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Energy Storage Paired with Community Solar in NYISO

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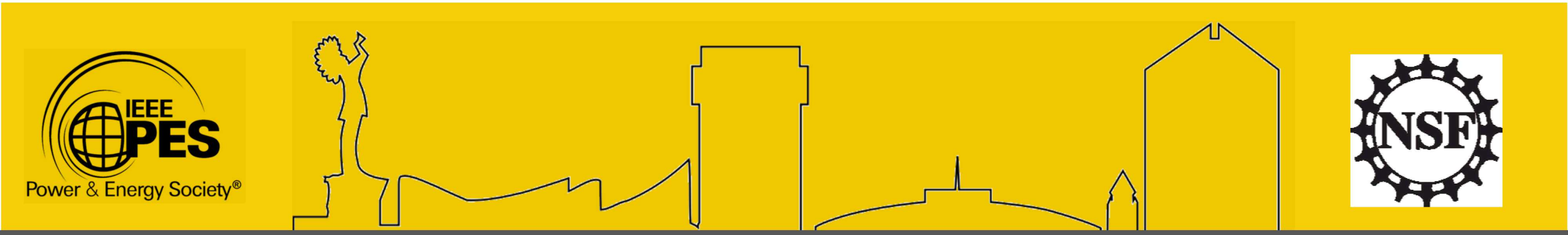

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Background

Before commissioning a system, you want to get an idea of what it could do

- What are the value streams?
- What system size?
- How will it operate?

A number of factors significantly affect the economic potential of energy storage

- **Pricing structures**
- System configurations
- Load Requirements

Sandia helps many entities determine value to help planning efforts

- Analyses of regional markets for specific applications
  - NY State VDER Program
- The QuESt tool streamlines analyses for common scenarios

NY State Case Study

- Major updates to NY Value of Distributed Energy Resources (VDER) Program
  - Assigns value to when and where energy is produced
- Incentives for community solar 5MW or less
- Multiple values depending on time and area
  - Day Ahead LBMP
  - iCap - Value for beneficial production capacity
  - E – Environmental Component
  - DRV – Demand reduction value
    - Generation 2:00-7:00pm summer months
  - LSRV – locational system relief value
    - Advanced notice calls for generation
  - CC – community credit
    - Limited capacity in each area

Proposed Solar Projects for ESS

- Proposed Community Distributed Generation (CDG) solar projects
  - 3 different locations
  - 3 different project sizes
- How much revenue can energy storage systems add?
  - AC-Tied, separate inverter
  - DC-Tied, shared inverter
- Subject to transmission limits, PV potential, etc.
- Optimized battery dispatch schedule using Python/PYOMO

	A	B	C
Service Territory	ConEd Westchester	National Grid	Central Hudson
NYISO Zone	H	A	G
MW DC	0.75	7.5	2.98
MW AC	0.577	5	2
ESS Connection	AC	DC	DC
Fixed VDER Values (2018)			
E - $/kWh	0.02741	0.02741	0.02741
DRV - $/kWh	0	0.01765	0.0417

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

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

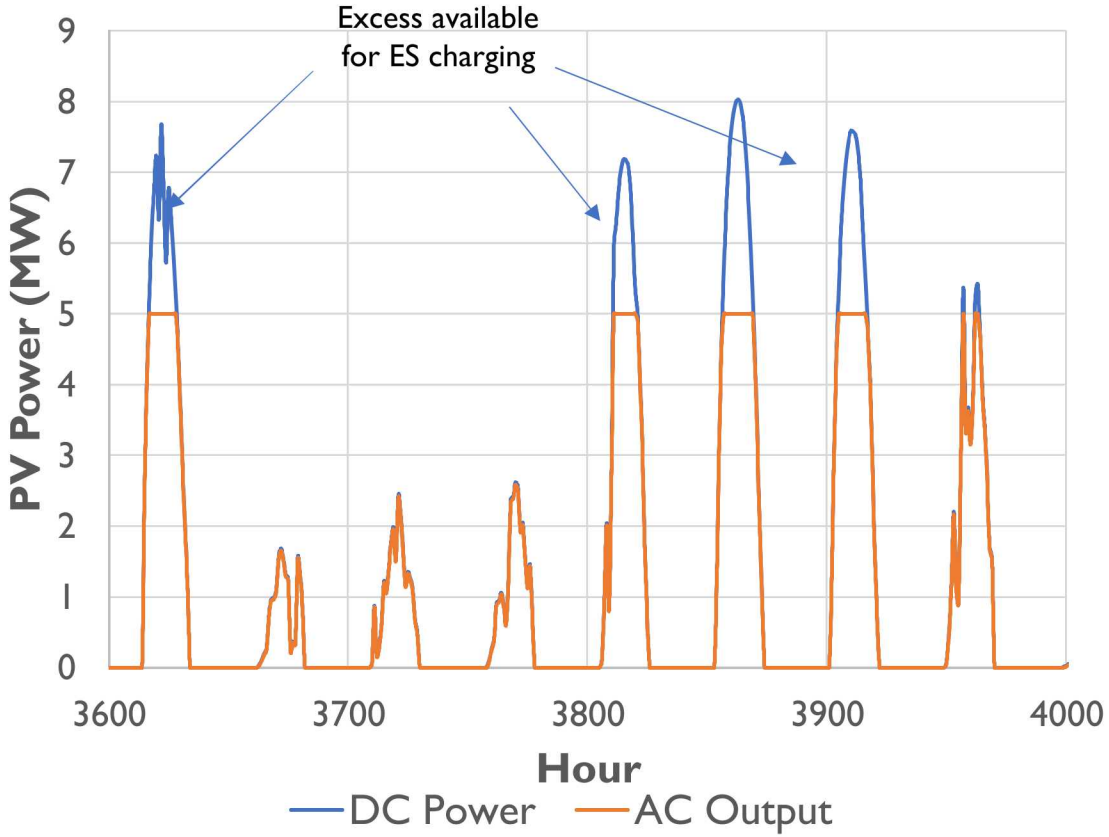
$$P_{out,t} = \eta_{inv} \left(P_{DC,t} + P_{D,t} - P_{C,t} - P_{curtail,t} \right)$$

$$P_D \le P_{sys}$$

$$P_{out,t} \le P_{sys}$$

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

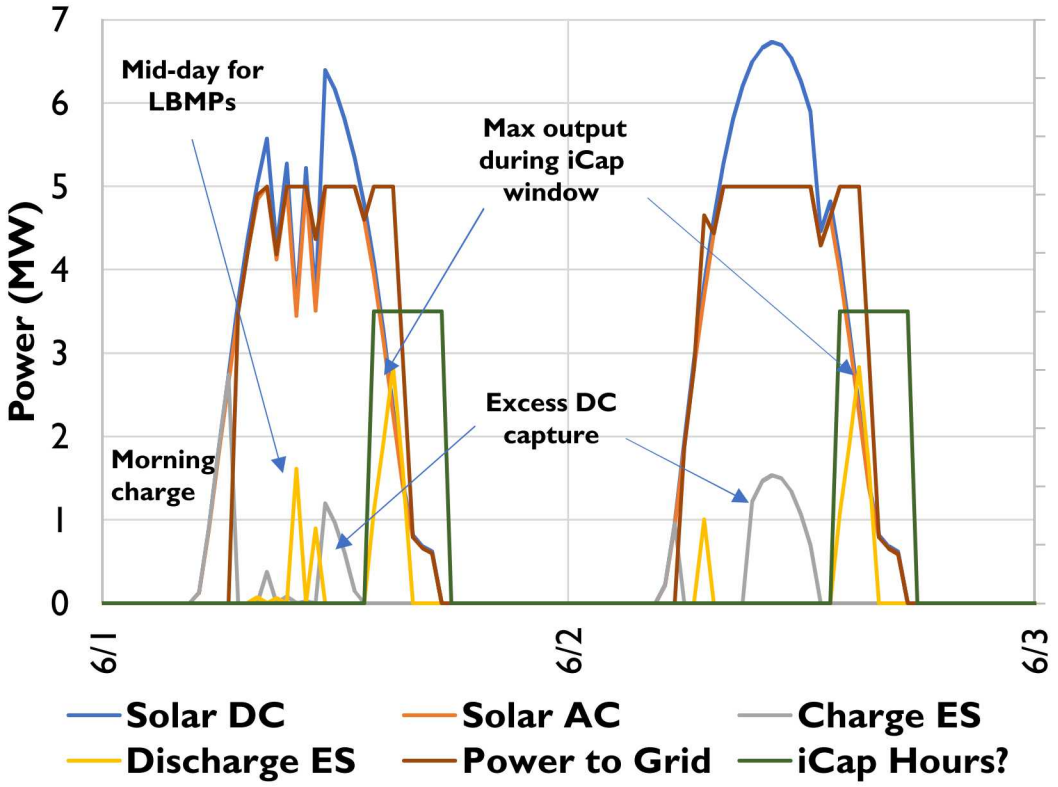
Modeling PV Output



- 30-min simulation using NSRDB irradiance data
- All projects using an DC/AC ratio of ~1.5
  - DC-tied systems can store excess power
  - DC connections can save on system cost by sharing an AC-DC inverter
  - ESS not limited by solar inverter in AC-tied systems
- PV output was modeled using PVLIB and data from the System Advisor Model (SAM)

2-7PM June-August Value Stream

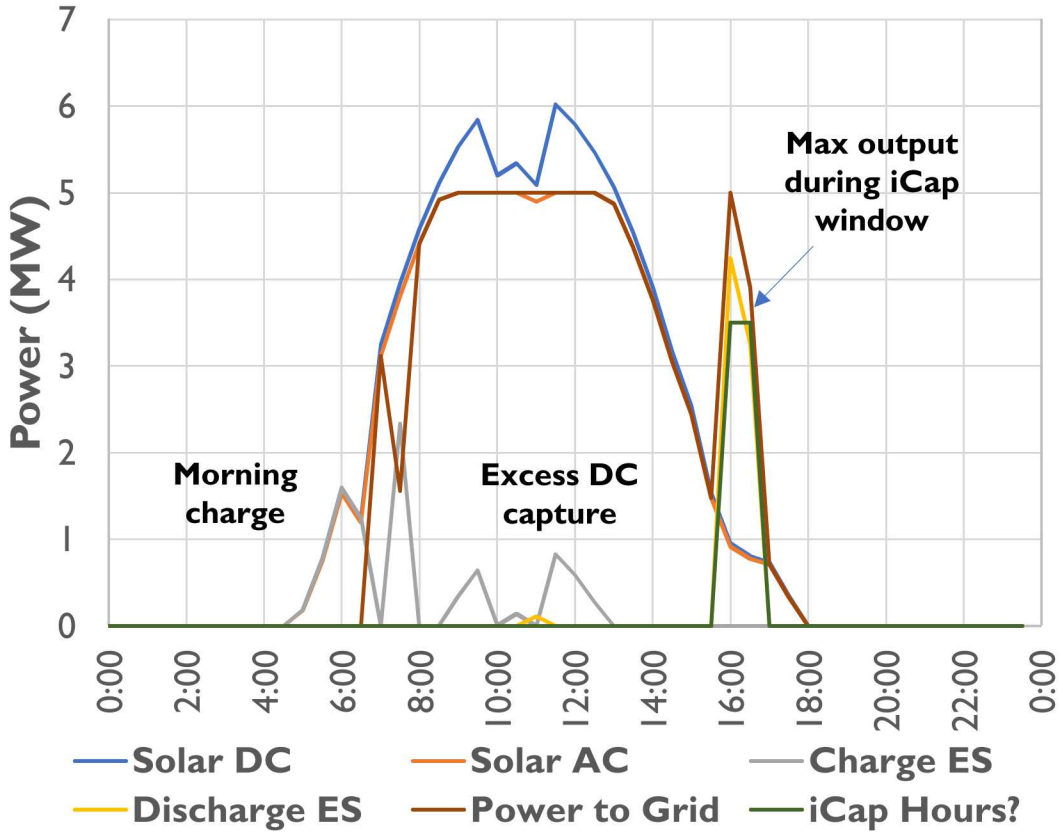
- Charge early morning and from clipped power
- Discharge mid-day to maximize LBMP
  - Fully charge for start of iCap window
- Discharge during iCap window to maintain peak power
  - Until battery hits lower SOC limit



Project B - 5 MW / 5 MWh

Coincident Peak Value Stream

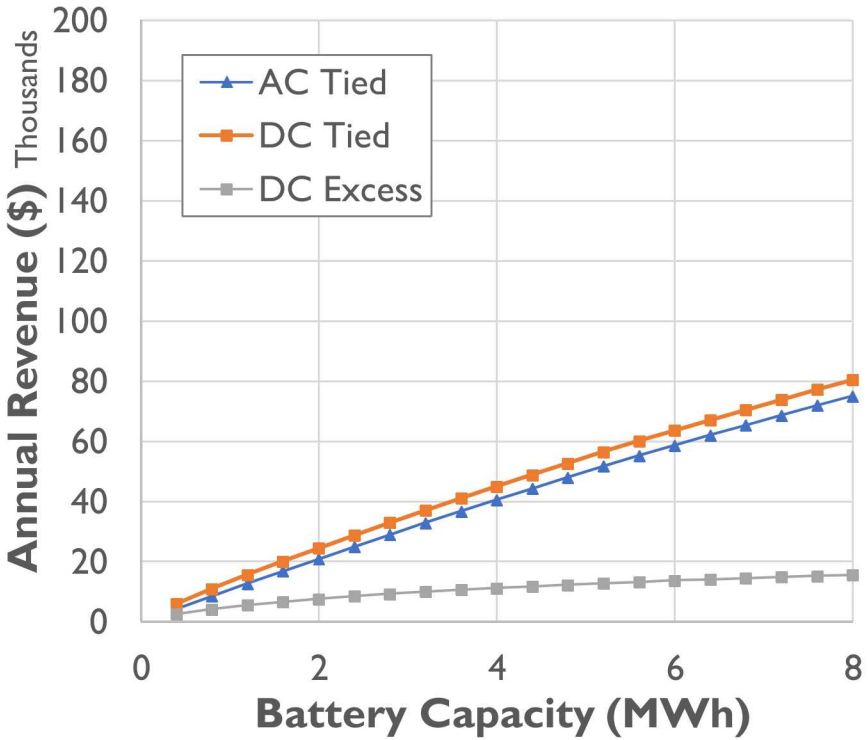
- Charge early morning and from clipped power
- Discharge mid-day to maximize LBMP revenue
  - Fully charge for start of iCap
- Discharge during monthly coincident peak
- Major difference here is the iCap window
  - 1 hour long
  - Only once a month
  - MUST be properly forecast or NO value



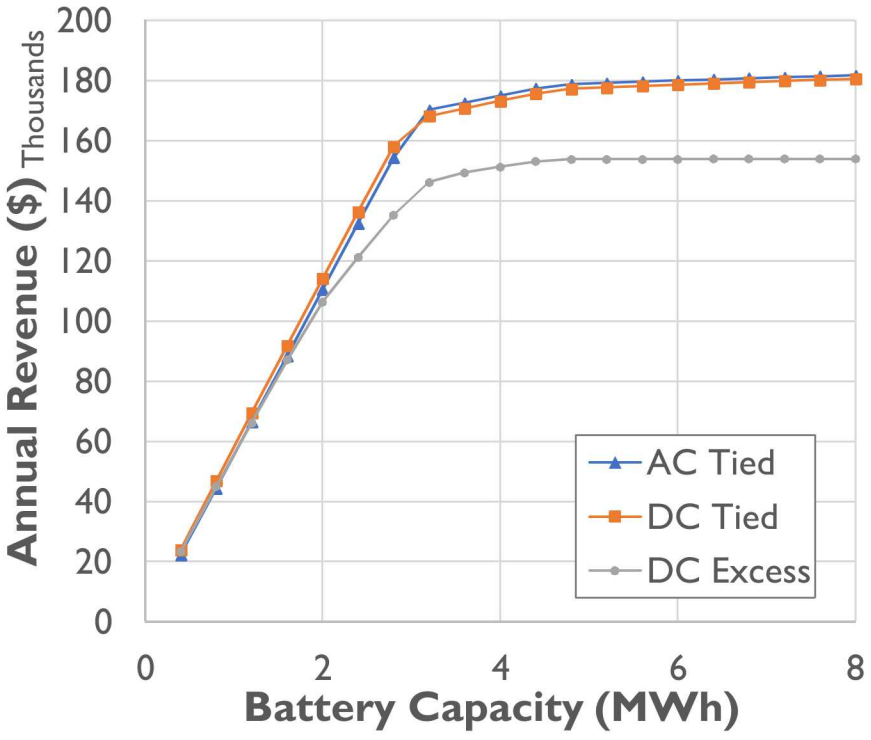
Project B - 5 MW / 5 MWh

Maximum ESS Revenue

2-7PM
June-August

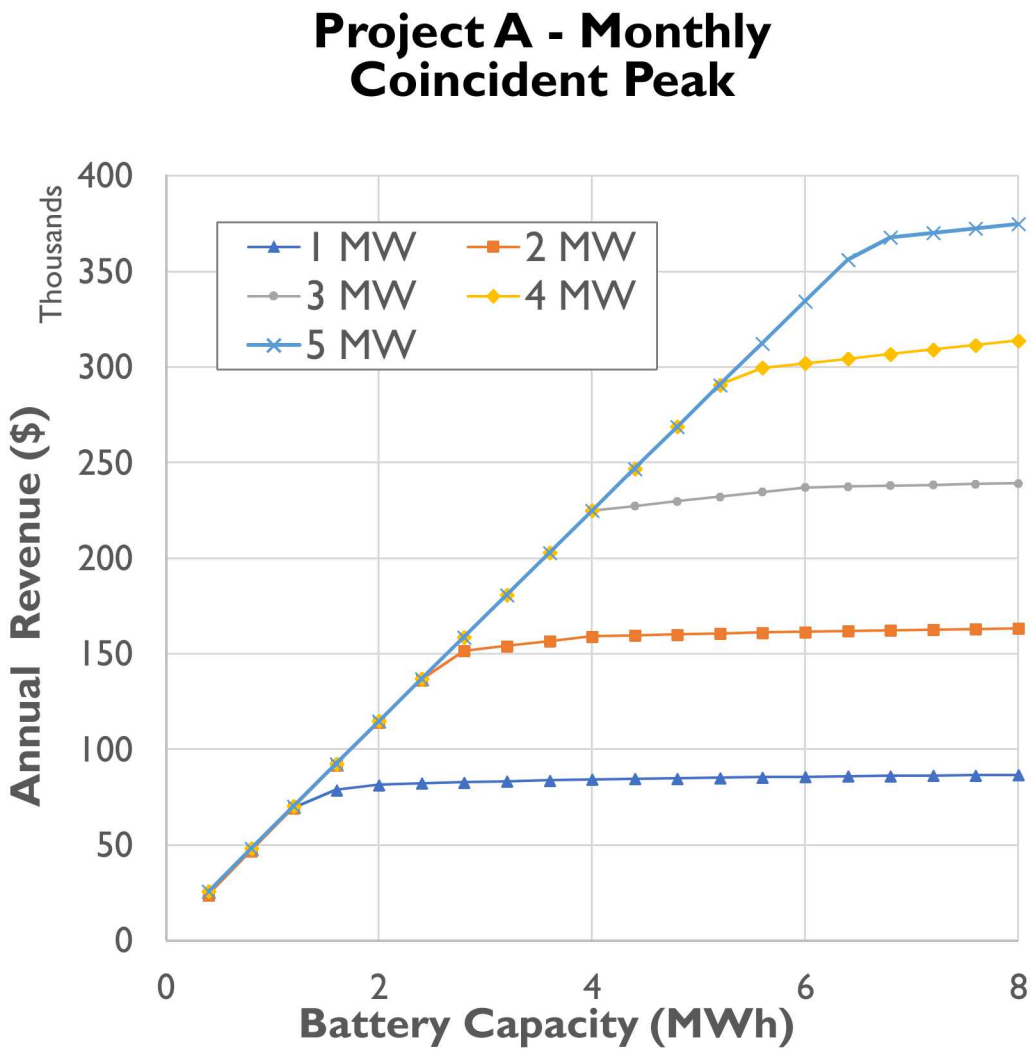


Monthly
Coincident Peak



Advantage of AC Connections

- A separate inverter decouples ESS output
- ESS can discharge above PV limit
- Good for high power / low energy applications
- Subject to transmission limits
  - 5MW for CDG



Lessons from Case Studies

- Scenario details need to be represented accurately for valuation
  - Local pricing structures
  - System configurations
  - Generation if being paired with renewables
- Low energy applications generally yield the most value per kWh
  - One or two hour applications
- For PV+storage systems, DC-DC connections are generally advantageous
  - Depends on PV inverter size and transmission limits
- Forecasting is important to capture coincident peak benefits
  - This is often a high value application
  - Peaks are often at the same hour in a month year-to-year
- Net revenue comes down to system cost coming from RFPs
  - Prior analysis helps to determine what to request and assessment of bids

Acknowledgements

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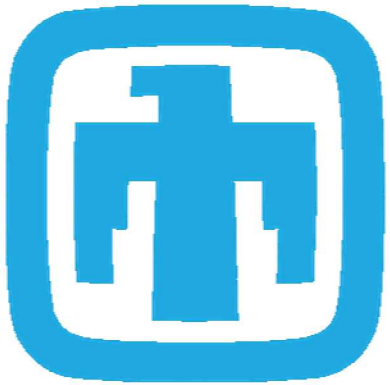

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