for energy monitoring and distribution. However, the "smart grid"—coupled with new wayside energy-storage devices—will create the potential for collaboration between transit and electric power utilities opening up new cost-sharing opportunities.

What Is a Smart Grid?

Smart grids are the application of communications and information technologies to the electric power transmission and distribution network. Smart grids use two-way communications, advanced sensors, and distributed computers to improve the efficiency and reliability of electric power delivery and use.

For many years, experts have recognized the need to modernize the U.S. electric power grid. Over the past few decades, additions to power generation have far outpaced upgrades in transmission and distribution, and as a consequence, much of the current infrastructure is aging, outmoded, and overburdened. Several major power corridors are at maximum capacity more than 80 percent of the time—the equivalent of rush hour traffic from 5 a.m. to midnight. The annual loss to U.S. businesses from power outages, power quality problems, and other grid failures is estimated at approximately $150 billion per year.

Deploying the smart grid became official U.S. policy with the adoption of the Energy Independence and Security

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Act in December 2007. Sophisticated software now under development will enable moment-by-moment decisions on power allocation across the grid communication network. Some have described the level of communication within a smart grid as analogous to bringing the power of the Internet to electricity distribution and use, predicting that the smart grid will result in a similar outpouring of knowledge and access.

With the smart grid, utilities will be able to shift power quickly and efficiently to where it is most needed. This will not only improve the stability and reliability of the grid but would also help prevent cascading power failures—such as the one that crippled the Northeast in 2003, affecting 40 million people. The smart grid will also save energy and money, by helping utilities to direct power more efficiently to meet demand at peak periods without having to invest in building expensive new generating plants.

Smart grids will require equipment to "talk" to the grid to enable utilities to better manage power supply to meet user demand. For instance, at the household level, "smart energy" meters will monitor and potentially regulate appliances such as dishwashers and washing machines based on energy demand conditions. Such meters are now being tested in several states, including California, Colorado, Florida, Texas, and Washington.

Transit and Utilities Share Interests in New Wayside Energy-Storage Technologies

As smart grids are deployed, transit systems will need to be integrated into them.

One key area of shared interest and potential collaboration between rail transit agencies and electric power utilities is energy storage. New wayside energy-storage technologies are now becoming available to help transit agencies capture energy that is often wasted.

Collaboration between public transit and utilities on new wayside energy-storage technologies would help address two areas of mutual concern: peak power demand and voltage sag.

For instance, new wayside energy-storage technologies would enable transit systems to store the energy that is captured from a braking train and release that energy for propulsion when and where it is needed. At present, conventional regenerative braking systems (used by an estimated 60 percent of U.S. rail transit systems) do not have this storage capability. If there is no nearby train that can use the regenerated energy (such as a train accelerating out of the same station), then the effective use of this energy is lost.

Peak loads are a growing problem for many power systems: the summer peak for power demand in 2005 equaled approximately 175 percent of average demand, compared with about 155 percent in 1980.

New energy storage technologies would potentially allow rail systems to use stored energy to "shave" the peaks in their electricity usage—a benefit to utilities (lowering the total demand for peak power across the grid) and to transit (by avoiding the costs associated with intermittent, high levels of peak power demand).

Another mutual benefit of wayside energy storage is in minimizing power quality problems known as voltage sag—a temporary reduction in voltage below a defined threshold. Although small in duration, voltage sags can seriously affect equipment and train operations, reducing the ability of a train to accelerate and also damaging sensitive electronic components in railcars.

New wayside energy-storage technologies can help alleviate voltage sag by storing and releasing energy to boost voltage when and where it is needed. Examples under development include electrochemical capacitors, nickel-metal-hydride batteries, lithium-ion batteries, and flywheels. Use of such devices benefits transit by helping to maintain train speeds and protect electronics, and benefits the local utility by having an added resource to improve utility power quality and stability problems.

Agencies Consider Energy Storage

The Washington Metropolitan Area Transit Authority is actively investigating the potential of wayside energy storage.

"Our ridership is booming right now, and electricity costs are going up along with that. So we need to think green and find ways to be more efficient in our use of energy," said WMATA Senior Vehicle Engineer Joe Krempasky. The agency's electricity costs for traction power rose from $40.5 million in fiscal year 2007 to $47.3 million in fiscal year 2008, and are currently budgeted at $63.6 million for fiscal year 2009.

Krempasky is particularly interested in new wayside energy storage technologies to increase the recycling of energy captured from regenerative braking, having used it since 1983 and saving in excess of 6-8 percent after first adopting the technology. During non-rush hour schedules, however, much of the regenerated energy is wasted, as there is no nearby train able to use it.

"For many years, transit systems have searched for an efficient and cost-effective way of capturing and using wasted regenerative energy. Now, manufacturers have recently developed energy storage systems that appear to meet our operational needs, size constraints, maintenance costs, and required return on investment," Krempasky said.

WMATA plans a two-phase demonstration project on the use of these technologies: a load study and computer simulation of operation, followed by installation of one or two systems from various manufacturers, collection of data, and report of findings.

The Los Angeles County Metropolitan Transportation Authority is also looking to develop a pilot project on energy storage is. "We believe that significantly more energy could be conserved with an energy storage substation," said Ram Krishna, LA Metro's director of systems engineering.

Installing energy storage substations on the lines that are currently under construction could enable the system to radically reduce capital costs. "We project that it could reduce capital expenditures by almost half," Krishna said.

Energy storage technologies could also help LA Metro reduce energy consumption during peak periods, when electricity rates are highest. "Using energy storage technology to shave our peak electricity consumption would make our overall energy bill much lower," he added.

Consortium Approach Provides Needed Support

To help the transit industry assess the potential of wayside energy storage and consider future smart-grid implications, APTA and the Electric Power Research Institute (EPRI) recently formed a consortium of transit agencies, representatives of the electric power industry, Sandia National Laboratory, and other interested parties.

The consortium represents a collaborative effort to evaluate opportunities and technologies and provide guidance to the industry on how it can reduce energy use and energy costs while simultaneously contributing to a more secure and stable electric power supply.

One focal point for the consortium's efforts is the assessment of emerging energy storage technologies. "We see the need for an organization like APTA to take the lead and provide some basic assessment of these technologies," said Jianguo (Gordon) Yu of Systra Consulting. "It's more efficient to do the assessment as a group and broadcast the results. This will make it easier for transit system engineers to consider how to utilize these new technologies."

The consortium's next research project is to study linking storage technologies with the needs of transit systems. The study will summarize methods for evaluating the potential benefits of energy storage, suggest methods for aligning specific technologies with specific needs of transit, and use simulation studies to examine sensitivities to system design and operation. As the events move forward over the next six months, look for further updates in *Passenger Transport*.

RESOURCES

- **White paper on Energy, Environment and Transit Research Program (M. Schroeder, February 2008):** http://www.apta.com/about/committees/rail/energy_Storage/
- **"Going Green: Reducing Rail Network Energy Consumption":** http://www.systraconsulting.com/files/Going%20Green%204.18.08%20(e).pdf
- **US Energy Independence and Security Act of 2007, Title XIII, Smart Grids:** http://www.thomas.gov/cgi-bin/query/z?c110:H.R.6.ENR:
- **Electric Power Research Institute, Intelligrid Program:** http://www.epri.com/IntelliGrid/default.asp