



# Contributions of Solar + Storage to Future Power Needs

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# Resource Planning Model

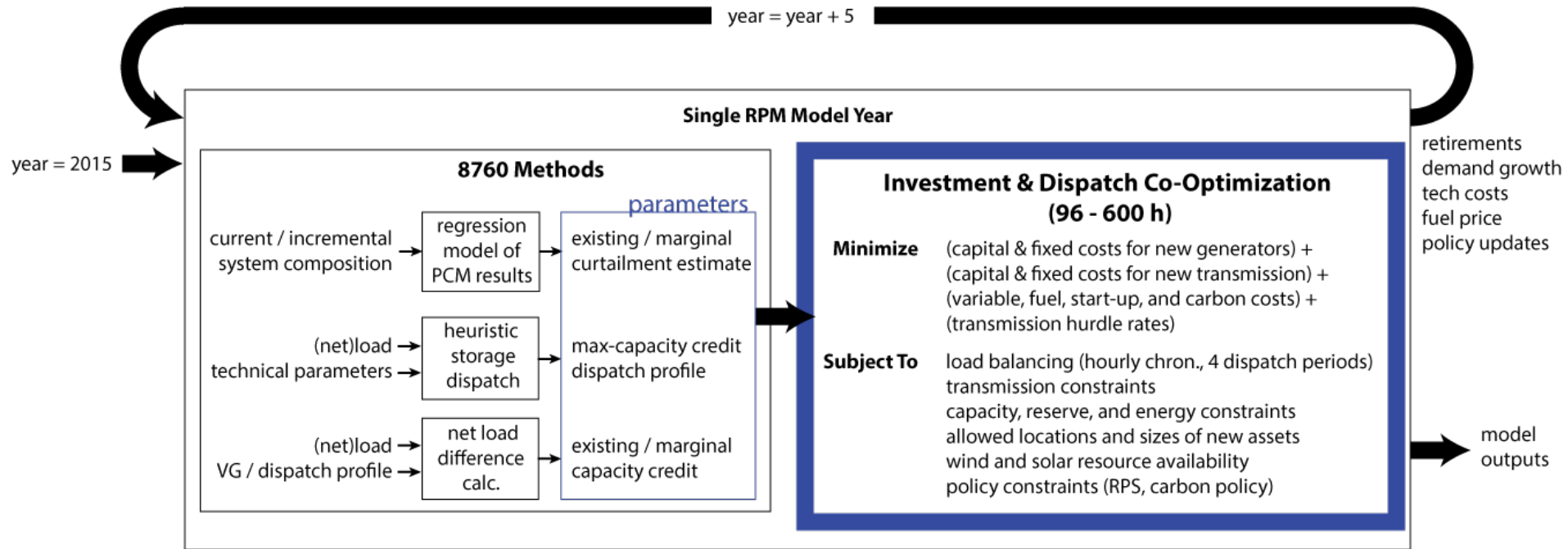
The Resource Planning Model (RPM) is a capacity expansion model that simulates least-cost investments in and operation of a generation and transmission system

Specialized for analysis of a *regional* electric system over a utility planning horizon (10-30 years)

- Includes hourly chronological dispatch of five dispatch periods
- High spatial resolution of existing and new resources
- Real-world transmission system



# Algorithmic Structure



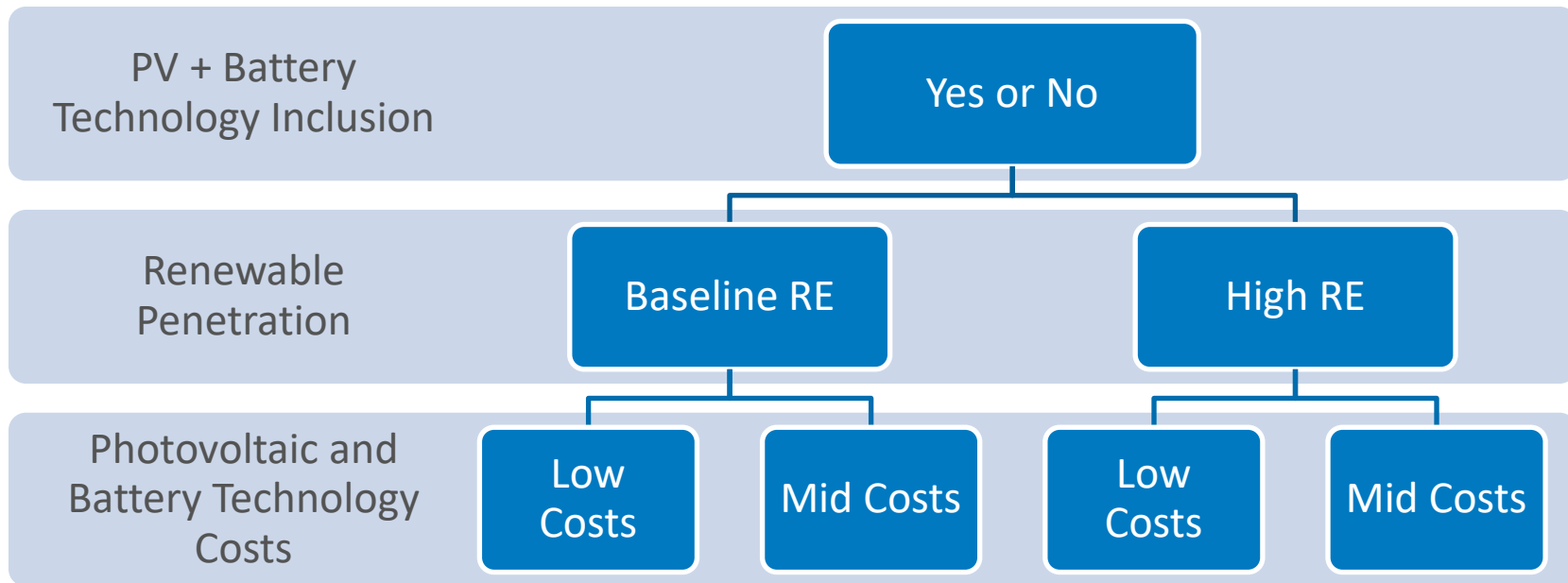
- Sequentially solves for resources that meet system needs at least cost
- 8760 methods adjust reduced-order co-optimization to dynamically account for VG & storage technology capacity value and curtailment impacts

# PV + Battery Technologies

- Utility-scale PV array coupled with Lithium Ion battery
- “Strongly-DC Coupled” connection mechanism, with the battery connected to the PV array behind the inverter

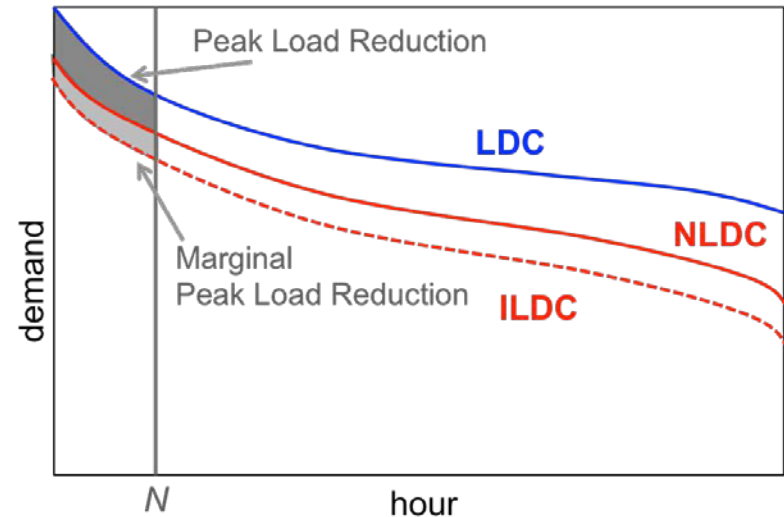
CLASS	RELATIVE CAPACITY OF BATTERY	BATTERY DURATION	ROUND TRIP EFFICIENCY
C0	50%	2 Hours	88%
C1	50%	4 Hours	88%
C2	50%	8 Hours	88%
C3	71%	4 Hours	88%
C4	71%	8 Hours	88%

# Scenarios Analyzed

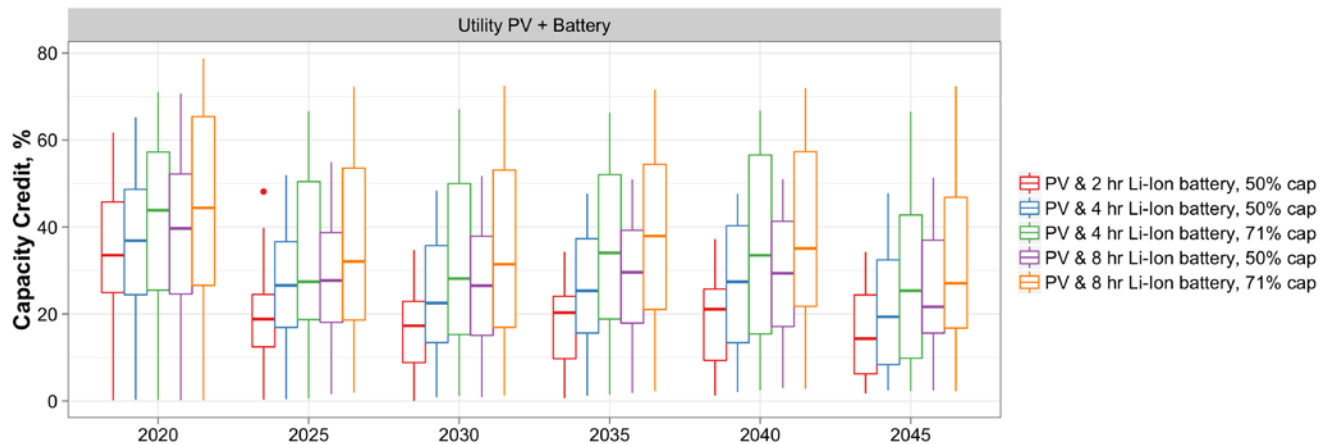
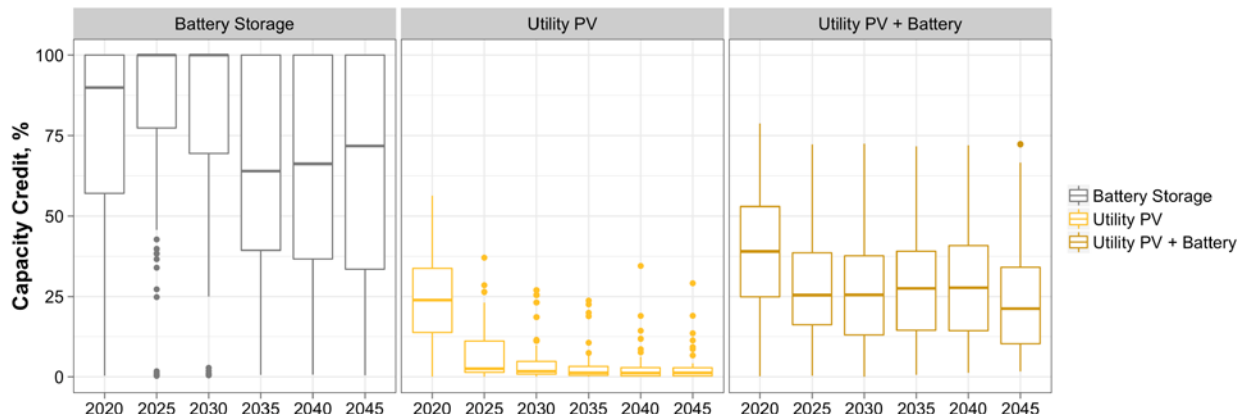


# Capacity Credit Methods

- Coupled technology should have an increased capacity credit due to increased dispatchability
- Still energy limited, so should not get full capacity credit
- Modified load duration curve methodology used, following a heuristic dispatch of the coupled technology

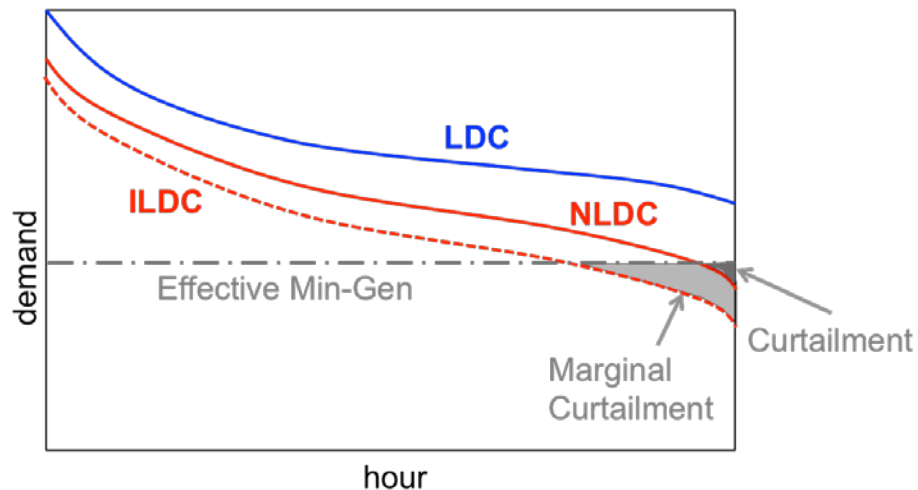


# Capacity Credit of PV + Battery



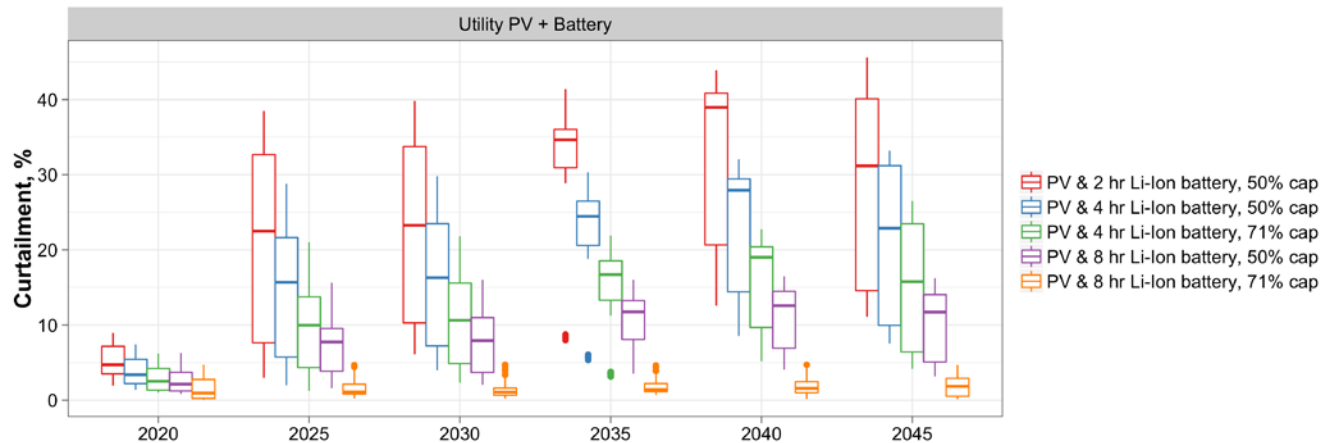
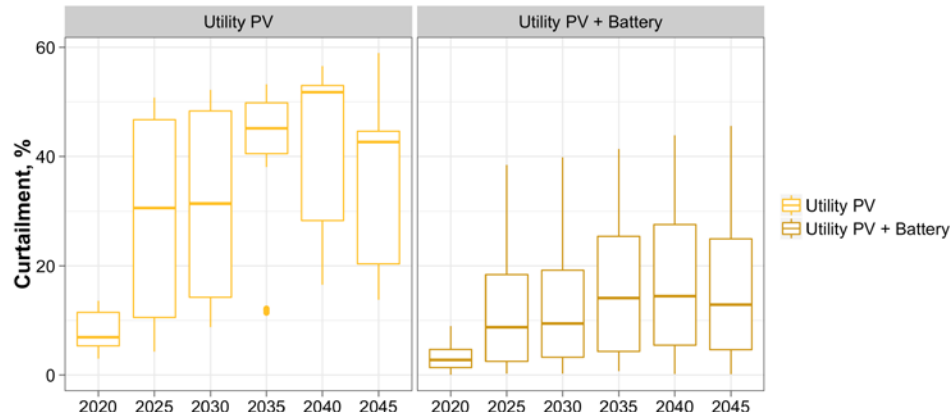
# Curtailment Methods

- Coupled technology expected to have reduced curtailment compared to stand-alone PV
- Storage not able to reduce curtailment of other resources
- Modified load duration curve methodology used, following a heuristic dispatch of the coupled technology

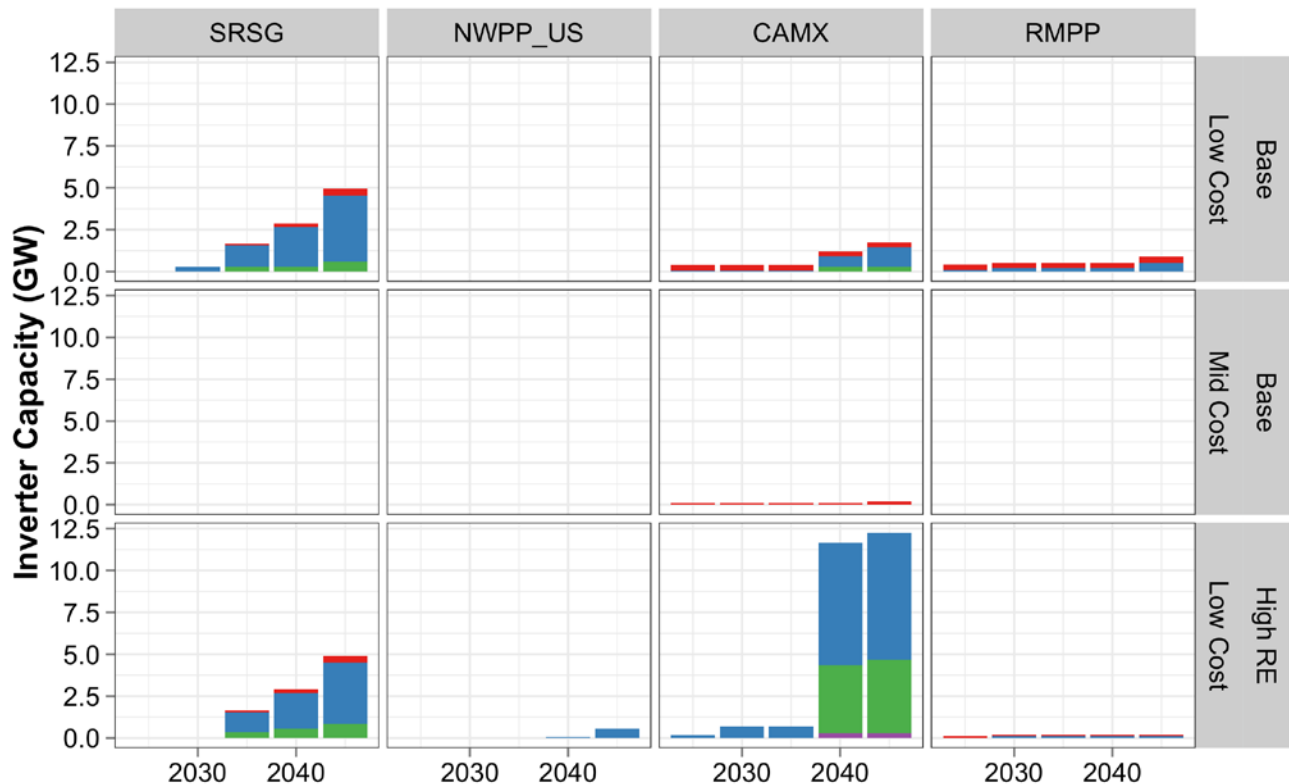




# Curtailment of PV + Battery



# Installed PV + Battery Technologies



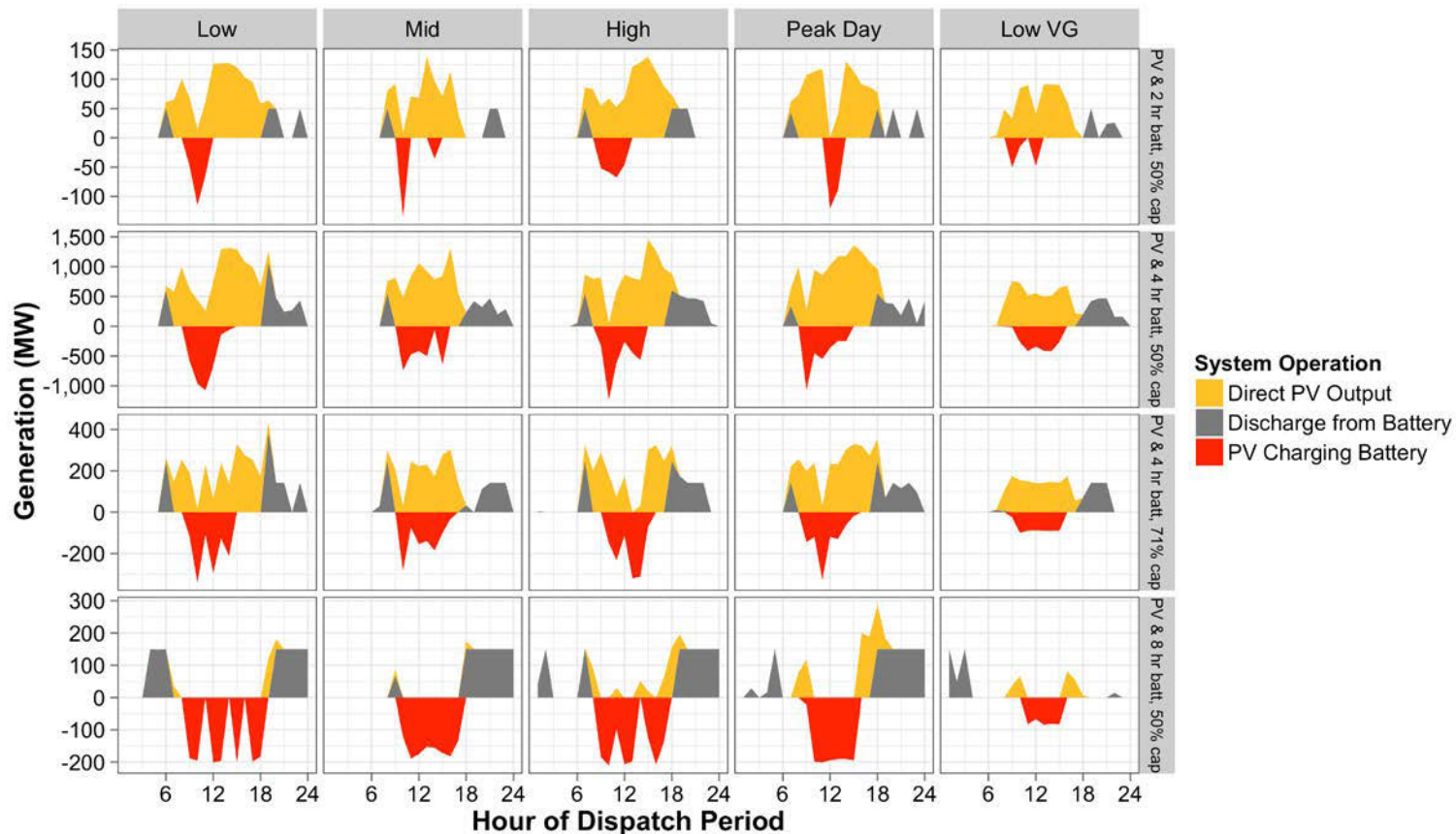
## Technology

- PV & 2 hr Li-Ion battery, 50% cap
- PV & 4 hr Li-Ion battery, 50% cap
- PV & 4 hr Li-Ion battery, 71% cap
- PV & 8 hr Li-Ion battery, 50% cap

# Model Revenues



# PV + Battery Dispatch



# Thank you

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[www.nrel.gov](http://www.nrel.gov)

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