PV + Storage, Resiliency, Capacity, and Ancillary Services in SAM

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Only publicly available tool with detailed battery model that accounts for voltage characteristics, calendar and cycle degradation, etc.

- Currently integrated with PV and “Generic System” model
- Available on DC or AC side of PV system
- Multiple automated dispatch strategies for different markets
- Behind-the-meter or front-of-the-meter operation
Battery Performance Model

Photovoltaic (detailed)

Ability to configure
- Battery size
- Battery voltage
- Cell properties
- Chemistry type
- Max charge, discharge rates
- Battery configuration
- Power electronics efficiencies
- Battery operational limits
- Battery dispatch
- Battery lifetime properties
- Battery replacement preferences
- Battery thermal properties
Behind-the-meter Dispatch

Peak shaving for demand charge reduction

Manual dispatch for energy arbitrage

System Advisor Model
Battery Dispatch Front-of-meter

- Recently added automated control strategies for large plants with DC-connected battery systems
- Optimize dispatch to charge from PV, capture clipping, and maximize value
Upcoming Battery Model Improvements

Behind-the-meter price signal optimal dispatch (end of 2019)

Given the utility rate tariff, forecast PV generation, battery wear costs, generate optimal dispatch strategy

Image from SCE TOU-GS-2 Option B datasheet

Improved battery lifetime model

Add predictive model which computes degradation based on battery characteristics and cycling
System offers multiple resources with different characteristics to improve flexibility and when meeting loads.

*Images from NREL image gallery*
Fuel Cell Operation

- Fuel cell operates with defined ramp rate limits, degradation rate
- Efficiencies govern fuel usage and thermal generation
- Multiple fuel cell chemistries
- Battery makes up difference between fuel cell operational limits and load following
PV + Battery for Resiliency

• Leverage the NREL REopt Lite methodology to:
  • Size PV+Storage systems to sustain critical load
  • Optimize PV and battery system sizes and dispatch strategy to minimize life cycle cost of energy
• Then run the optimally sized system through SAM’s more detailed technology & financial models to understand realistic system performance
PV + Battery for Resiliency

Output metrics quantifying resiliency of your site to withstand outages for full load, critical loads

System Advisor Model

![Graph showing power output over time with various data points and labels for battery states and load metrics.](image)
Participation in Capacity Markets

Adding ability for commercial and utility-scale systems to participate in capacity markets

- Include revenue in cash flow in addition to PPA revenue
- Accounting for capacity credit of renewable systems
Participation in Ancillary Service Markets

Mimic merchant plant operation allowing battery to dispatch according to cleared market capacity

Multiple available revenue streams (reserves, frequency regulation, etc)
Thank you! Questions?

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http://sam.nrel.gov