Wayside Energy Storage Project:
Progress Update & Lessons Learned

Andrew Gillespie, Chief Engineering Officer – Power
Presentation to:
APTA Rail Conference, June 2012
SEPTA Sustainability Program

Goals

• 10% Energy Reduction by 2015
• 5% GHG Reduction Annually Through 2015

Principles

• Budget Neutral
• Leverage Existing Assets
• Provide Multiple Benefits

Strategy

• Grants, Revenue-Generation, Self-Sustaining Projects
Connects Region to a Dense Urban Core

Wayside Energy Storage – Budget Neutral

Grants

- Pilot: $900K Grant from PA Energy Development Authority (PEDA)
- $1.44M Grant from Federal Transit Administration (TIGGER)

Return on Investment

- Energy Savings (Projections for Pilot): $95,000-$190,000 Per Year
- Market Revenue (Projections for Pilot): $75,000-$250,000 Per Year

Self-Sustaining

- Partnership with Smart-Grid Firm Viridity Energy
- Scalable to Other Parts of the System
Wayside Energy Storage – Provides Multiple Benefits

- **Electricity Consumption Reductions**
  - Projected to Reduce 1050-2100MWh Per Year (10%)

- **Market-Based Revenue**
  - To Serve as Distributed Energy Resource

- **Energy Assurance**
  - Power in Event of Emergency Outage
Connects Region to a Dense Urban Core

Study Areas

Letterly & Griscom Substations, Market-Frankford Line
• 2009 – Strategic Business Plan Elevates Sustainability as Corporate Objective

• June 2010 – SEPTA Partners with Viridity Energy on Grant Proposal

• August 2010 – Grant Awarded ($900K from PEDA)

• 2011 – Saft (Battery) & Envitech-ABB (Integrator) Hired as Manufacturers

• March 2012 – System Commissioned

• April 2012 – Demonstration Phase Begins

Project 1: Letterly Substation
- **Study Area:** Letterly Serves 5 Stations with Nearly 400 Daily Weekday Train-Stops
- **Braking Energy:** 3 kWh per Braking Event for Married Pair of M4 Cars (15-18 Seconds)
- **Power Feed:** 13.2 kV AC Commercial Feeds with Three 3 MW Rectifiers
- **Voltage:** 675 V DC No Load & 650 V DC Nominal; Regen Capable up to 800 V, Clipped at 735 V

Pictured: M4 Cars on Market-Frankford Line

**SEPTA System Specifications**
- **Battery**: Lithium-Ion (Saft) – 1.5 MW on DC Side of System
- **Power Control System**: Envistore™ Regenerative Energy Storage System (ABB Envitech)
- **Market Interface**: Commanded by Vpower™ Module (Viridity)
- Modular Architecture
- Chemical Makeup - Lithium Ion Nickel Cobalt Aluminum (NCA)
- Cells - 3.6V, 30 Ah
- Module - 14 - cells in a 2 parallel 7 series configuration
- ESSU – 29 Modules in series
- Container – 10 ESSUs in parallel
- Operating in Range of 609 V to 812 V
- Controls the Regen and Assist Events Under All Operating Modes
- Balance the Load Current Between Converter Cabinets
- Calculate Energy Sums of all Converter Cabinets
- Extend Alarms & Status to Remote Terminal Unit
- Maintain a Time-Stamped Log File of Metered Energy Flows & Fault Events
- Report Energy Storage System Status & Energy Flow
- Command Power Control System
- Interact with Energy Markets
- Receive Commands from PJM
- Ensure Charge and Discharge are Proportional to Set Value
- Integrate Proper Algorithms to Optimize Efficiency of Energy Flows

Pictured: View of battery cabinets inside the container

Vpower™ Module Specifications
Completed Tests (April 2012) for Six-Car Train @ 735V

- Remote Capabilities
- Full Discharge Onto Line – Down to 20% State-of-Charge (SOC)
- Full Charge from Regen Only – Up to 90% SOC
- Regen Capture Only to Charge – Up to 70% SOC, with Steady State of Discharge Once Limit Hit; Discharge Down to 50% SOC
- Viridity Signal Tests (“Square Wave Following” – 800kW Charge → 0 kW → 800 kW Discharge) – With Regen and:
  - 1) Assist Inhibited
  - 2) Assist On
Connects Region to a Dense Urban Core

Braking Energy Capture

4.13kW·hr
14.9 MJ
Braking Energy Capture
Wholesale Energy
Frequency Regulation
Connects Region to a Dense Urban Core

Frequency Regulation
Ongoing Tests (June 2012)

- **Vpower Controlling** – Weeklong Baseline with Regen and:
  - 1) Assist Inhibited (Week 1); and
  - 2) Assist Only (Week 2)

- **PJM Review** –
  - Preliminary Reviews Favorable
  - Following Vpower Controlling Tests, Chance to “Qualify” the Asset with PJM

**Next Steps for Testing**
Lesson Learned #1: Partnerships Are Essential

- **Getting Off The Ground:** Increased Competitiveness for Grants
- **Return on Investment:** Making the Financials Work
- **Specialization:** Allow Each Organization to do What They Do Best (SEPTA is a Transit Agency, First & Foremost)

Pictured: Site view of the storage system and battery container
Lesson Learned #2: Theory ≠ Reality

- Take Time to Scope Project
- Base Specifications on Measured Performance
Lesson Learned #3: Scalability is Possible
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