FTA
FEDERAL TRANSIT ADMINISTRATION
U.S. Department of Transportation
Federal Transit Administration

REPORT SUMMARY

WMATA Energy Storage Demonstration Project
Final Report

Background

The WMATA (Washington Metropolitan Area Transit Authority) Metrorail System is the second busiest rapid transit system in the U.S. and includes 6 lines with more than 117 route-miles of track and 91 passenger stations. The trains are powered by more than 100 traction-power substations across the network through a third-rail 700 V dc distribution system. This system consumes about 500,000 MWh per year, at a cost of approximately $48 million.

The Metrorail cars in operation are capable of regenerative braking, which has benefitted WMATA in energy saving and reduction in energy cost. As the amount of energy saving is dependent on the chances that trains demanding power are near trains that are generating power, a significant amount of energy is lost as heat dissipated to the surrounding environment by braking resistors. Therefore, there is a lot of potential to achieve more energy savings through the adoption of new technologies and innovations.

Objectives

Research has shown that wayside energy storage substations can help capture more regenerative braking energy and increase the amount of energy saving. They also can help reduce peak power demands and provide voltage support to trains. Installation of wayside storage substations may also help delay or defer some of the need for capital investment in the upgrade of the traction power system. However, since this technology is relatively new with limited operational history, WMATA decided to evaluate its effectiveness through a demonstration project. FTA partially sponsored this project so that the experience gained from this demonstration can be shared in the wider industry.

Findings and Conclusions

The installed Battery Power System (BPS) tests showed an annual energy saving between 7.2% and 15.4%, a peak power reduction between 121 kW and 436 kW, and a system voltage stabilization effect between 42 V and 139 V.

After an extensive initial assessment of different wayside energy storage technologies, including flywheels, electrochemical capacitors and batteries, WMATA selected the Battery Power System (BPS) manufactured by Kawasaki. The BPS was installed in West Falls Church traction power substation on the Orange Line and the demonstration was conducted in 2013 and 2014. The installed BPS uses Kawasaki's high-capacity Nickel-metal Hydride GIGACELL technology, with a power rating of 2MW and an energy capacity of 378 kWh. The installation was tested under normal revenue service conditions. Electronic data recorders were used to collect the performance data.

Comprehensive test results were obtained for two test scenarios at the West Falls Church substation, one with the existing 6MW rectifiers and the other without any rectifier, with its dc bus and feeders acting as a tie-breaker station. In each scenario, the BPS was turned off for one week and then turned on for the next week to assess its effects. Results from the available test data are the following:

- Energy saving – Equivalent annual energy saving between 7.2% and 15.4%.
- Peak power reduction –Between 121 kW and 436 kW.
- System voltage improvement – Voltage stabilization effect between 42 V and 139 V
- Emergency power – This special test was conducted in engineering hours. A section of track was powered by the BPS alone and a 6-car train without passengers (AW0 load) started from standstill and moved 2,800 feet at a speed limit of 10 mph. This train movement consumed 4% of the BPS energy capacity. If the train had been loaded at AW2 load (with 175 passengers per car), the same train movement would have consumed 5.24% of the BPS energy capacity. From this test, it was calculated that the fully-charged BPS can support 19 such train movements at AW2 load in succession if the BPS is not used to supply any other load.

Benefits

Return-on-investment (ROI) calculations were performed based on projected electricity prices and equipment maintenance cost for both 10 years and 20 years. Quantification of other additional benefits (such as voltage support, deferred investment of other equipment, and emergency power) is dependent on the actual situation, and the realization of these benefits may significantly improve the ROI calculation results. This is consistent with the findings from a previously-published study by the Transit Cooperative Research Program—an energy storage installation in a rail transit environment is most practical when it realizes more than one benefit simultaneously rather than focusing the application primarily on solving any one problem alone.

Project Information

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