ENERGY

Advanced Energy Storage Use Cases

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SAFER, SMARTER, GREENER

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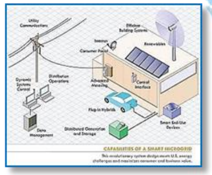
Energy | Maritime | Oil & Gas | Software | Business Assurance



Solar and Storage Applications

151
Year History

400
OFFICES

100
COUNTRIES

16,000
EMPLOYEES

DNV GL is the world's largest independent energy and renewables advisory firm.

We have over 2500 energy experts.

More than 1000 are focused on renewables.

DNV GL has advised on over 3000 solar projects.

Extensive experience in storage technology and applications.

DNV GL - ARPA-e CHARGES

New battery technologies for the grid require new testing and validation.

Past ARPA-e battery technology awardees will be evaluated.

Task 1: Testing Protocols

Task 2: Economic Models

Task 3: Battery Testing

Task 4: Microgrid Testing

Task 5: Commercialization

Partners

NIR Group Renewable Energy Solutions

New York Battery and Energy Storage NY BES+ Technology Consortium

CAR Technologies

Program Advisory Board

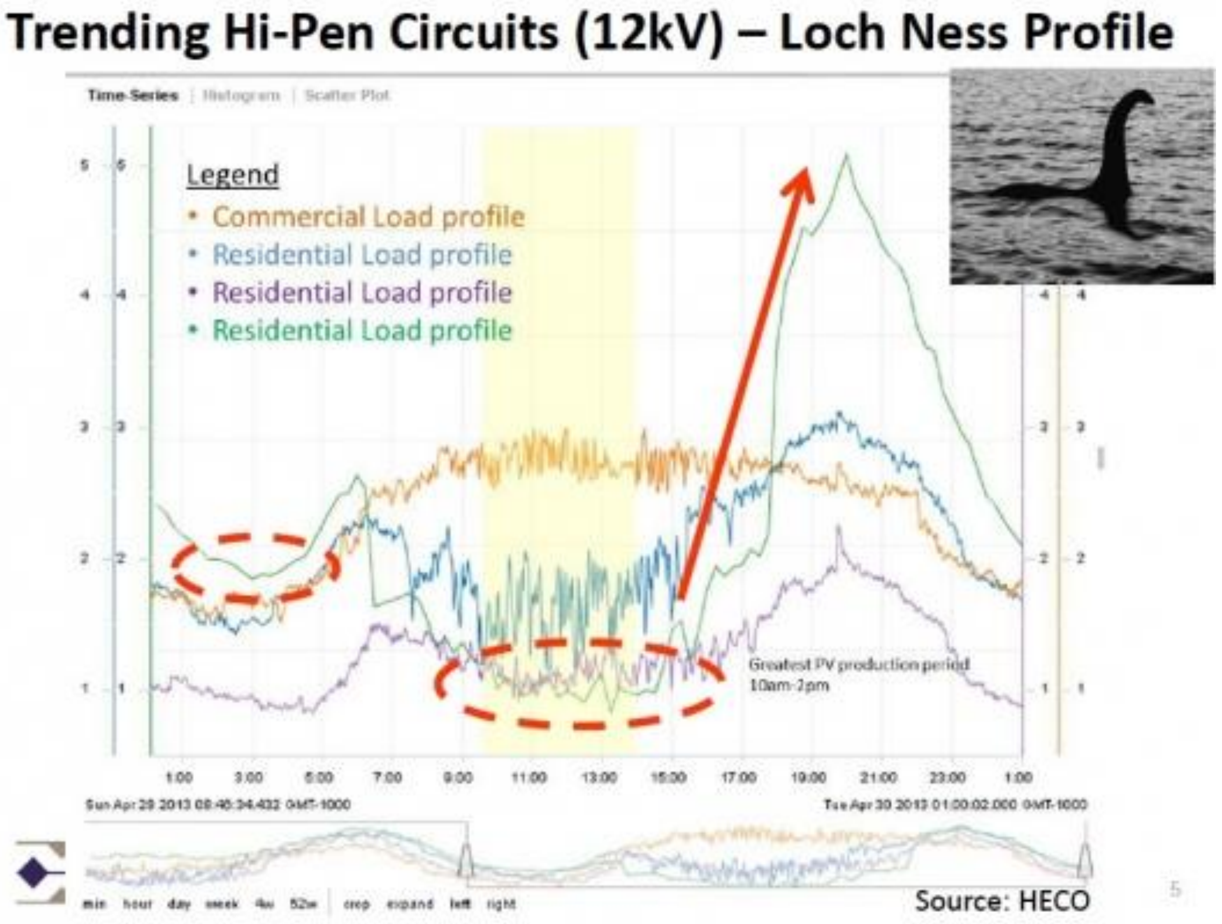
NAATBatt National Alliance for Advanced Technology Batteries · NY BES+ · nyserda Energy. Innovation. Solutions. · conEdison · South Plains Electric Cooperative, Inc. · NextEra Energy · Google

Zero Net Energy

- What is Zero Net Energy building?
  - Building with net energy consumption of zero over a typical year
- Policy Drivers
  - Climate goals
  - Governor’s goals
  - CPUC’s strategic plan
- Consumer drivers
  - Environmental awareness
  - Bill reduction (Net energy metering)

Challenges

- Excessive PV penetration and production is creating grid and system issues
  - Circuit back-feed, excessive ramping.
- Net-metering is replaced by:
  - Self supply (solar + storage)
    - Expedited interconnection
    - Energy sell-back to grid is forbidden and not compensated
  - Grid supply
    - Limited sell-back to grid is allowed at highly reduced rates
- Similar situations expected to arise as distribution installed renewable penetration increases, e.g. CA, NY



Advanced Application Modeling

Solar Self-Supply

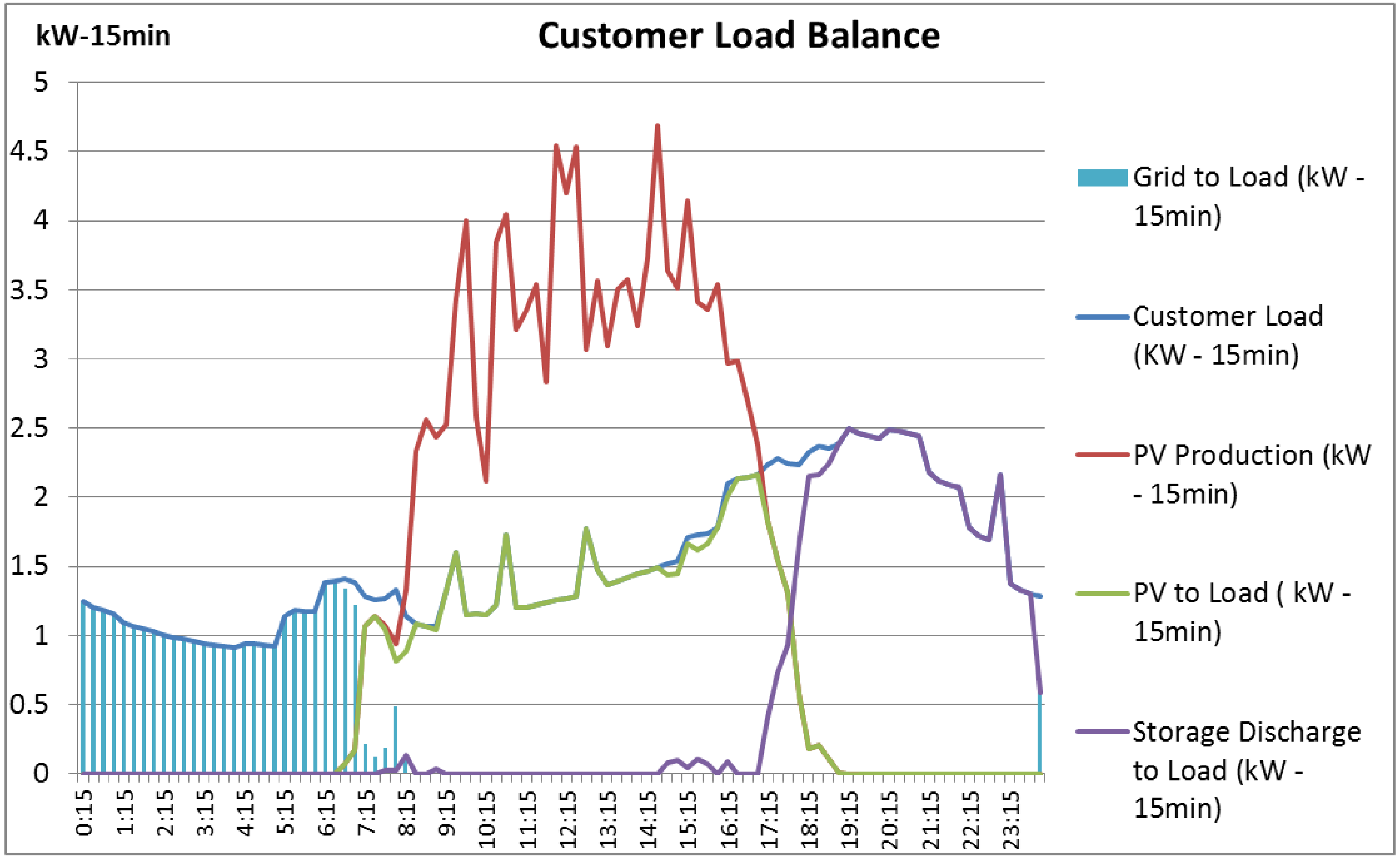
Solar Self-Supply – Storage Dispatch Strategy

- Battery is charged whenever PV production is greater than load
  - excess solar is curtailed

- Key challenge is to appropriately size solar+storage w.r.t. customer load such that:
  - Maximize solar utilization
  - Maximize energy storage throughput

Residential Self-Supply Operational Example

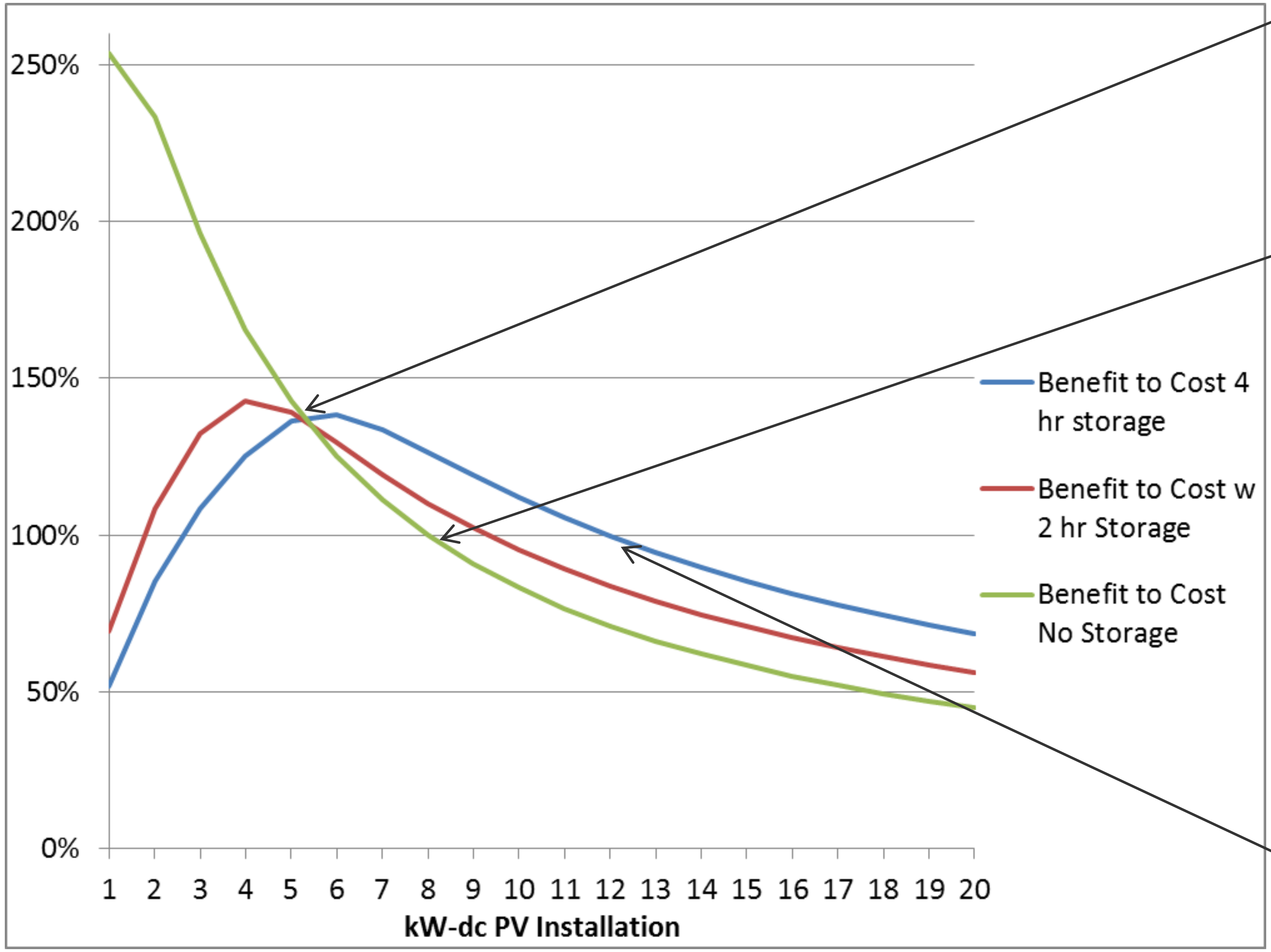
- Example residential customer
  - Peak demand: 6.25 kW-1min
    4.84 kW-15min
- DER Installed:
  - PV: 6kW-dc
  - Storage: 3.3 kW, 4 hours
- Grid supply is required only between midnight and 8 am
  - Without storage: 48.1% PV curtailment over 24 hours
  - With storage: 7.5% PV is curtailment



15-min operations shown for clarity

Residential Self-Supply Resource Sizing Optimization - Financial

- 20 year cash-flow analysis considering O&M costs, ITC rebates, battery replacement on 10th year.
- PV cost $3,200 per kW
- Storage cost:
  - $460/kWh for battery
  - $450/kW for inverter
  - $1500 for installation



Above 6 kW-dc PV, Solar + Storage is more cost-effective than stand-alone Solar

Stand-alone PV cost-effective up to 8 kW

Solar + Storage is cost-effective till 12 kW PV (BCR > 100%)

Advanced Application Modeling

Demand Charge Reduction + Fast Regulation

Demand Charge Reduction + Regulation

- Nearest term application for behind-the-meter storage to participate in wholesale markets

- Pilot projects recently funded in CA, NY and NJ.

- Proceedings underway in CA and NY to provide (generation side) wholesale market access to behind-the-meter resources.

- FERC recently opened Docket No. AD16-25 to investigate storage compensation for bundling applications in wholesale, transmission and BTM markets
  - *"…FERC's announcement also recognizes the importance of distributed energy storage in wholesale markets. The Commission is seeking input on how distributed and customer-sited storage systems are able to provide local benefits while simultaneously providing competitive wholesale market services, which is currently possible to a limited degree in California."*

- Newswire, Oct 3rd, 2016

DCR + Fast Regulation – Storage Dispatch Strategy

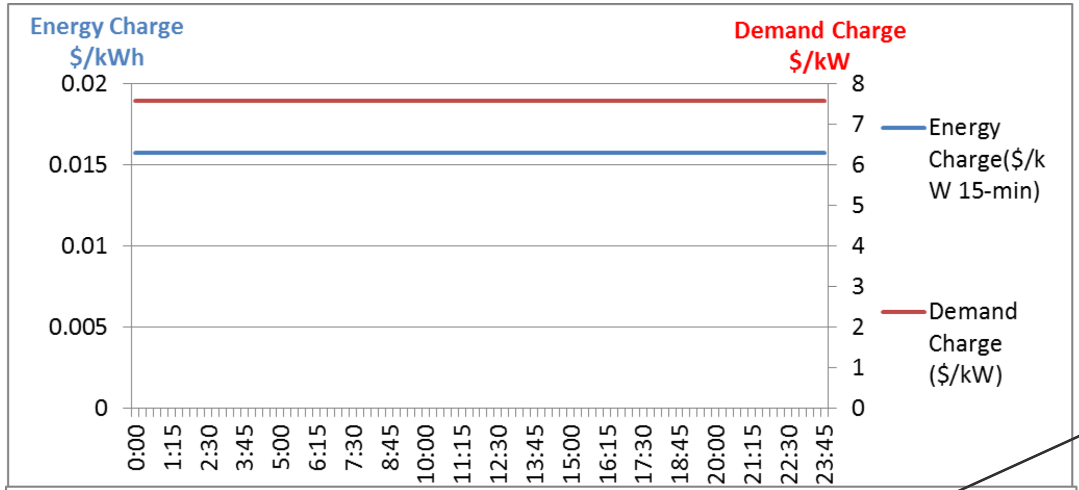
- Customer bill management application is assigned priority

- Available capacity after bill management is then committed to regulation

- Regulation participation performed while minimizing impact on customer quality of service
  - Controls need to manage SoC so regulation participation does not impact bill management

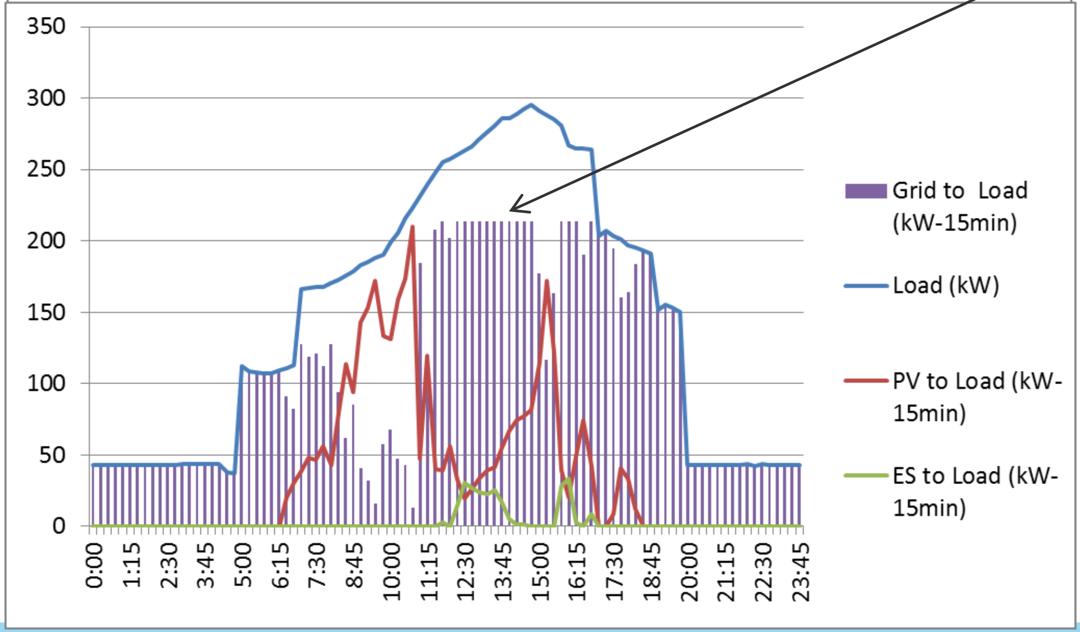
  - SoC offsets result from lack of a net-zero regulation signal

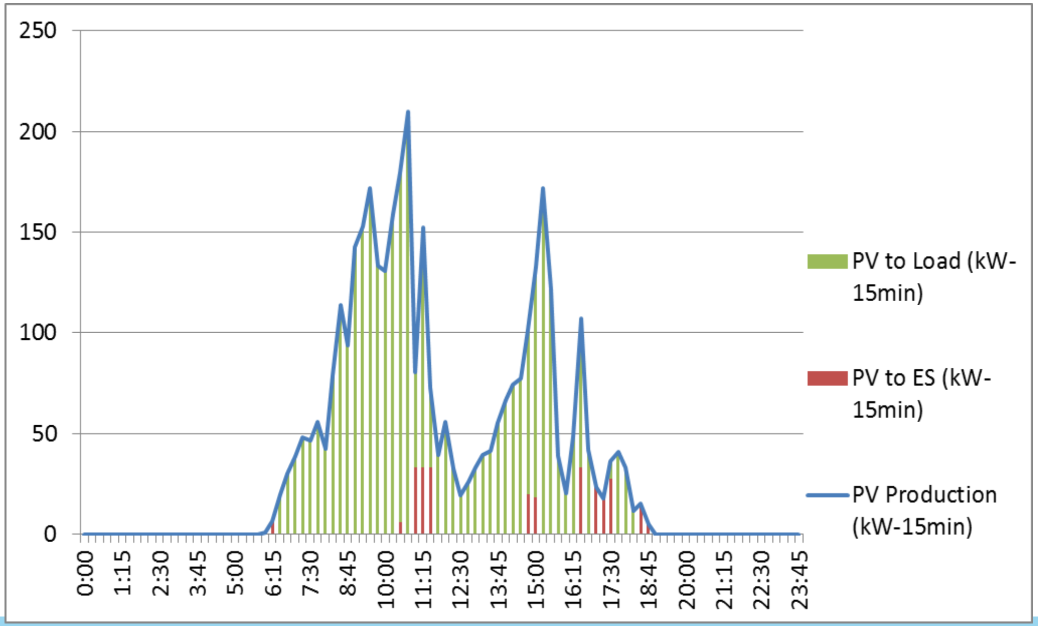
Demand Charge Reduction Operation – Secondary School



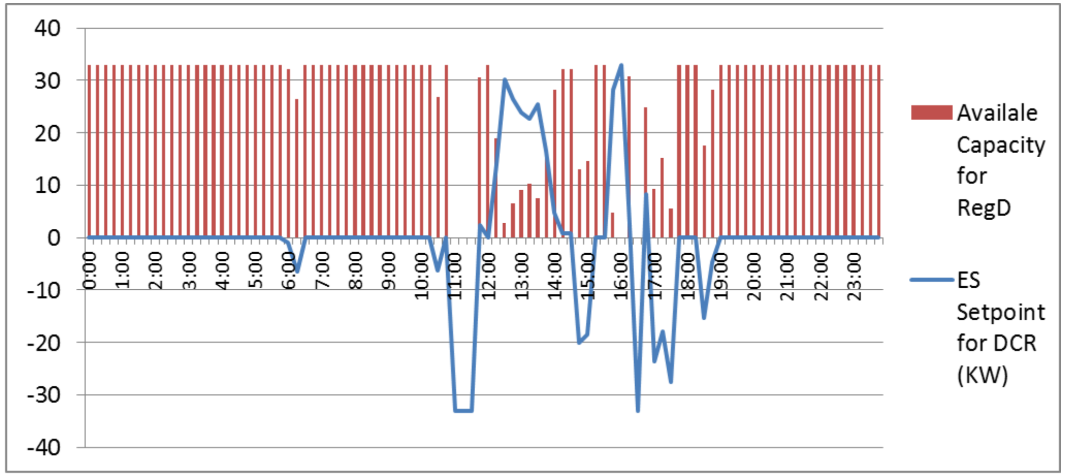
- Example day – July 14
- Charges are low:
  - 6.3 /kWh, $7.15/kW.

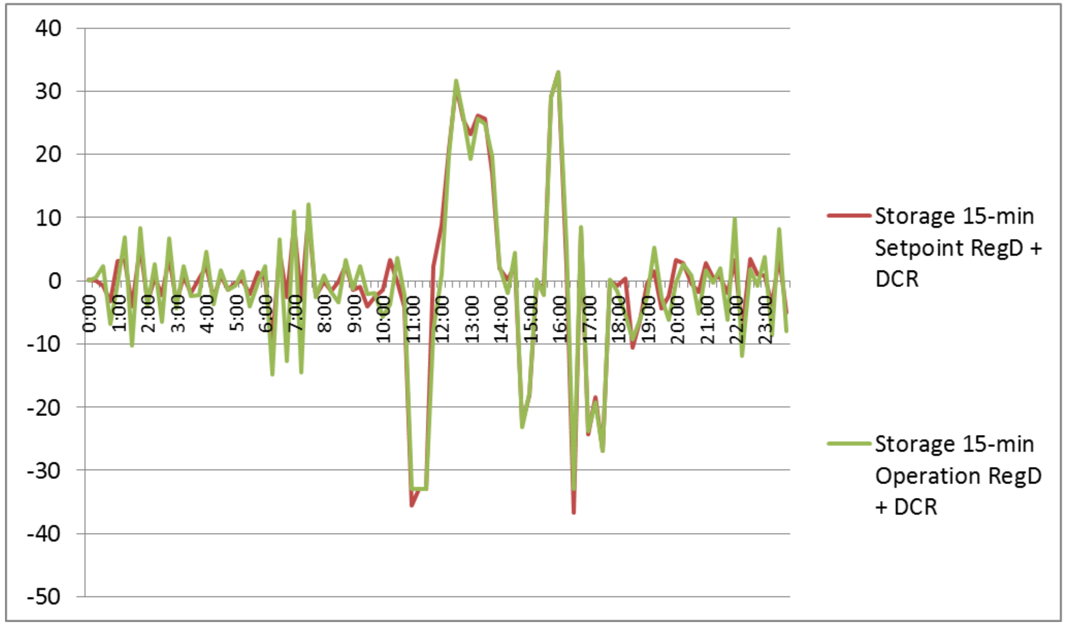
Storage compensates PV intermittency and flattens load





Storage Setpoints and Regulation Commitment



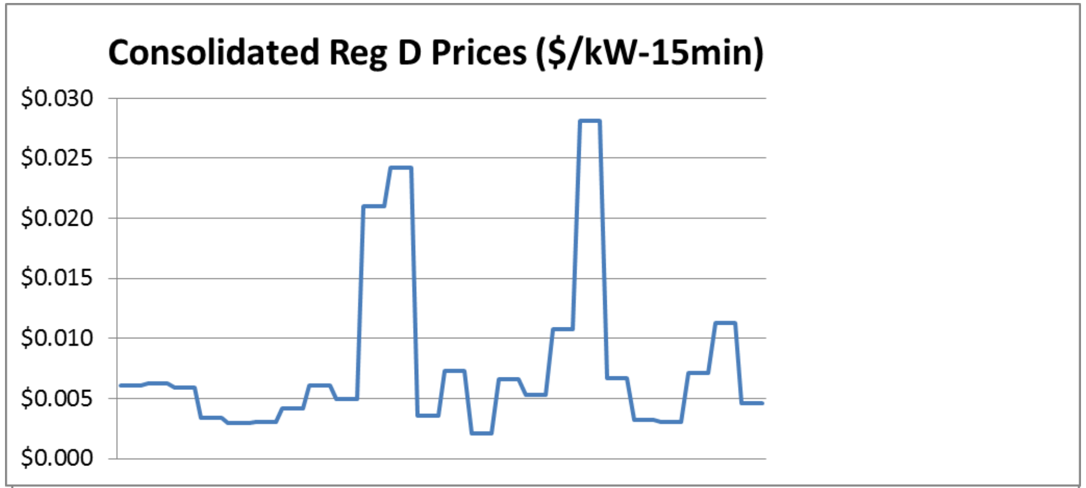


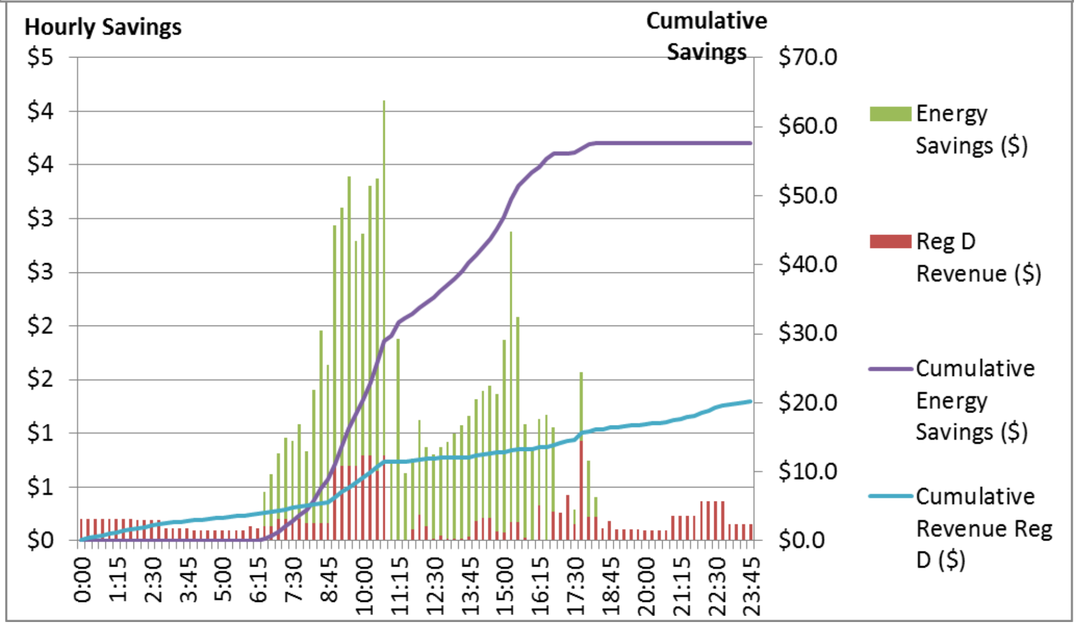
- Regulation commitment is based on capacity availability after bill management.

- Reg-D set-points calculated every 15-mins based on energy compensation requirements

- Actual operation shows energy transaction while following RegD signal during the 15-min interval from set-point.

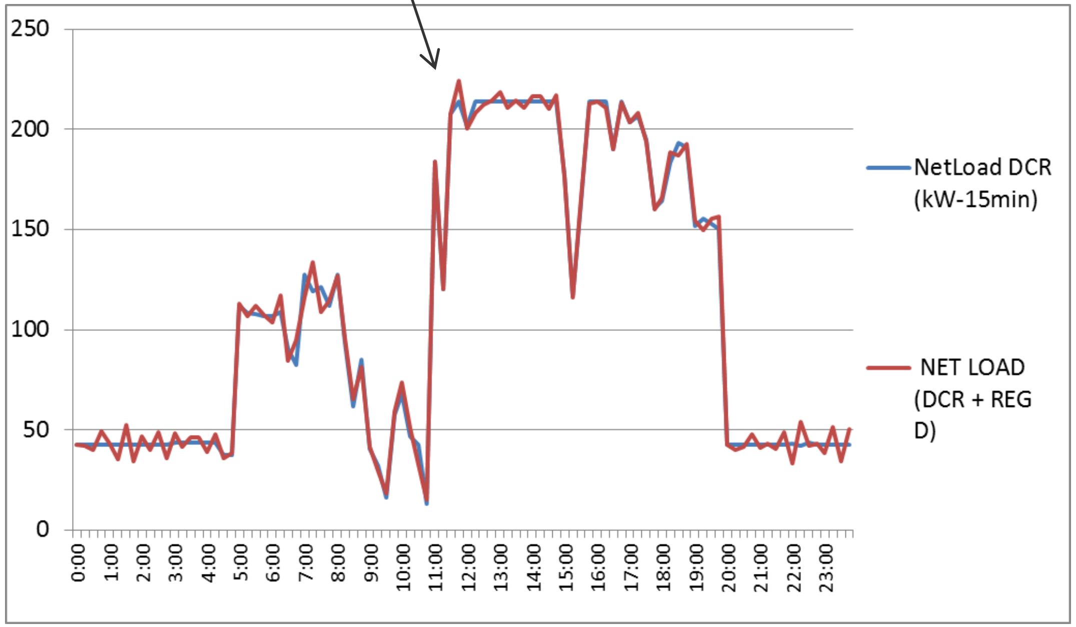
Daily Operation Results





- Cumulative savings over day
  - $58 from energy (PV)
  - $20 from regulation
- Effect on net-load over day is minimal

Peak demand increases slightly over the day



Financial Impact of Combining Applications

Demand Charge Reduction Payback

	Utility	Storage Cost	Storage Benefit	Payback Period (yrs)
Secondary School	JCPL	$33,747	$2,131	16
Secondary School	PSE&G	$33,747	$1,540	22
Retail	JCPL	$14,059	$795	18
Retail	PSE&G	$14,059	$609	23

Combining applications enables cost-effective storage where tariffs not suited for individual applications.

Demand Charge Reduction + Regulation Payback

	Utility	Storage Cost	Storage Benefit (DCR)	Storage Benefit (RegD)	RegD impact on energy charge savings	RegD impact on demand charge savings	Reg D impact on net metering revenue	Reg D impact on BM Benefits	Final Storage Benefits	Payback Period (yrs)
Secondary School	JCPL	$33,747	$2,131	$9,238	($317)	($810)	($16)	($1,143)	$10,226	3
Secondary School	PSE&G	$33,747	$1,540	$9,238	($657)	($276)	($33)	($966)	$9,812	3
Retail	JCPL	$14,059	$795	$3,714	($151)	($547)	($24)	($722)	$3,786	4
Retail	PSE&G	$14,059	$609	$3,714	($151)	($547)	($24)	($722)	$3,601	4

Thank You!

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