LIRR High-Speed Flywheel Demonstration

Guy Sliker
Program Manager
Research & Technology Development
New York Power Authority

This project is part of the Joint Energy Storage Initiative between the New York State Energy Research and Development Authority (NYSERDA) and the Energy Storage Systems Program of the U.S. Department of Energy (DOE/ESS), and managed by Sandia National Laboratories (SNL).

Presentation Layout

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New York Power Authority Highlights

- A public benefit energy corporation founded 1931
- Largest non-federal public electric utility in United States
- Wholesale power supplier throughout New York State and neighboring states as required by law
- Supplied approximately 23% of New York State electricity needs
- 2006 Generation: 26.9MM MWh
- 75% hydro; 25% fossil
- 2006 energy sales: 42.9MM MWh
- (includes 16.5MM MWh purchased power)
- Transmission lines: more than 1,400 circuit miles
  115kV, 230kV, 345kV and 765kV

Long Island RailRoad (LIRR) Description

- One of the busiest railroads in North America, chartered in 1834
- LIRR serves commuters in Long Island, Queens, Brooklyn and Manhattan; has 6,000 employees, 124 stations, 1,060 rail cars, and 701 miles of track;
- 82 million riders in 2006
- Current projects include new M-7 electric train cars; the overhauling of existing cars; station upgrades and cyclical replacement of tracks, ties and switches

Flywheel Energy Storage

- Flywheels have been developed for energy storage and power quality applications. They are capable of frequent and fast charge/discharge cycles and producing high power output for short durations (1–30 seconds)
- Flywheel technology can be split into two design types:
  - Low speed flywheels (1800 – 3600 rpm) consist of a high mass flywheel and optional power electronics for conversations between DC and AC voltages
  - High-speed flywheels (>30,000 rpm) rely on magnetic bearings, vacuum chambers, and permanent magnet motor/generator to provide high efficiency operation and high energy density storage capability.

Project Reasoning

- LIRR is upgrading its aging fleet with the new AC drive trains
- LIRR is assessing its current and future needs to upgrade its railroad system to meet ever increasing demand for commuter rail. The studies indicate that increased traffic on the railroad presents two challenges for the traction power supply system:
  - Voltage support is critical in meeting power demands of the trains
  - The existing substation capacity may need upgrading to handle the predicted increase in train traffic

Project Reasoning Continued

- LIRR is planning to the following:
  - Change out substation rectifiers with new thyristor rectifiers.
  - Replace conventional third rail with composite rail
  - Build additional circuit breaker houses and substations.
- LIRR is exploring the use of flywheels throughout its system to meet the new demand and possibly avoid substation upgrades.
- Properly utilized, flywheels will reduce incremental peak power demands and stabilize voltage levels

Project Objective

- Design, fabricate, install and evaluate a 2.5 MW Flywheel Energy Storage System (FESS) on the Long Island Rail Road (LIRR) Deer Park Station
- Regulate voltage on the west end of the station to within 10% of the nominal voltage
- Demonstrate peak power shaving during acceleration
- Provide complete analysis and reporting on safety issues (such as harmonics, electromagnetic interference, flywheel failure, etc.)
- Demonstrate the FESS technology viability and monitor the performance, characteristics, and benefits for a minimum period of 18 months,
- Present an economic analysis of the installed system including an estimated cost/benefit ratio, and a plan to measure the actual cost/benefit ratio during the demonstration period.

FESS Functional Requirements

- Turn-key installation
- 2.5 MW continuous output for a minimum of 30 seconds
- Recharge to full 2.5 MW in 30 seconds or less
- Operating voltage range from 500 VDC to 800 VDC
- Response to train acceleration/breaking within 50 ms
- Control architecture to maintain operating setpoints despite voltage variations
- Modular design (independently operated units to sum up to 2.5 MW).
- Units installed in enclosure(s) suitable for trackside installation as well as relocation to other sites
- Embedded UPS for 24hr support for the control, vacuum and cooling systems
- Designed for a 20 year operating life
- Capable of 10 charge/discharge cycles/hour over the life of the unit rated at 20 years
- Capable of remotely monitoring the appropriate FESS data/parameters by a data acquisition system.

Project Participants

- Special thanks to the DOE/NYSERDA Energy Storage Initiative for project funding and guidance
- NYPA will be the overall project manager and prime contractor to DOE/NYSERDA for related cost sharing support
- LIRR, a division of NY Metropolitan Transit Authority (MTA), is the customer/owner/operator of the unit
- NYPA and LIRR jointly will be responsible for site preparation, foundations and final connections
- FESS supplier and contractor to NYPA

Project Schedule

- Contract Award: December 2007
- FESS Commissioning: December 2008
- FESS Monitoring: through May 2010

Expected Benefits

- Third rail voltage sag correction and reduction of peak power demand
- Capability to supply emergency backup power in a case of power outage
- Deferral or avoidance of infrastructure upgrades
- Indoor/outdoor seating flexibility, small footprint, remote operation, minimal maintenance, high efficiency, re-locatable and expendable, no emissions and no hazardous materials involved
- Altogether, the proposed project offers a broad range of benefits that are broadly applicable in the State and nationally.