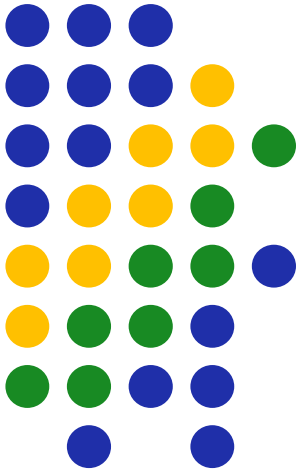
How Solar-Plus-Storage Can Re-Align Customer and Utility Values

Presented by Brock Mosovsky and Cory Welch



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Customer Perspective

- Mid-day solar gen has significant value

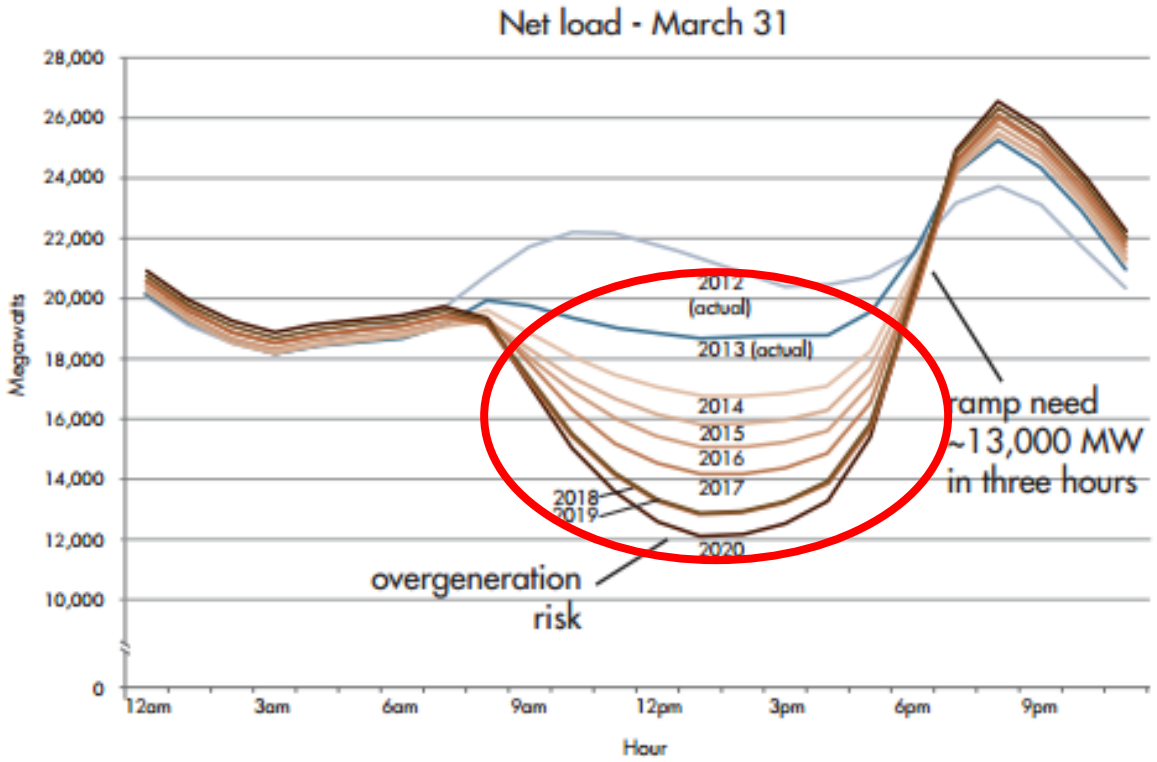
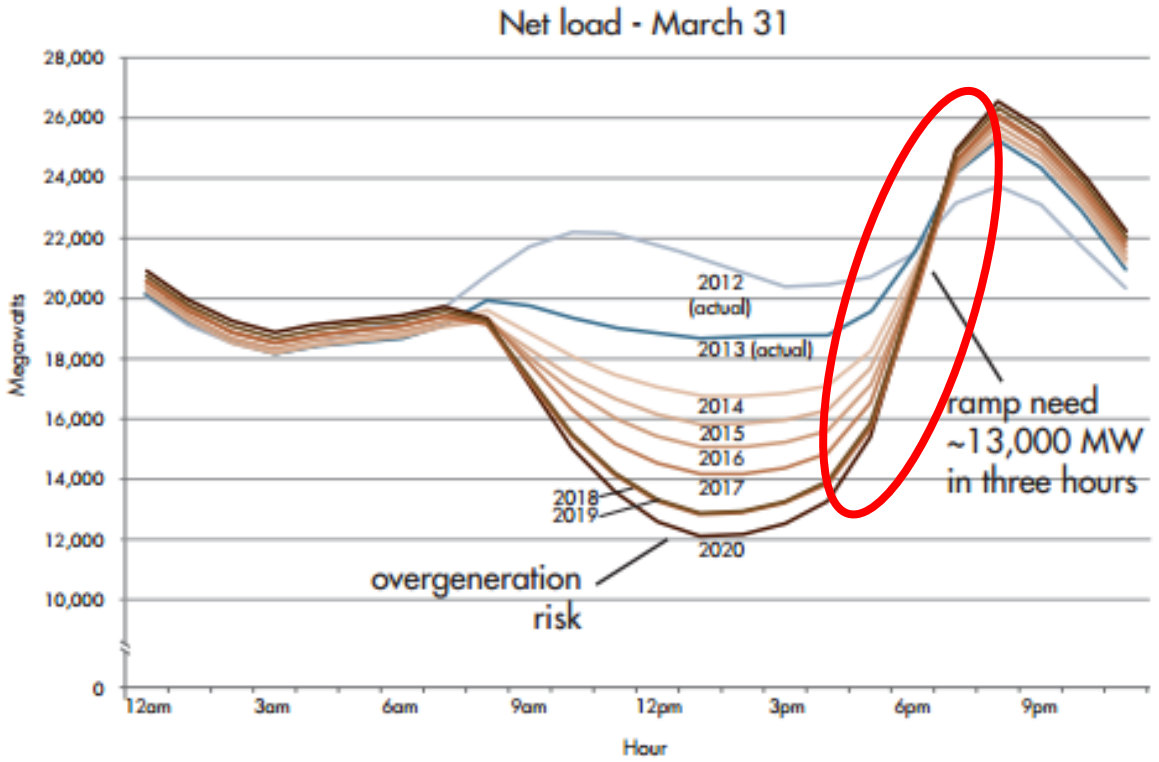


Image Source: https://www.caiso.com/Documents/FlexibleResourcesHelpRenewables_FastFacts.pdf

Utility Perspective

- Mid-day solar gen presents significant risk



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How Can Residential Solar + Storage Systems Help?

- Shift Energy
- Provide dispatchable solar gen
- Open additional value streams

BUT…

- Residential customers will install storage systems only if there is **value** in doing so!

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Questions Explored in this Talk

- What does optimal solar + storage system operation look like?
- How does the value of storage depend on:
  - Differences between time-of-use rates?
  - Demand charges?
  - Export compensation rates?
- Under what conditions are residential solar + storage systems cost-effective?

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Solar PV Only

- Significant mid-day over-generation

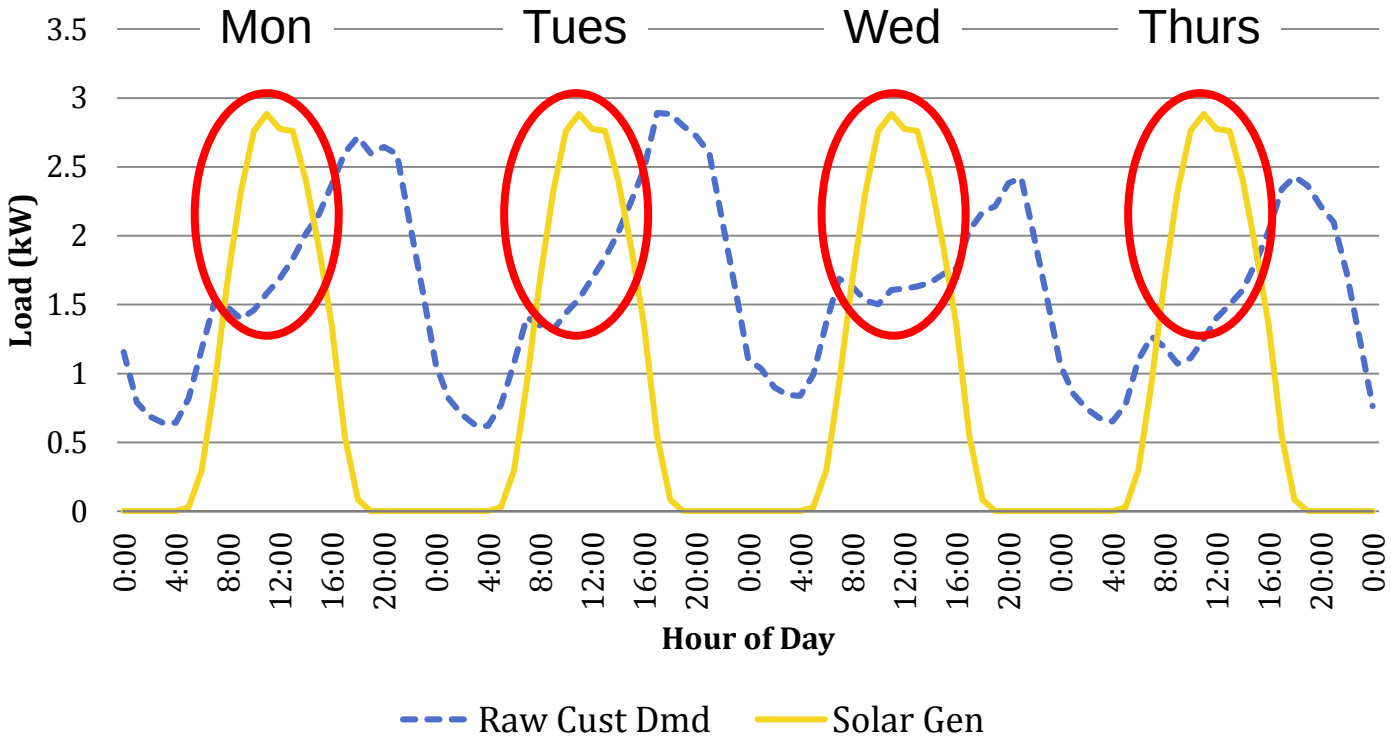

Image Source: Navigant Analysis

Solar PV Only

- Net load goes negative: export to grid

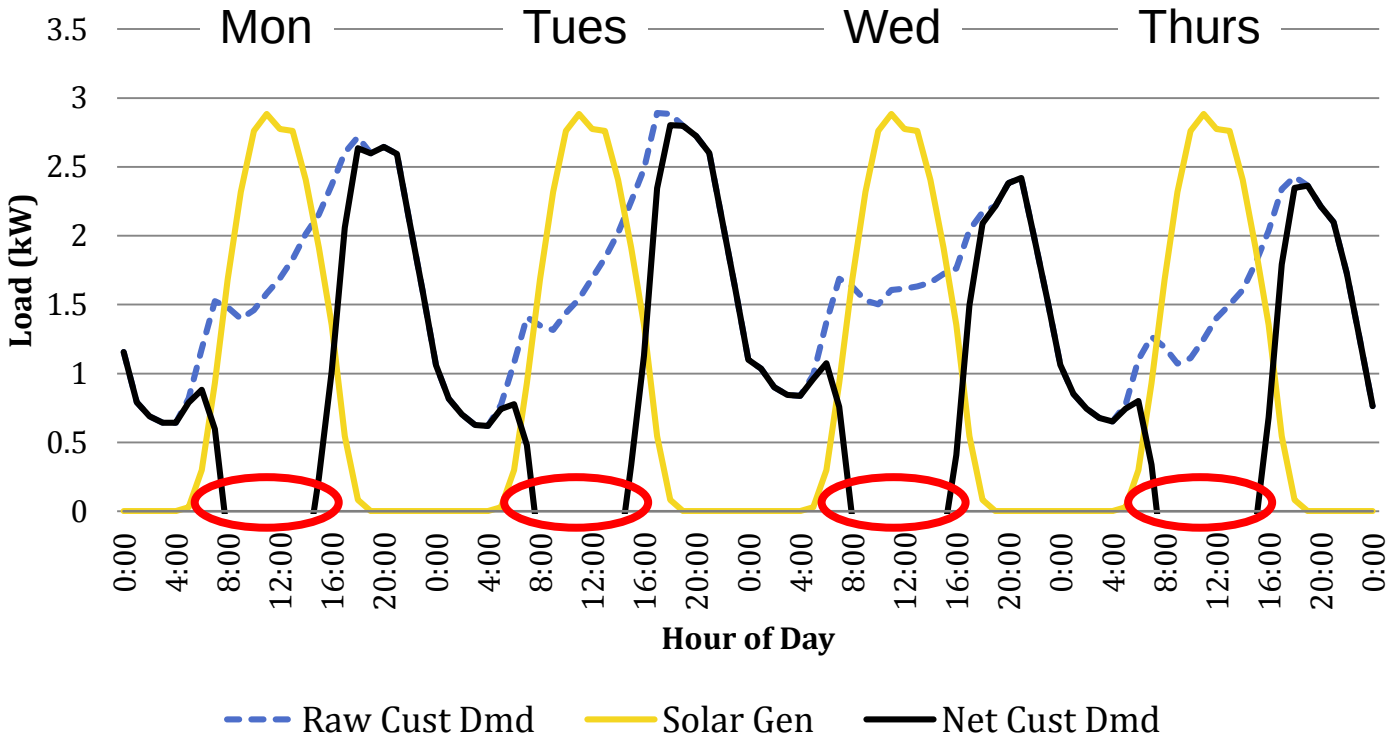

Image Source: Navigant Analysis

Solar PV + Storage

- Storage charges during over-generation

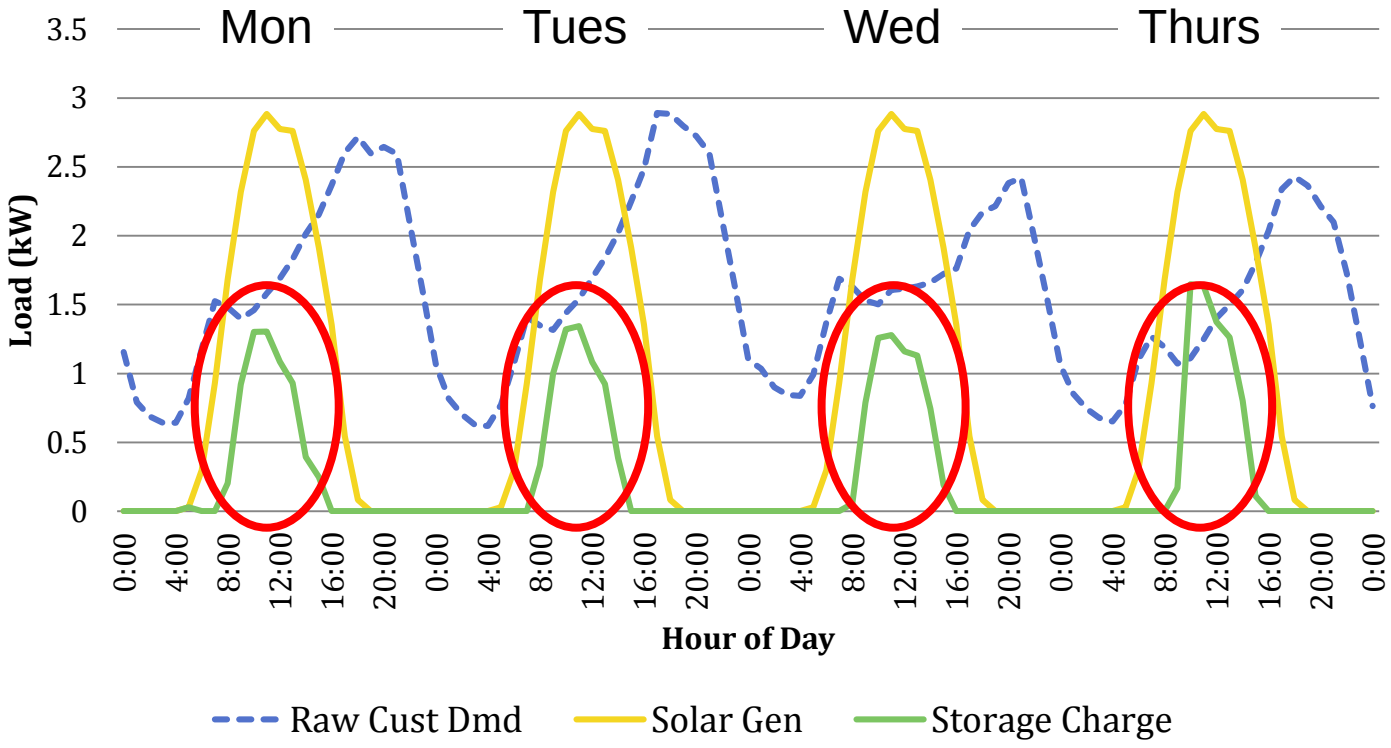

Image Source: Navigant Analysis

Solar PV + Storage, Demand Charge

- Storage discharges to reduce peak demand

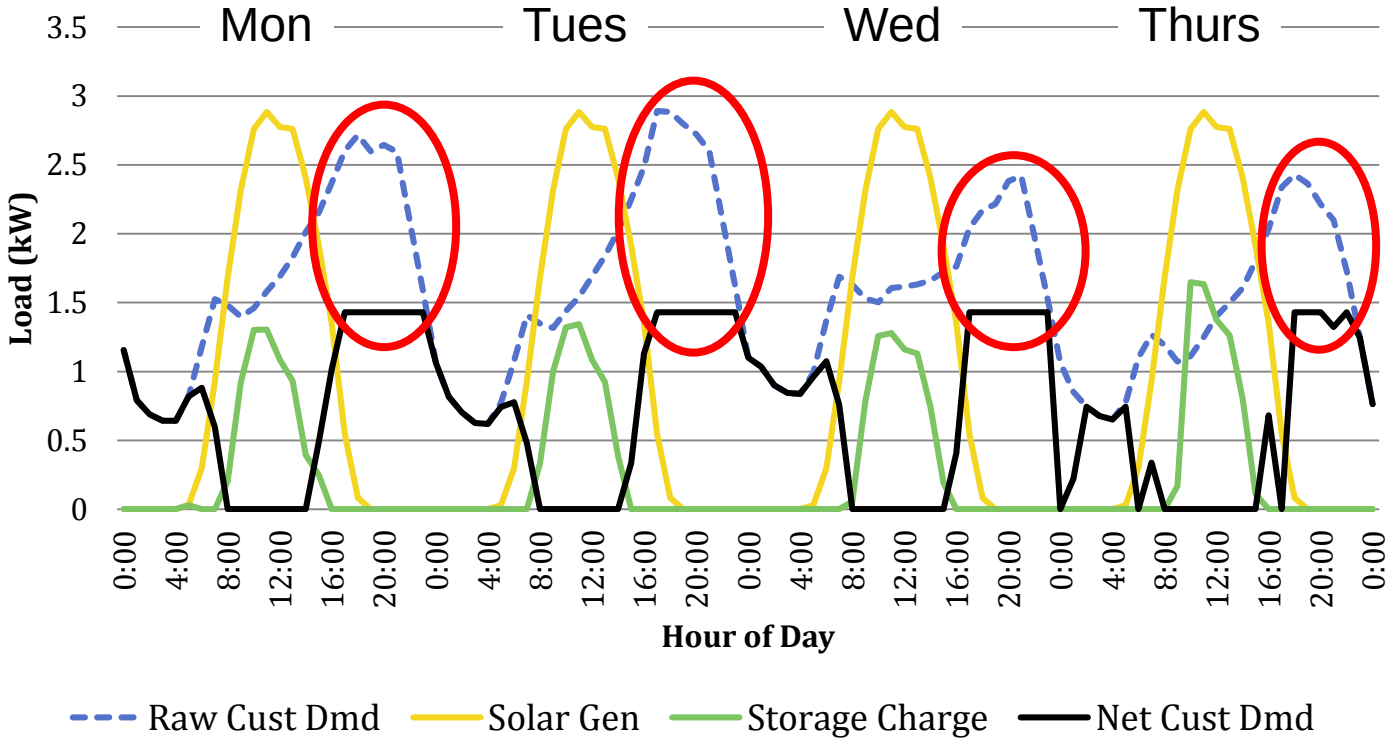

Image Source: Navigant Analysis

Solar PV + Storage, Time-of-Use Rate

- Storage reduces demand during the time-of-use peak period

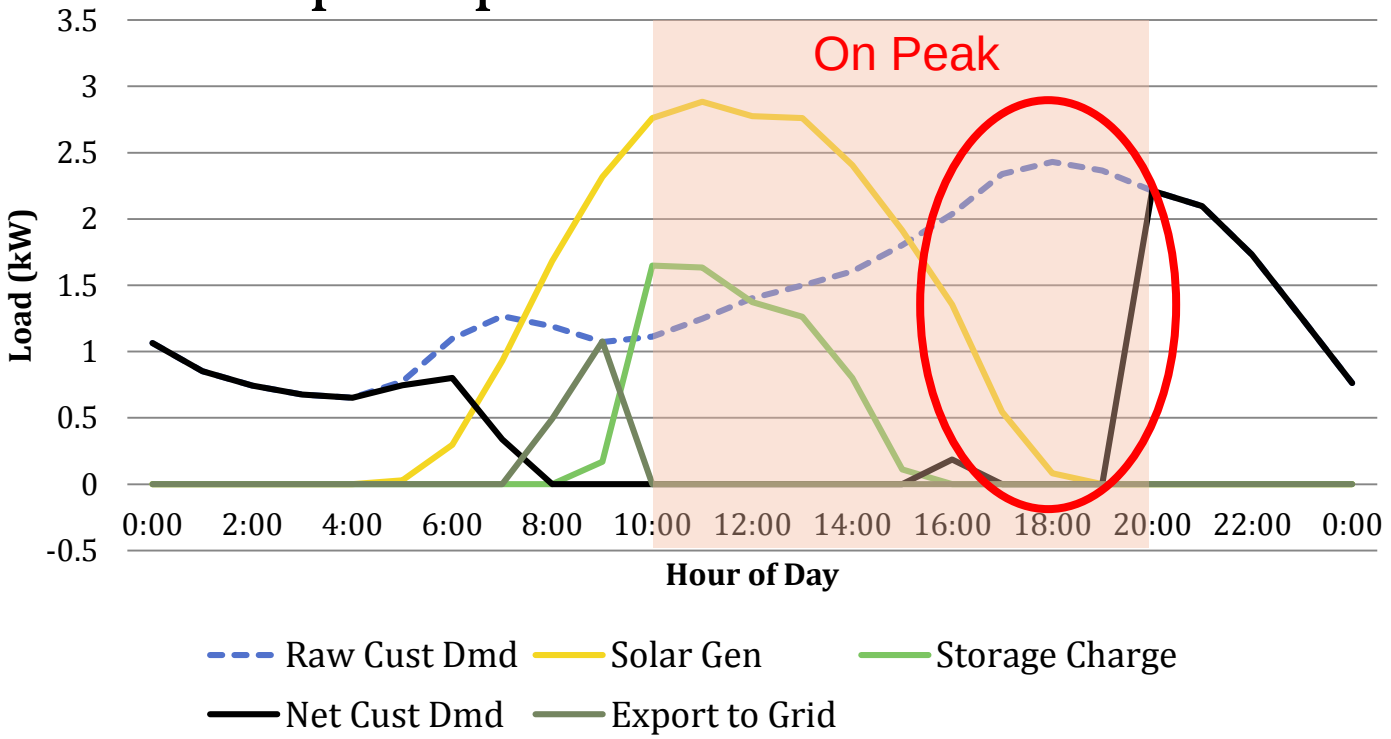

Image Source: Navigant Analysis

Solar PV + Storage, Time-of-Use Rate

- Peak demand is only marginally reduced, since there is no demand charge.

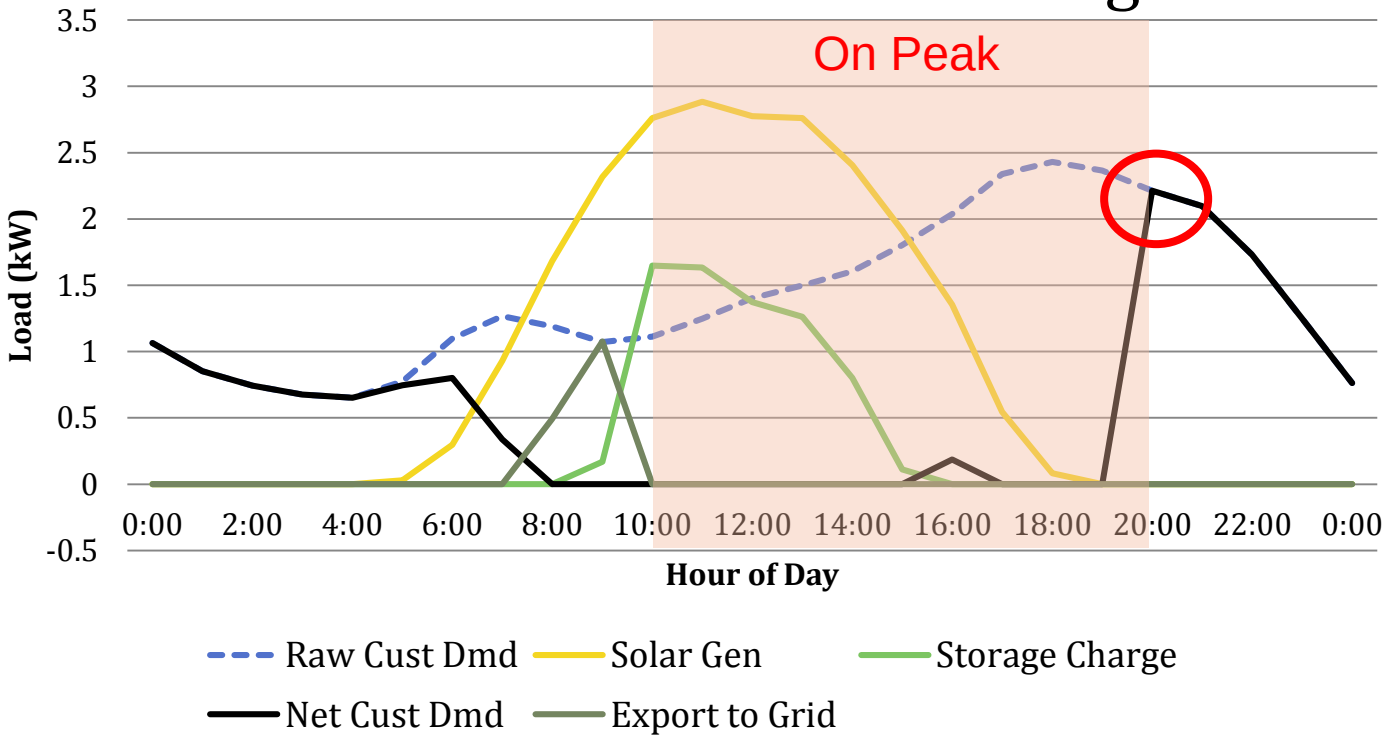

Image Source: Navigant Analysis

What/Where is the Value?

Valuation assumptions:

- Full system cost incurred: no incentives
- Revenue neutrality against raw customer load
  - A customer with no solar or storage should have the same annual bill under each TOU and demand charge scenario.
- 5.5 kW solar system, 3.3 kW/7kWh battery
- 20 year lifetime, replace battery at year 10

Electricity Rate Scenarios

Base Electricity Rate ($/kWh)	TOU Peak Rate Multipliers [1] (Peak / Off-Peak)	Demand Charge [2] ($/kW-Month)	Export Comp. Rate (% of Retail)
$0.10	1	$0	100%
$0.20	1.25	$2	60%
$0.40	2.5	$10	20%
	5	$20	

Avg. Illinois residential retail rate in 2014 was $0.119

Source: EIA Form 861 Annual Electric Power Industry Report

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Flat Rate, Net Metering

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[1] On-peak periods: weekdays only, 10 AM-8 PM in summer, 7 AM-11 AM and 5 PM-9 PM in winter

[2] Monthly demand charge assessed based on highest hourly demand in each month

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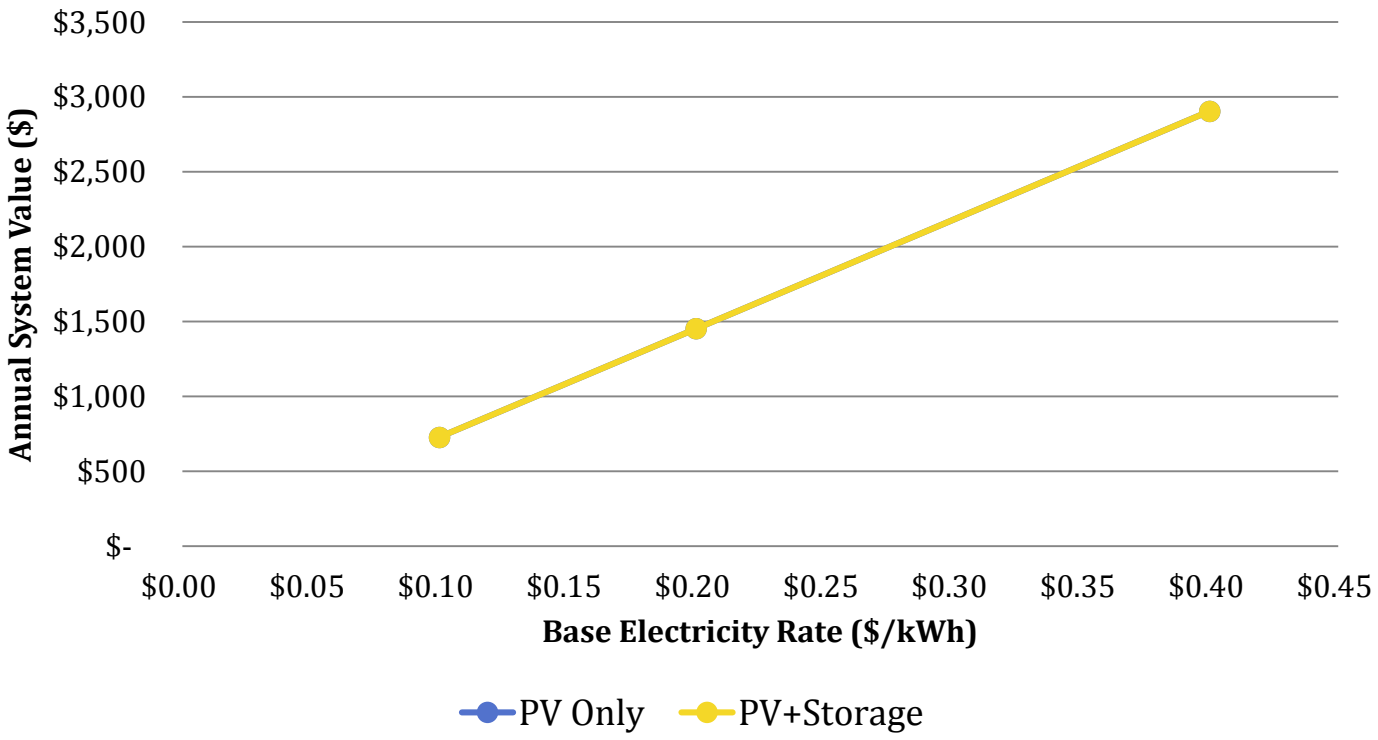
Flat Rate, Net Metering

- PV Only and PV+Storage have equal value



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Flat Rate, 20% of Retail Export Comp

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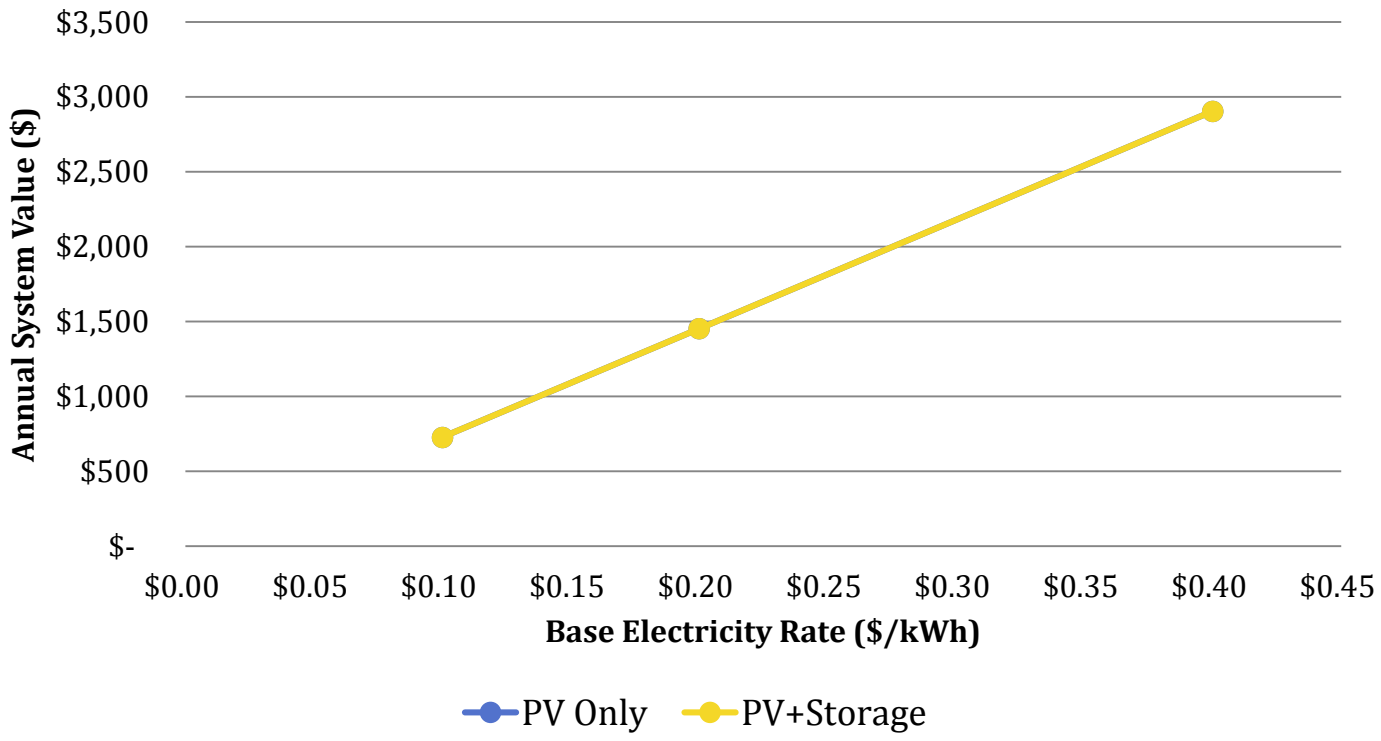
Flat Rate, Net Metering



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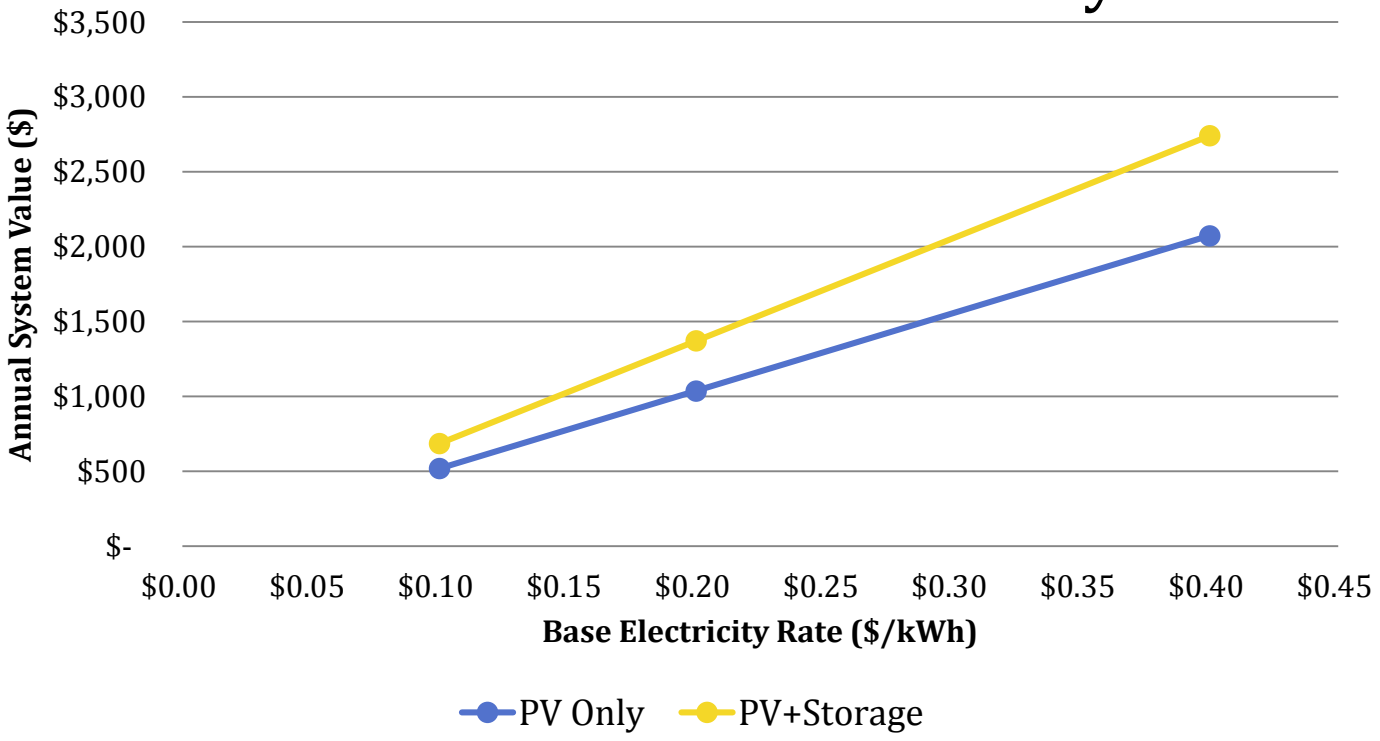
Flat Rate, 20% of Retail Export Comp

- Value **falls** for both systems, but much **more** so for PV Only



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Flat Rate, 20% of Retail Export Comp, $10/kW Demand Chg

Base Electricity Rate ($/kWh)	TOU Peak Rate Multipliers [1] (Peak / Off-Peak)	Demand Charge [2] ($/kW-Month)	Export Comp. Rate (% of Retail)
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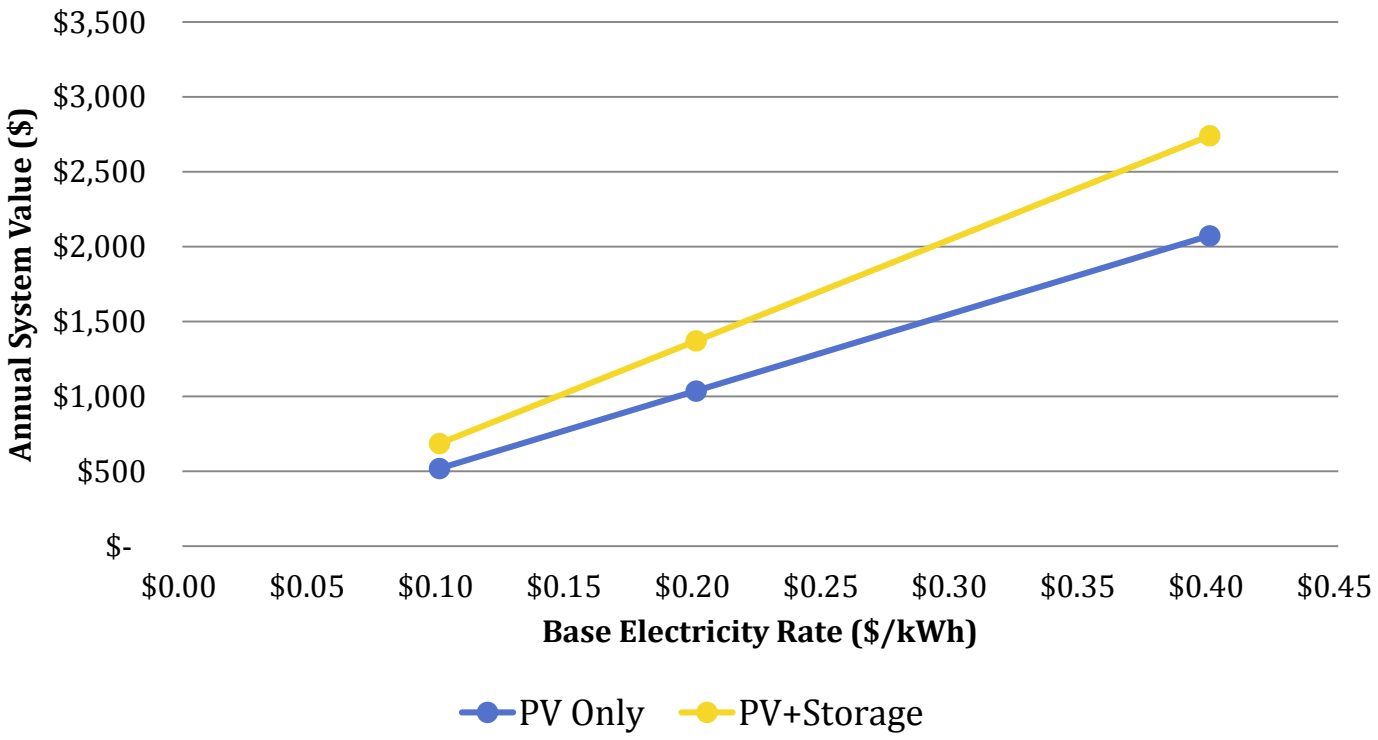
Flat Rate, 20% of Retail Export Comp



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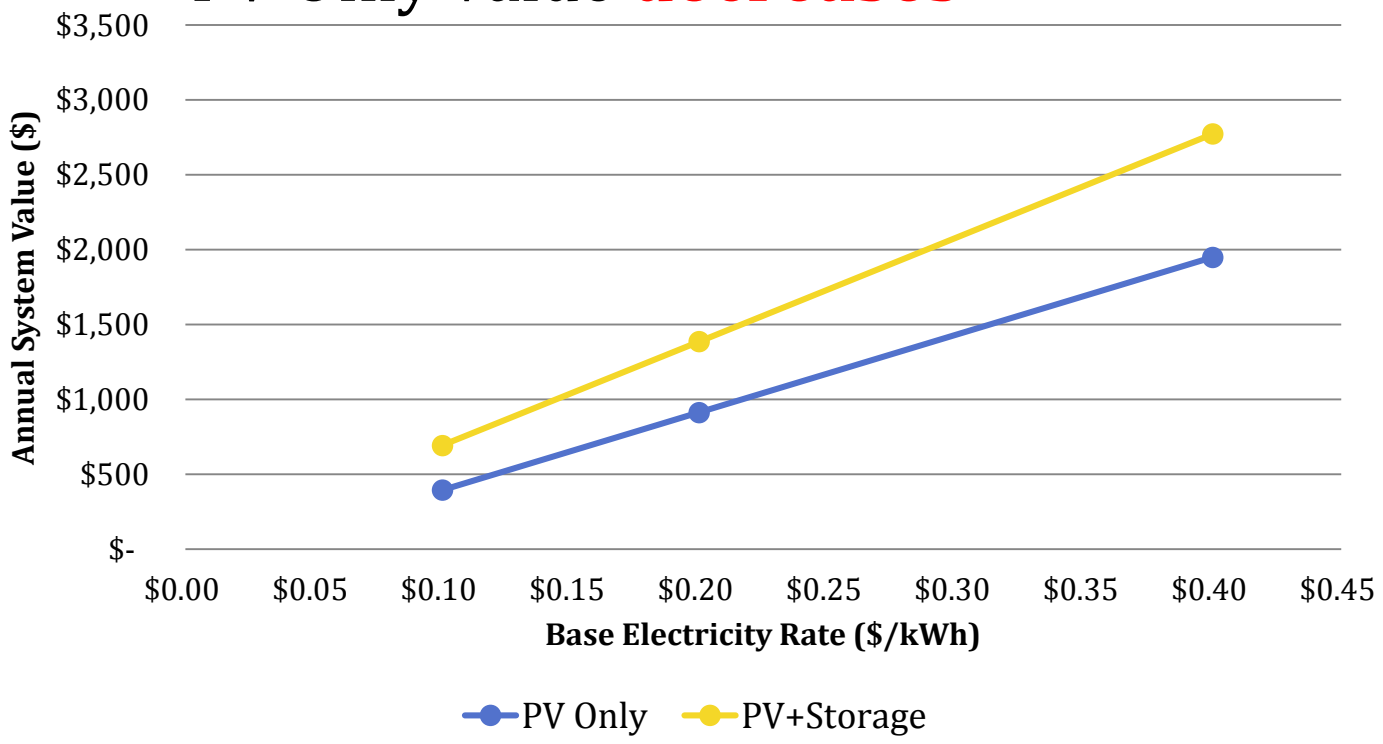
Flat Rate, 20% of Retail Export Comp, $10/kW Demand Chg

- PV+Storage value **increases**,
  PV Only value **decreases**



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Flat Rate, 20% of Retail Export Comp, $10/kW Demand Chg

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Flat Rate, 20% of Retail Export Comp, $10/kW Demand Chg, 5x TOU Mult

Base Electricity Rate ($/kWh)	TOU Peak Rate Multipliers [1] (Peak / Off-Peak)	Demand Charge [2] ($/kW-Month)	Export Comp. Rate (% of Retail)
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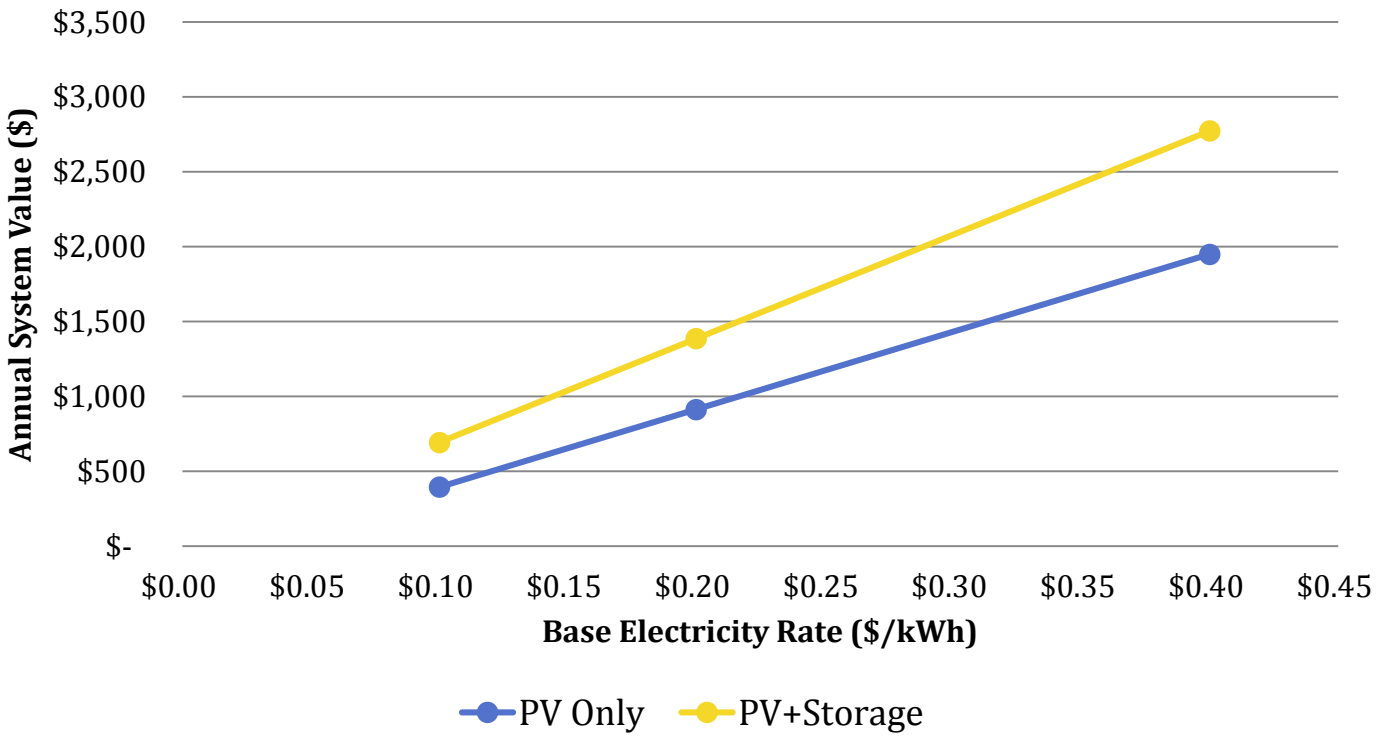
Flat Rate, 20% of Retail Export Comp, $10/kW Demand Chg



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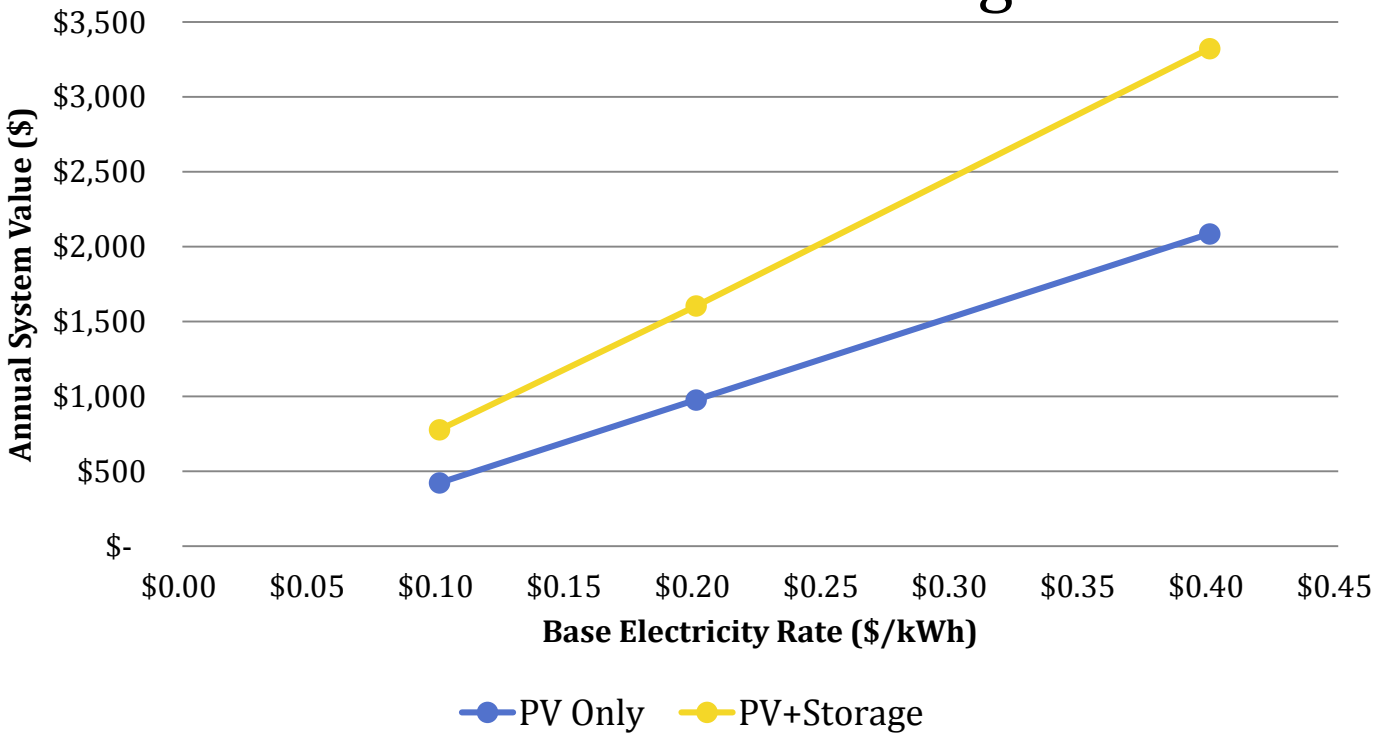
Flat Rate, 20% of Retail Export Comp, $10/kW Demand Chg, 5x TOU Mult

- Value **increases** for both systems, but **more** so for PV+Storage



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How do System Costs Affect Value for the Customer?

- **Value** varies with electricity rates, but **costs** do not

- $$Bill\ Ratio = \frac{Annual\ Bill\ With\ System}{Annual\ Bill\ Without\ System}$$
  - Bill Ratios less than one are cost-effective
  - Bill with system includes loan payments and O&M
  - Financing at 6% interest, $0 down payment

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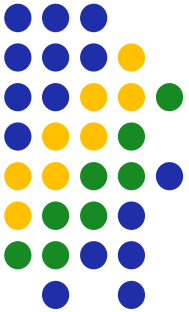
A Cost-Effective Scenario



- 2016 solar PV and battery storage costs
- $0.40/kWh energy rate (e.g., Hawaii)
- Export compensation at 20% of retail

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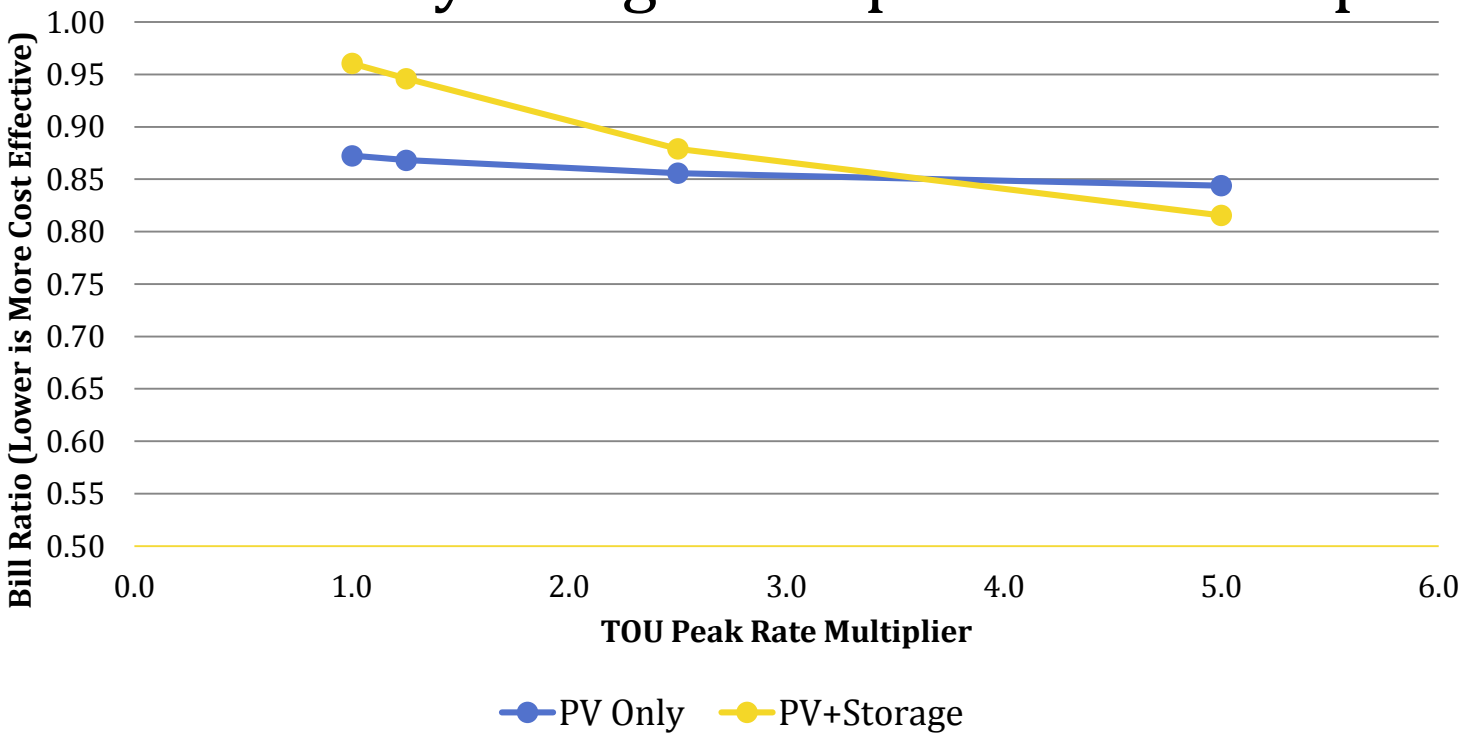
A Cost-Effective Scenario

- PV+Storage **more** cost effective than PV Only at high TOU peak rate multipliers



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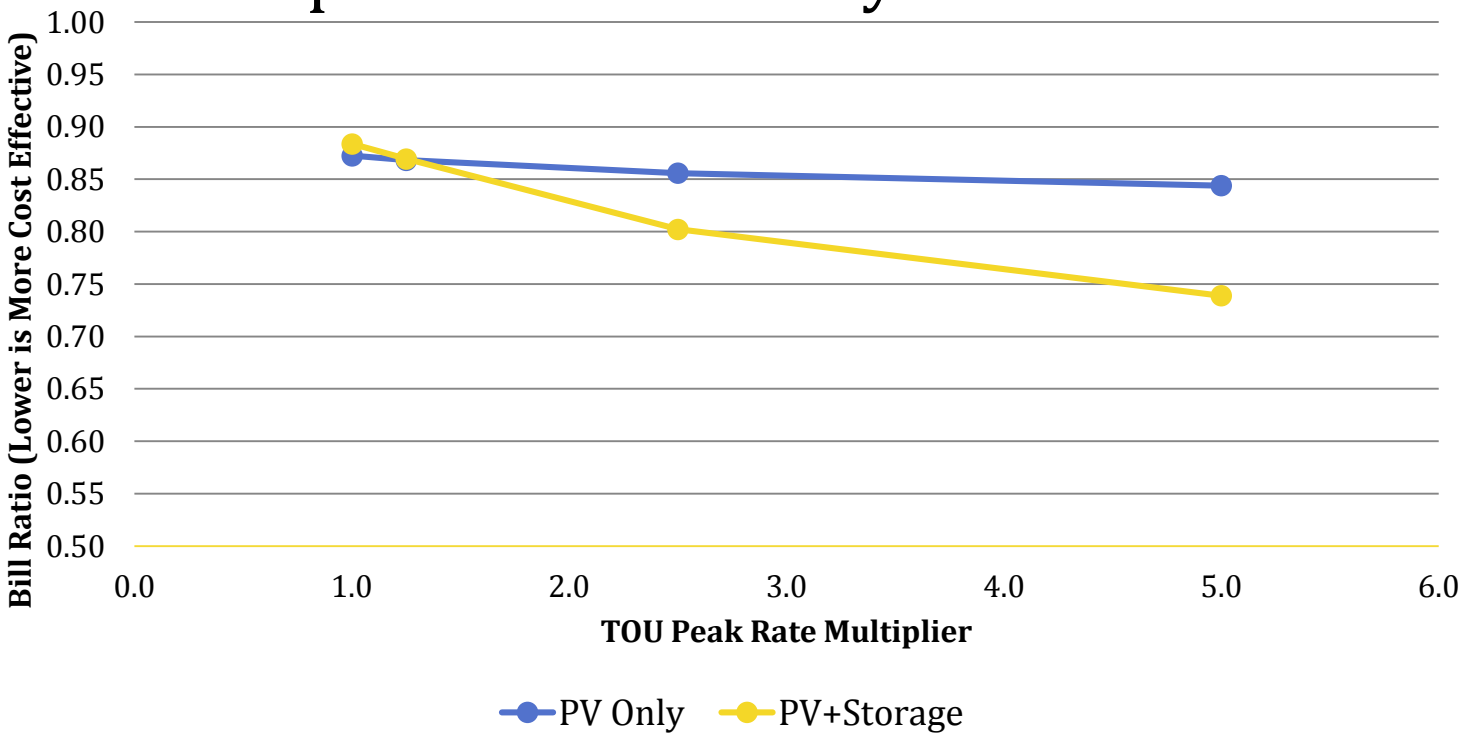
A Cost-Effective Scenario – 50% 2016 Battery Costs

- At lower battery costs, economics improve considerably



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Conclusions

- Solar+storage can be more cost effective than solar alone, given the proper electricity rates.
- Rate structure components interact in a complex way to prescribe optimal solar+storage system operation.
- With an understanding of how rate components contribute to system value, utilities can design rates that “shape” solar+storage dispatch.

Acknowledgements

Thanks to:

- All of you in the audience for participating
- AESP for hosting a wonderful event
- Navigant for financial support

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Questions?

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