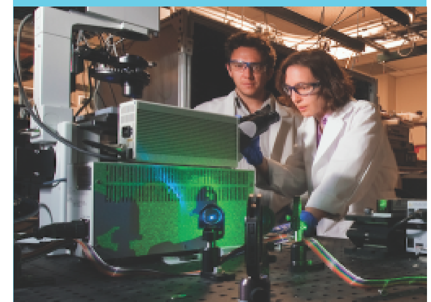
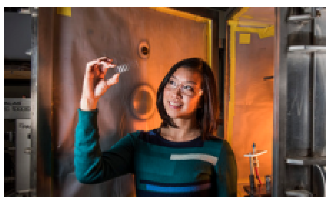
SAND2021-7673PE

Energy Storage Project Team





Daniel Borneo
2018

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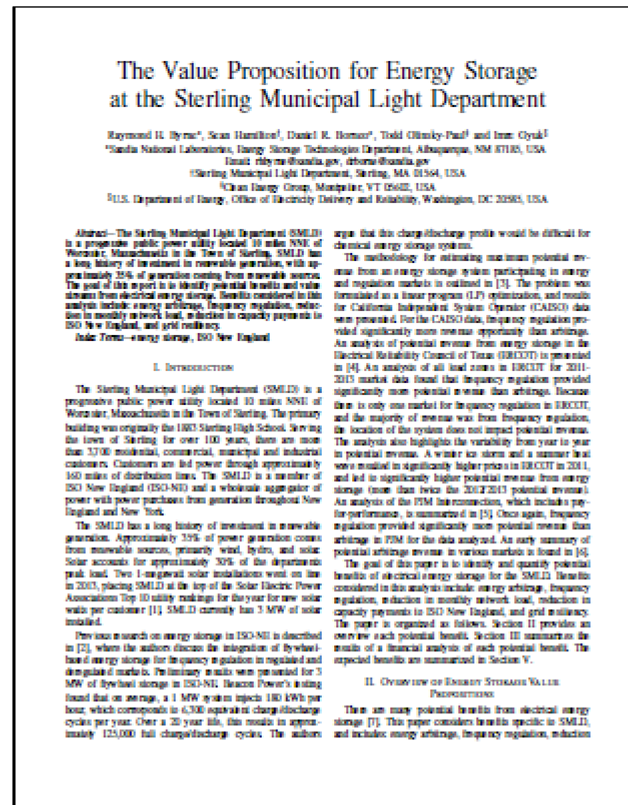
Example Deployment Project: Sterling Municipal Light Department

- Conducted an economics analysis showing ~6 year payback for battery system (2.5 years with grants)
- Installed a 2 MW/ 3.9 MWh Li-ion battery storage system in Sterling Massachusetts
- Along with the existing PV array, ES can island from grid and provide 12 days of backup power to the Sterling police station
- Demand reduction application saves the ratepayers ~$400,00 per year by decreasing the costs associated with capacity and transmission charges



The Value Proposition for Energy Storage at the Sterling Municipal Light Department

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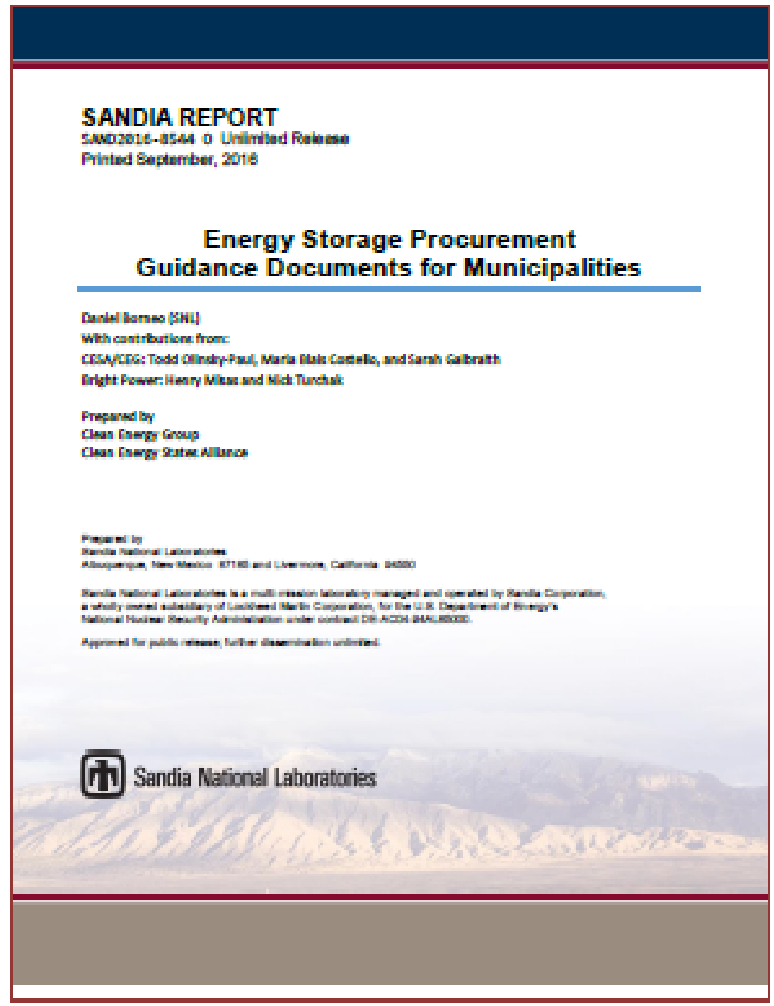
Example Deployment Project: Sterling Municipal Light Department

- Issue
  - Lack of knowledge and experience regarding procurement of a combined system lead to a difficult and arduous process for vendors
- Lessons Learned
  - For successful integration of storage, it can be helpful to have 1 project combining PV and Storage done by 1 company rather than 2 separate projects done by 2 companies
  - There is a growing need for companies who can do both



SANDIA REPORT
SAND2016-8544 O Unlimited Release
Printed September, 2016

Energy Storage Procurement
Guidance Documents for Municipalities

Daniel Borneo (SNL)
With contributions from:
CESA/CEG: Todd Olinsky-Paul, Maria Blais Costello, and Sarah Galbraith
Bright Power: Henry Misas and Nick Turchak

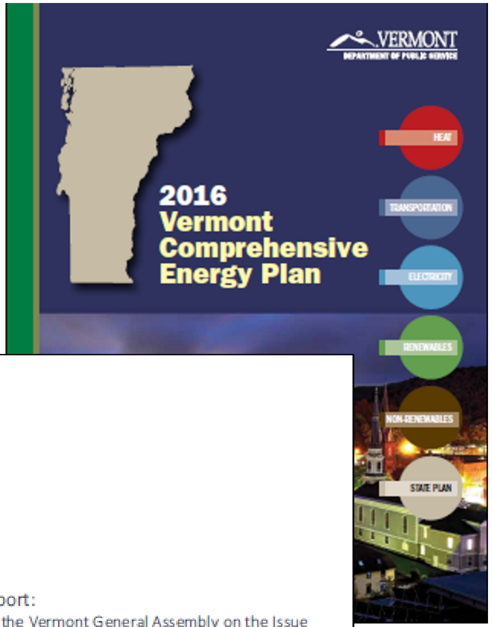
Prepared by
Clean Energy Group
Clean Energy States Alliance

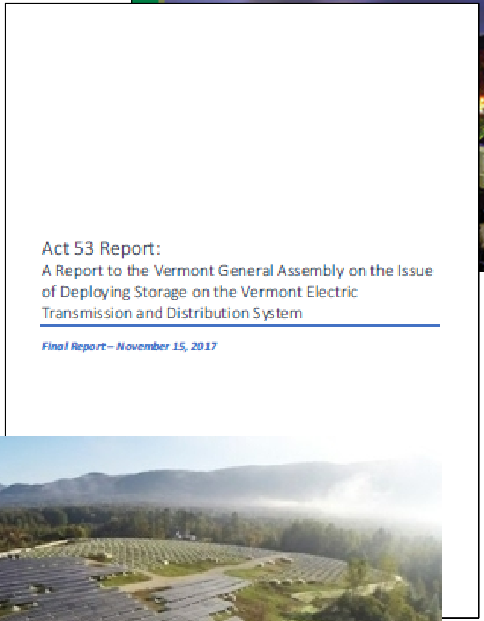
Sandia National Laboratories

Example Deployment Project: Green Mountain Power

- 4Mw/3.4MWh of a combined lead-acid and li-ion system Installed in Rutland, Vermont
  - Integrated with 2.5 MW of PV
- Helps with ancillary services, backup power for an emergency shelter, and demand management

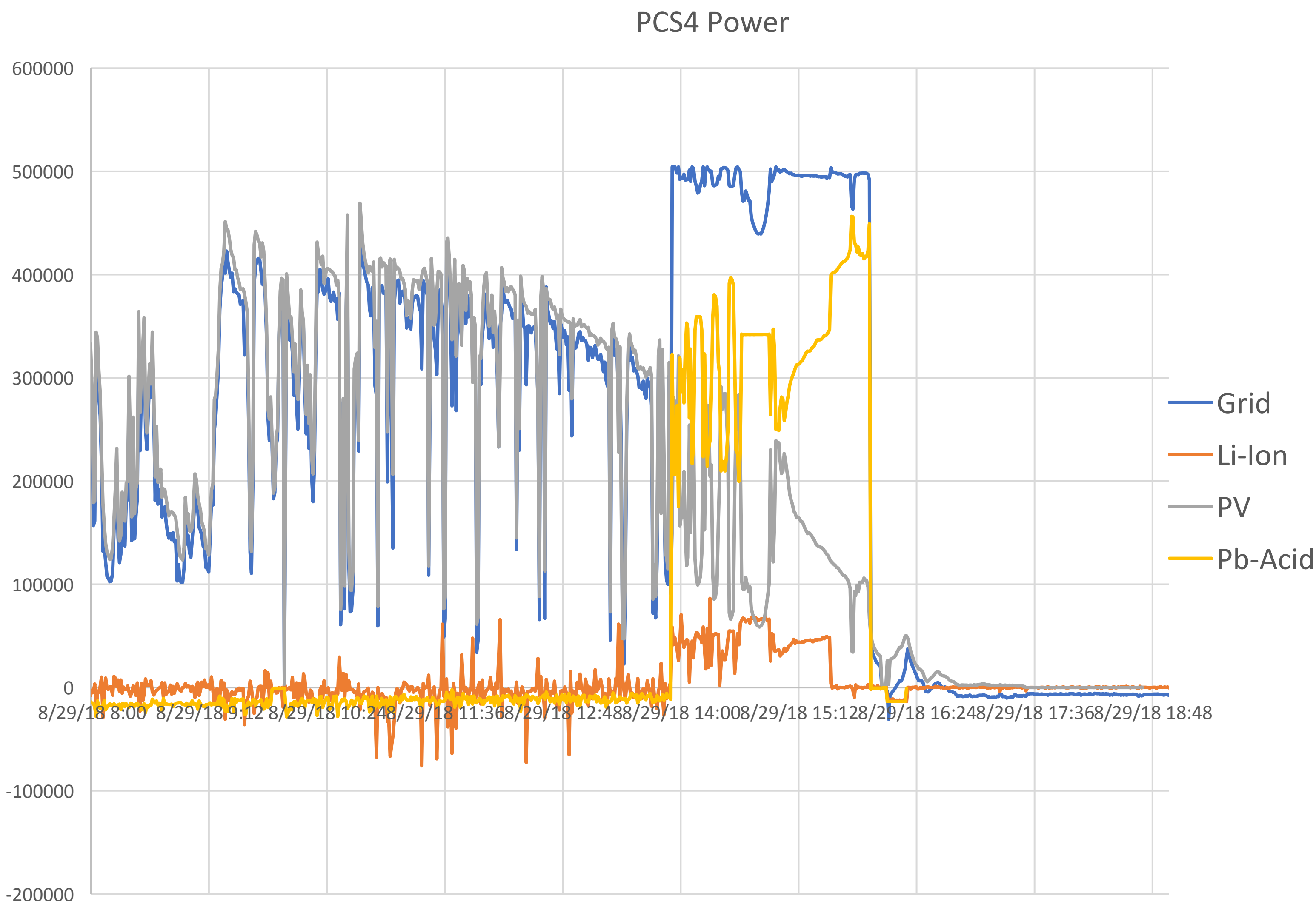
- Issues
  - Project built with 4 - 500KW multi input (DC) inverters
  - 500KW ea. of LA and Li-ion, plus ~500KW of PV per inverter
  - Inverters limit output
    - Reduced demand reduction capability
- Lessons Learned
  - Not designing for flexibility of applications limited DR value




Act 53 Report:
A Report to the Vermont General Assembly on the Issue of Deploying Storage on the Vermont Electric Transmission and Distribution System

Final Report – November 15, 2017

GMP Operational Data



EWEB Energy Storage Project

- System
  - A .5MW/1MWh NEC Li-on system
    - Installed by Worley Parsons
  - Will support 50 kW of solar
- Location
  - The ESS will be located at Howard Elementary School
- Completion Date
  - Operational October 2018

Partners
  - DOE/OE, Sandia, EWEB, ODOE, Contractor: Worley Parsons

- Goals
  - Demonstrate battery storage and distributed generation as a part of EWEB's community resiliency plan
    - Eugene is located in an area vulnerable to earthquakes
    - In the event of a disaster the ESS can provide power to the emergency water distribution system located at Howard Elementary School
  - The system will also be utilized to test microgrid use cases
    - Increased site reliability
    - Energy Arbitrage
    - Voltage support
    - Peaking shifting

Lessons Learned

- Microgrid Controller
  - For smaller distributed microgrids, it is cost ineffective to have a fully featured microgrid controller
  - Costs for a fully featured controller can be 50% of the cost of the battery system
- System Design
  - Current design is 2 smaller systems combined in a master-slave configuration
  - Preferred to have a single system
    - Fewer conduits
    - Fewer conductor runs
    - Smaller footprint
    - Simpler metering
    - Simpler configuration

Cordova Electric Energy Storage Project

Cordova Electric Energy Storage Project

- System: Saft, 1 MW, 1 hour Li-ion Battery
- Location: Cordova, AK
- Completion: Estimated Summer of 2019
- Partners: CEC, DOE-OE, Sandia, PNNL, SAFT
- Goals :
  - Reduce Diesel - In winter, the two CEC run-of-river projects, Hum

  Power Creek, freeze up and diesel generation is required to supplement the hydro.

  Maintain system frequency while eliminating need for Hydro spinning reserve requirement

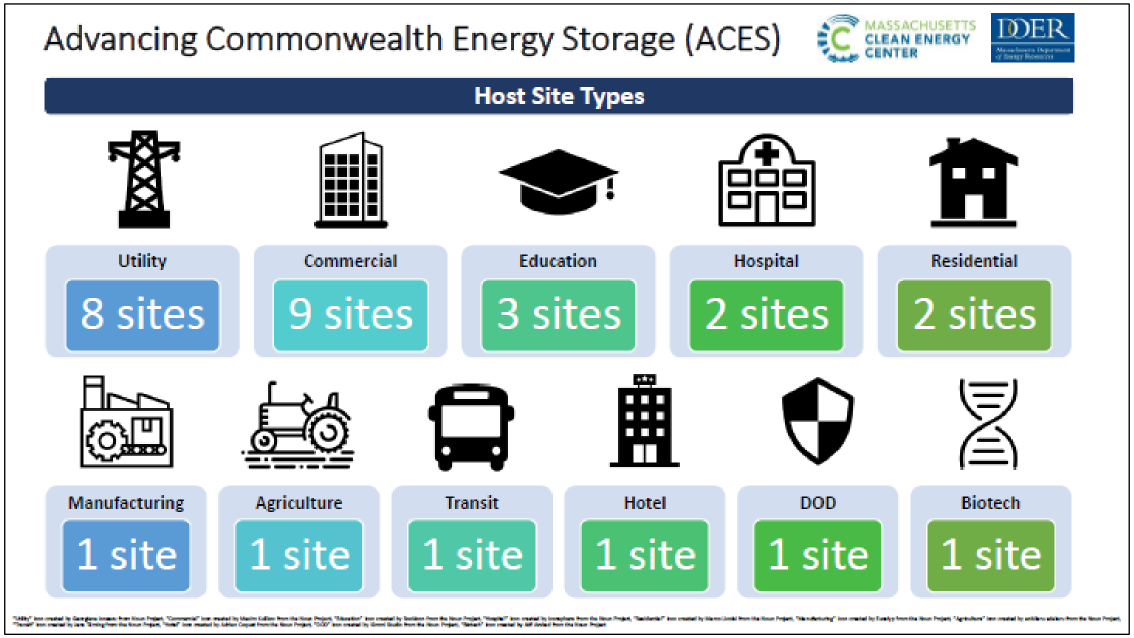
  Microgrid services. (Fuel savings are estimated at ~ 35,000 gallons/year.)
- Lessons Learned during Analysis
  - Batteries have calendar aging capacity loss of 1.5% per year, our chemistry is estimated at 0.5%
  - Capacity loss is kWh; kW remains near constant, round trip DC efficiency drops slightly
  - Deep cycling causes rapid loss of life – this indicates frequency control as a high-value case
- Frequency controls (small charges/discharges) can occur while bulk charging or discharging is conducted
- Removal, recycling, replacing a full battery set can cost 60% of initial package cost.
- Factory warranties and required annual maintenance are expensive

Example ES Benefit Analysis Projects

- **Boston Medical Center, Massachusetts:** Optimization analysis for major metropolitan hospital using battery storage for demand charge management and resilient power. Focus on optimizing the BESS with an existing CHP plant to improve power quality and reduce voltage fluctuations to the CHP.
- **Gunnison Rural Electric Co-op, Colorado:** One of several analyses for rural electric co-ops, to show the economic benefits of battery storage. Focus on using battery storage to reduce costs and improve power reliability.
- **Albuquerque Public Schools, New Mexico:** Analysis for Rio Grande High School, optimizing battery for demand charge management.
- **Burlington International Airport, Vermont:** Technical assistance to airport for installation of solar storage microgrid for resiliency and cost savings.
- **Peaker plant replacement:** Analysis of the technical capability of energy storage to replace gas peaker plants for capacity provision and grid stabilization.
- **EV fast chargers:** Analysis of economic opportunity for energy storage co-located with electric vehicle fast chargers, to reduce demand charges that present a barrier to EV adoption.

Example State Technical Support Projects

- **Connecticut:** Department of Energy and Environmental Protection microgrid grant program. Technical support for state agency to review proposals for microgrid grants.
- **Vermont:** VT Energy Storage Study. Technical support to Vermont Department of Public Service to write an energy storage study for the state legislature.
- **Massachusetts:** Mass Clean Energy Council ACES grant program. Technical support for state agency developing energy storage demonstration grant program. This program awarded $20 million to support 26 energy storage projects demonstrating new applications, business models and economics in the state of Massachusetts.



Thanks

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