White paper

ENVILINE™ ESS voltage support case study
How can Rail Transit Authorities mitigate voltage issues due to increased power demand?

A frequently encountered problem with increased ridership in electric rail networks is the voltage drop due to higher power requirements. Whether it is because of added railcars, reduced headways or newly deployed trains, the increased load demand draws more amperage from the substation rectifier(s) and voltages start to sag. At the same time, Transit Authorities (TA) face increased energy costs, the need for more energy efficient substations and pressure to achieve sustainability objectives. ABB's Enviline™ Energy Storage System (ESS) for DC rail transportation is an effective and economical solution that addresses these issues.

Traditional way of solving voltage problems

Traditionally, TAs have met the increased power demand by deploying inefficient energy and infrastructure solutions by building new or expanding existing substations or by adding additional conductors to reduce the voltage drop. These solutions are capital intensive. Is this money well spent?

The peak demands are not constant and vary in time and day. Therefore the additional rectifier power capacity is really only needed part time and is underutilized the rest of the time. The Enviline™ ESS is able to stabilize the line voltage at a fraction of the cost of a substation upgrade or new construction.

Additionally, when there are peak demands due to the high traction current drawn at the substation, the result is high energy losses due to line impedance. The Enviline™ ESS is able to meet these peak demands efficiently with little or no losses.

How it works

When the train is braking or coasting the dissipated energy is captured either in the ESS super capacitors or Li-Ion batteries. When the train starts to accelerate, the current is supplied by the traction power rectifier and the voltage starts to drop. Once the voltage reaches a low voltage threshold the ESS starts providing current. When the railcar reaches cruising speed the current draw decreases and the cycles begins again.

ABB's Enviline™ ESS addresses voltage drops in DC Traction Power systems by capturing and returning braking energy to the network

Additional benefits from recovering surplus braking energy

- Up to 20% of energy savings
- Reduce peak power demand
- More leveled draw from the utility
- Positive return on investment
- Possibility of "Smart grid" integration
- Scalability
- Ease of deployment – No AC connection
- Low maintenance
- Off-grid power supply

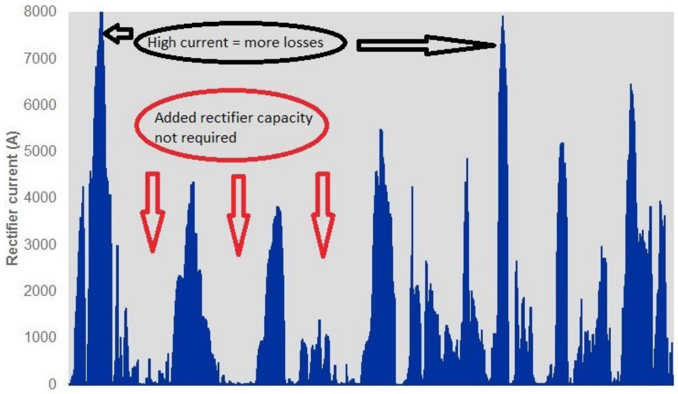


Figure 1 – Rectifier current draw vs time at one station 7:30am-7:40am

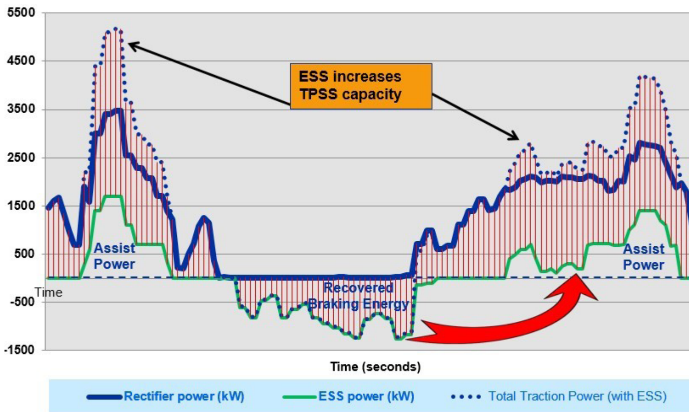


Figure 2 – ESS 60 second charging cycle

Real case study: Voltage drop in Sacramento

In 2009 in Sacramento CA USA, Envitech (now part of ABB) demonstrated with a pilot project how an energy storage system can fix the voltage sag observed between two stations. As the fleet of light rail vehicles expanded over the years it was observed that there was an important voltage sag particularly at three stations, sometimes reaching levels at around 572V at station A (see figure 3).

150kWh Battery storage site Sacramento CA

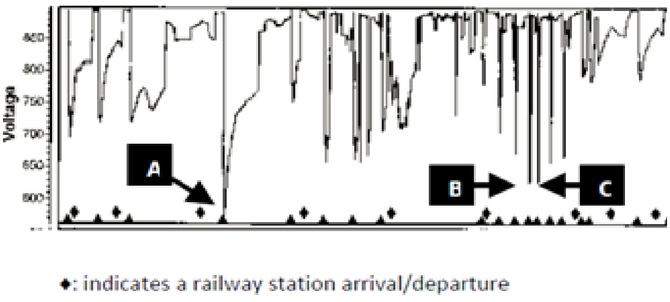
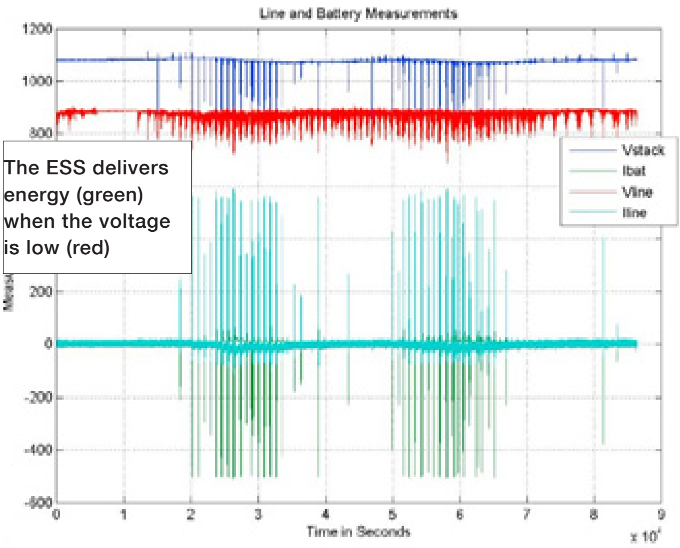


Figure 3 – Train traction grid voltage



Conclusion

- The initial estimation of 500A peak current demand per battery bank can be delivered
- The battery recharge algorithm works as predicted
- The ESS successfully addressed voltage sag problems

Project study simulation: 1500Vdc ESS off-grid

Important voltage fluctuation is what prompted a TA to investigate the possibility of installing an ESS between tow distant substations where a regularly used crossing loop frequently sees very low voltages and frequent DCCB (load) tripping. As a result, the trains must reduce speed to avoid unwanted tripping of the feeding DC HSCB. Based on ABB's simulations and observations, the installation of an ESS can maintain the train voltage above 1000V in contrast to periods where the observed voltage sags were around 850V (minimum operating range) without the ESS. This innovative solutions is a viable cost effective alternative to the expensive construction of a new substation. The scalability of the ESS will allow for future expansion of the power and storage capacities if required.

ABB has over 20 years of DC traction power management with wayside braking energy. ABB has over $1B global annual revenue in rail/mass transit and differentiates itself with technological innovation and customer support.

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