Energy Storage Analysis for Regional Demonstration Projects

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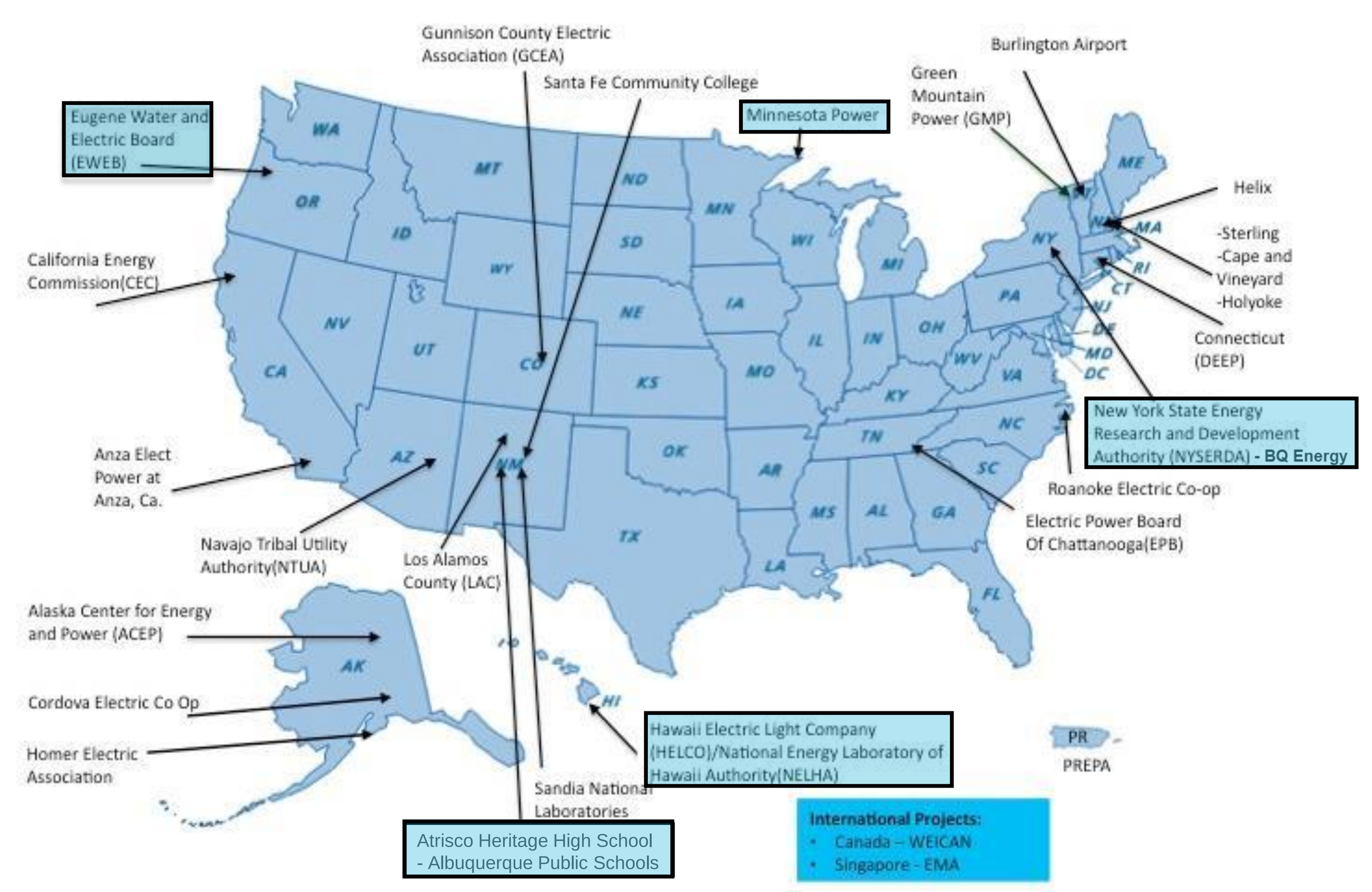
Overview

In FY19, we performed analyses to assist with planning, project development, and valuation for: the Eugene Water & Electric Board in OR, Atrisco Heritage High School in Albuquerque, NM, Minnesota Power, BQ Energy in NY, and the NELHA research campus in HI. In these analyses, we optimize the benefits from energy storage for the customers for different grid applications such as peak demand charge reduction, PV utilization, and time-of-use rate structures. Below is analysis from two particularly interesting cases.



Community Distributed Generation in NY

Background

Recent changes to pricing in NY include updates to increase the value of energy storage. BQ Energy, a community distributed generation developer in NY, requested analysis of three different solar projects for energy storage integration.

Unique Considerations

Value Stacking in NY

- Six value streams
- Time-of-generation windows
- Generation requests

System Configurations

- DC vs. AC coupling

Proposed Solar Projects

	A	B	C
MW DC	7.5	3.0	0.75
MW AC	5	2	0.577
Fixed Values (2018)			
E - $/kWh	0.02741	0.02741	0.02741
DRV - $/kWh	0.01765	0.00417	N/A
LSRV - $/kW	2.56	N/A	14.08
CC - $/kWh	0.0225	N/A	0.12

Analysis

- PV modeled with PVLib
- AC-tied, DC-tied, DC excess charging

Optimization Framework

$$\max_{P_C, P_D} \sum_{t=1}^{T} P_{out,t} \cdot \left(iCap_t + DRV_t + LSRV_t + E + CC + LBMP_t\right)$$

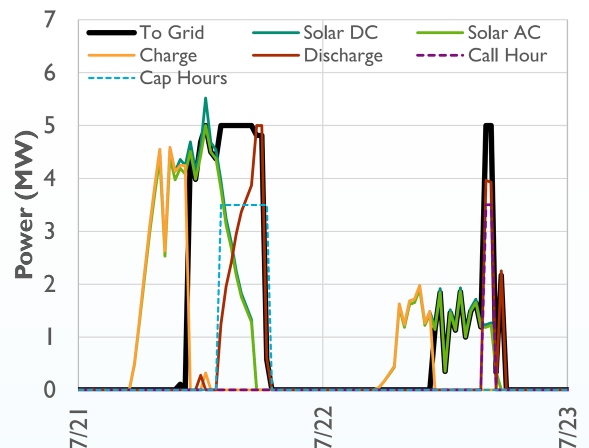
$$\text{subject to} \quad SOC_t = SOC_{t-l}\eta_s + \Delta t\left(P_{C,t-1}\eta_C - P_{D,t-1}\right)$$

$$P_{out,t} = \eta_{inv}\left(P_{DC,t} + P_{D,t} - P_{C,t} - P_{curtail,t}\right)$$

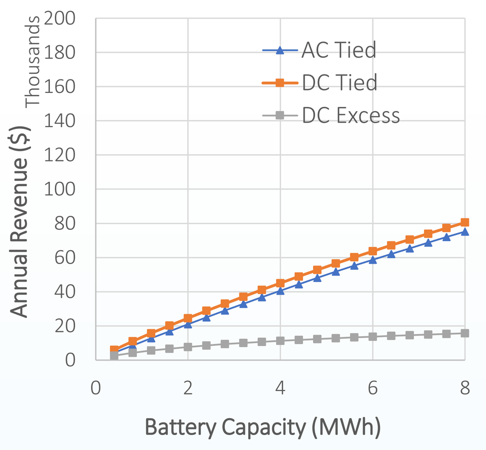
$$P_{C,t} \le P_{DC,t} - P_{AC,t}$$

Results

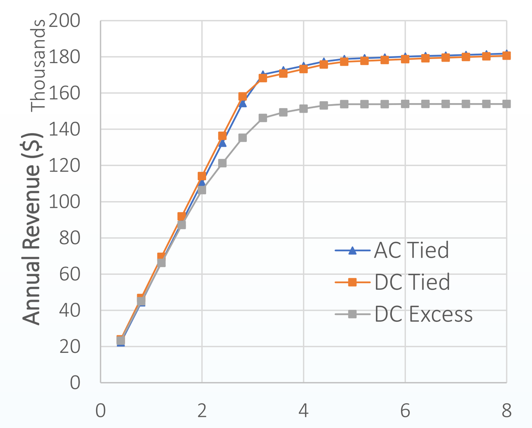
- Value from coincident peak discharge (38%), scheduled calls (30%), and LBMP arbitrage (24%)
- AC / DC tied similar value in low energy applications



Project A optimal ESS dispatch schedule



Project B 2-7PM Capacity Option



Project B Coincident Peak Capacity Option

Project Status

- BQ Energy soliciting energy storage proposals for Projects A & B

Energy Storage and Large Scale Hydrogen Production – NELHA Research Campus

Background

The NELHA campus will soon support a large water electrolysis facility generating hydrogen for three fuel cell buses. Early tests of the facility more than doubled the peak demand for the campus.

Unique Considerations

Hydrogen Production

- 250kW electrolyzer
- Flexible operation from 10-100%

Analysis

- Time-of-use and flat rate options
- With and without hydrogen facility

Research Campus

Demand and Energy Charges

$$\min_{P_C, P_D, P_{H2}} \boxed{P_{peak} \cdot C_{Dem} + \sum_{t=1}^{T} P_{FG,t} \cdot \frac{\Delta t}{60} \cdot \left(C_{E,t} + C_{fixed,kWh}\right)} + \frac{\sum_{t=1}^{T} S_{t+} + S_{t-}}{K}$$

$$\text{subject to} \quad \boxed{SOC_t = SOC_{t-l} + \frac{\Delta t}{60}\left(P_{C,t-1}\eta_{RT} - P_{D,t-1}\right)} \quad \text{Battery SOC Model}$$

$$P_{FG,t} = P_{Dem,t} + P_{H_2,t} + P_{C,t} - P_{D,t} - P_{sol,t} + P_{curt,t}$$

Hydrogen Facility

Hydrogen Storage Model:

$$SOE_{H_2,t} = SOE_{H_2,t-1} + \frac{\Delta t}{60} P_{H_2,t} - D_{H_2,t}$$

$$0 \le SOE_{H_2,t} \le SOE_{H_2,\max}$$

Operation Limits:

$$P_{H_2,t} - \alpha_{H_2,t} \cdot P_{H_2,\max} \le 0$$

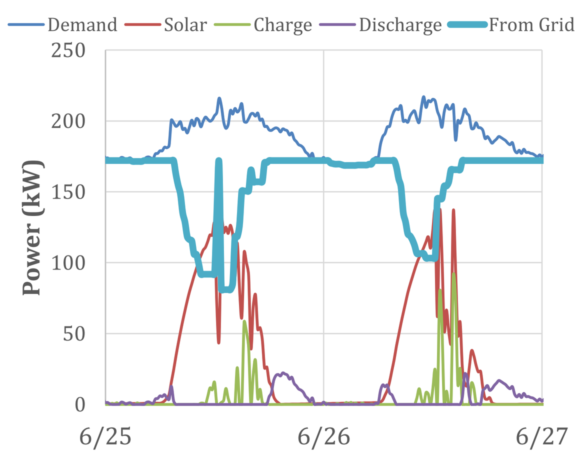
$$P_{H_2,t} - 0.1 \cdot \alpha_{H_2,t} \cdot P_{H_2,\max} \ge 0$$

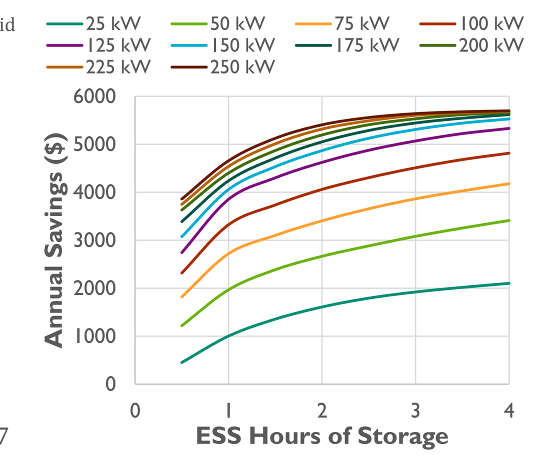
$$S_{t+} - S_{t-} = P_{FG,t} - P_{FG,t-1}$$

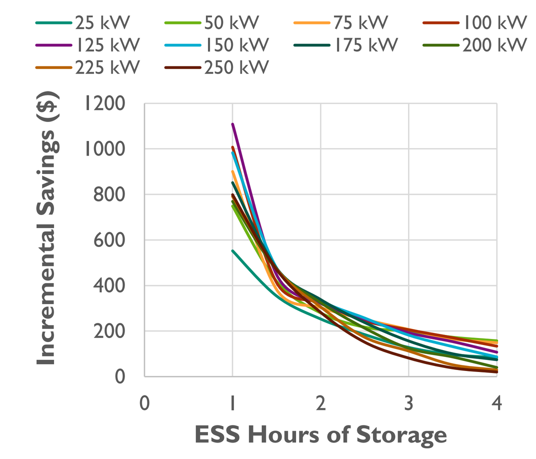
Results

No Hydrogen Production

- Savings up to ~$5500/year

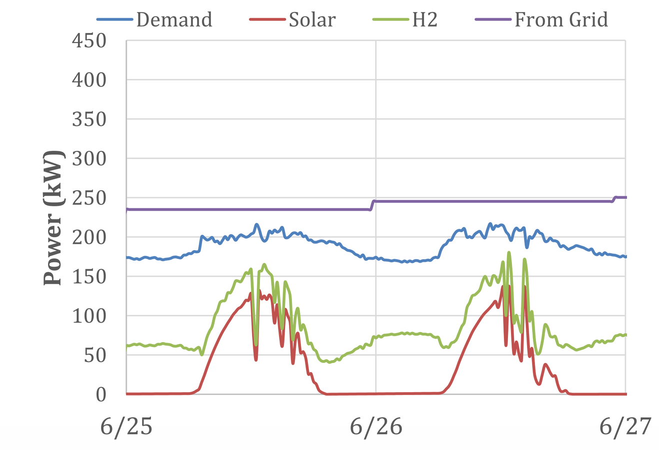


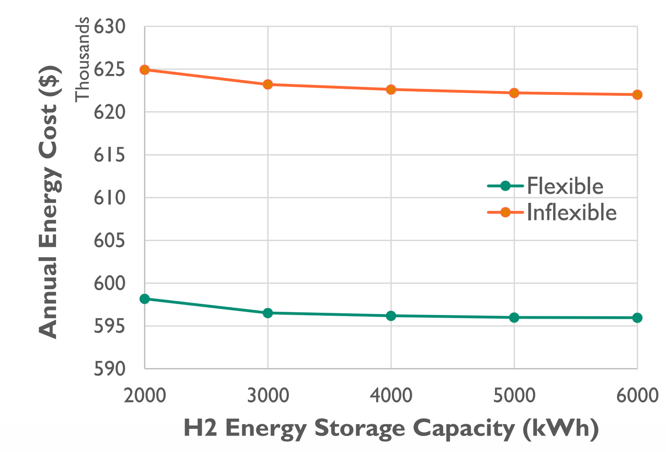




With Hydrogen Production

- Flexible operation would save ~$25000/year
- ES value decreases with demand response





Project Status

- NELHA / HNEI investigating hydrogen facility interface and control to lower demand increases
- Continued work on microgrid development which may incorporate more energy storage

Acknowledgements

This work was supported through the Energy Storage Program managed by **Dr. Imre Gyuk** within the US Department of Energy's Office of Electricity. Also, a special thanks to collaborators Laurence Sombardier and Keith Olson from NELHA as well as Mitch Ewan at HNEI.

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SAND No. SAND2019-11016 C

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