
ENERGY

# Advanced Energy Storage Use Cases

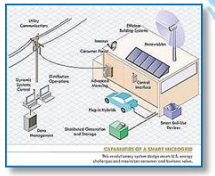
*Michael Kleinberg, PhD.*

*NYSERDA On-Site Power – December 7, 2016*

# About DNV GL

DNV·GL

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

# 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

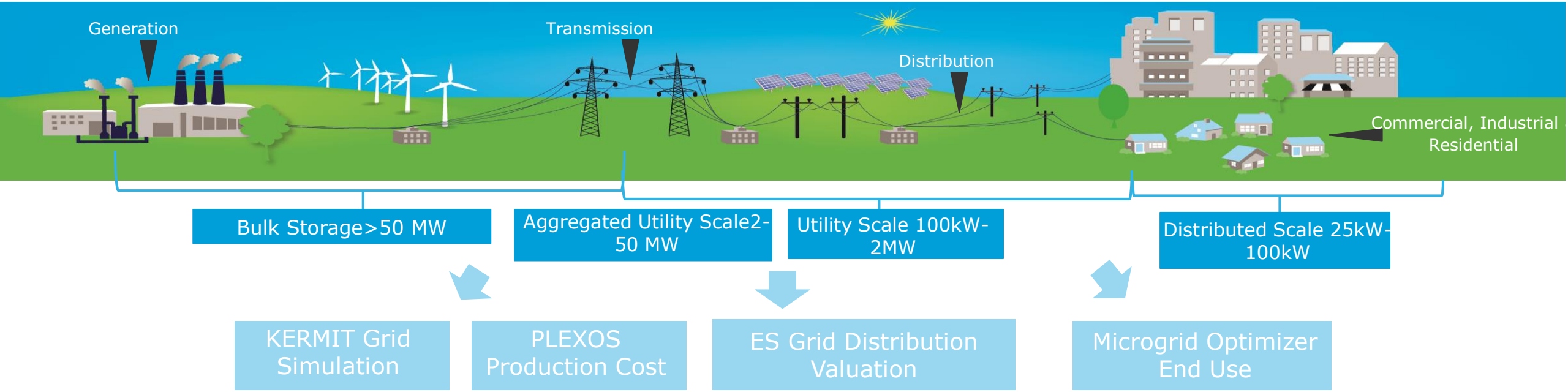
Task 4: Microgrid Testing

Task 5: Commercialization


**Partners**

**Program Advisory Board**

# Capturing the Value of Storage




## Bulk Storage Applications

- Large renewable support – shifting, smoothing or firming
- Fossil generation support
- Contingency Reserve, Resource adequacy

## Utility Scale Applications

- Distribution circuit upgrade deferral
- PV Smoothing

## Customer Scale Applications

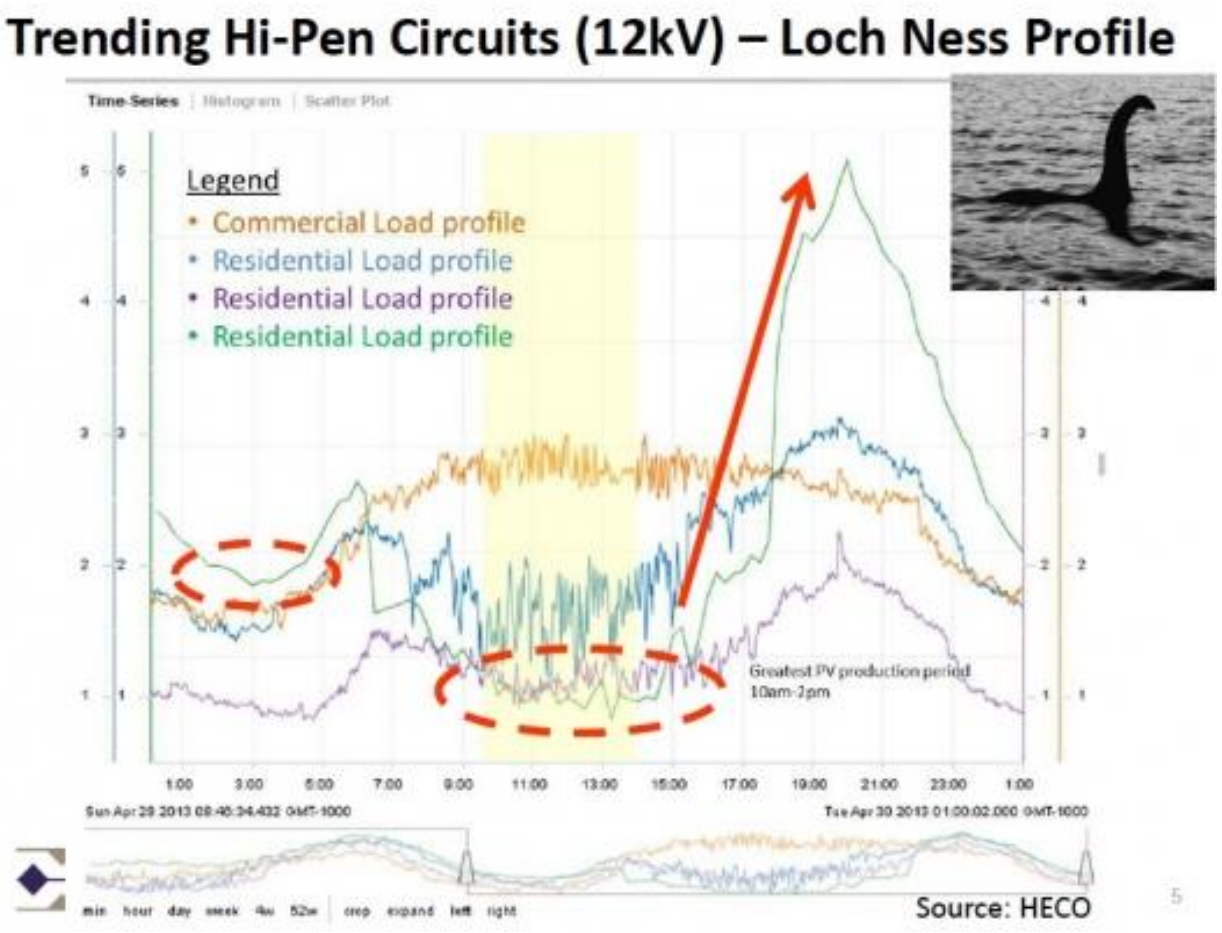
- Customer bill management
- Outage mitigation

# Advanced Application Modeling

## Solar Self-Supply

# Solar Self-Supply

- 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



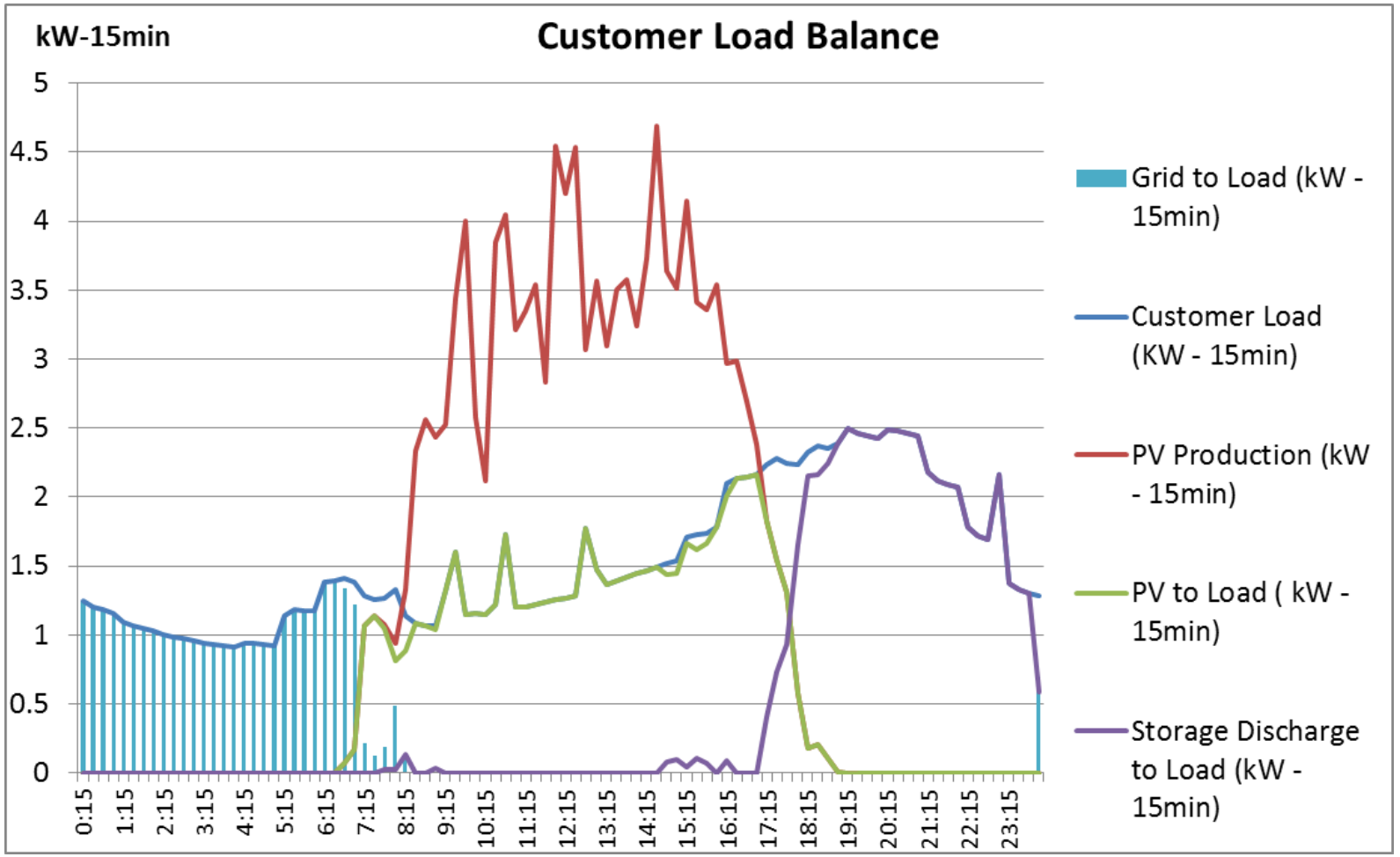
# Solar Self-Supply – Storage Dispatch Strategy

- 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

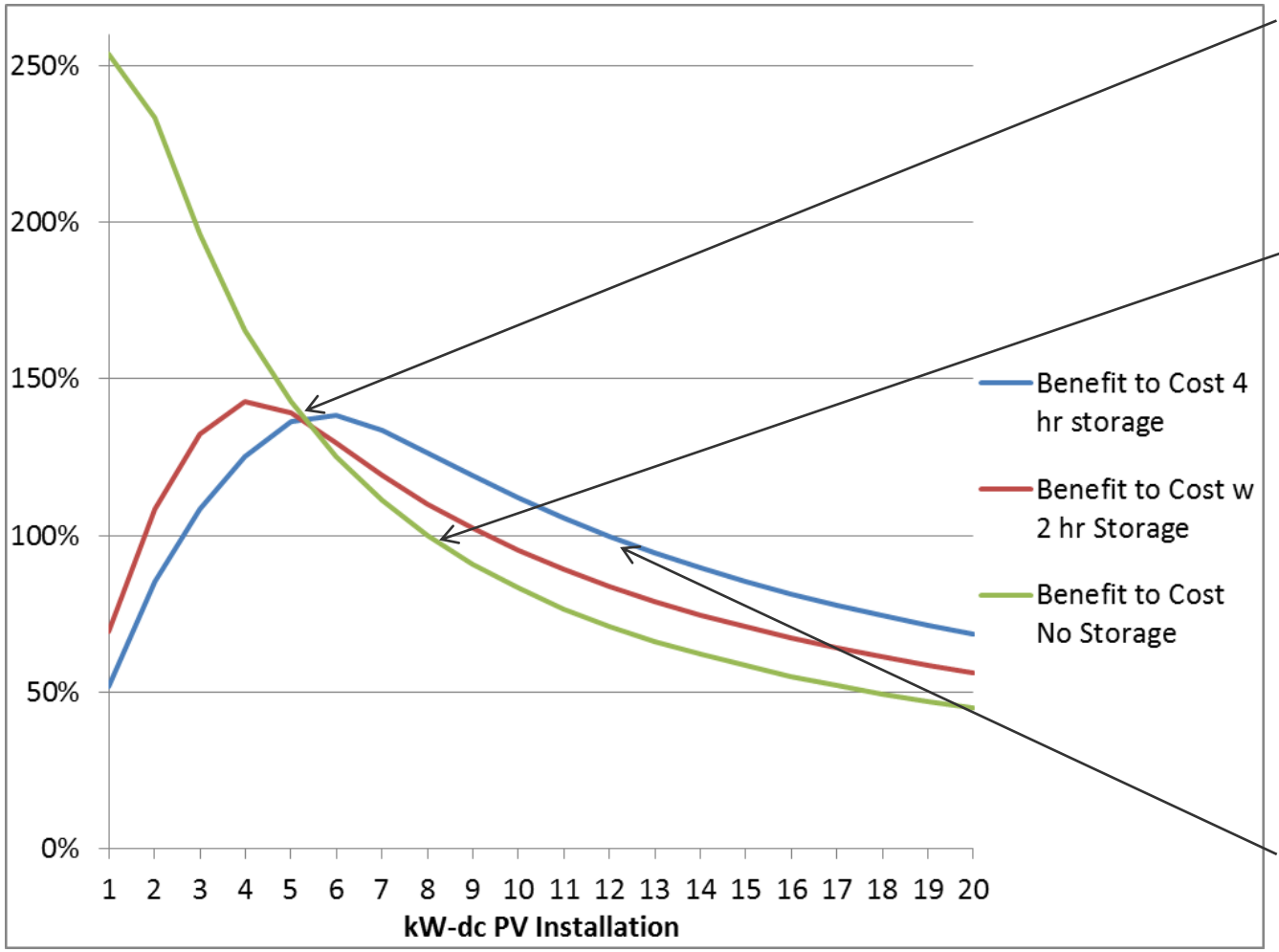
- Example residential customer
  - Peak demand: 6.25 kW-1min
    4.84 kW-15min
- DER Installed:
  - PV: 6kW-dc
  - Storage: 3.3 kW, 4 hours
- Grid supply is required only between midnight and 8 am
  - Without storage: 48.1% PV curtailment over 24 hours
  - With storage: 7.5% PV is curtailment




*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.

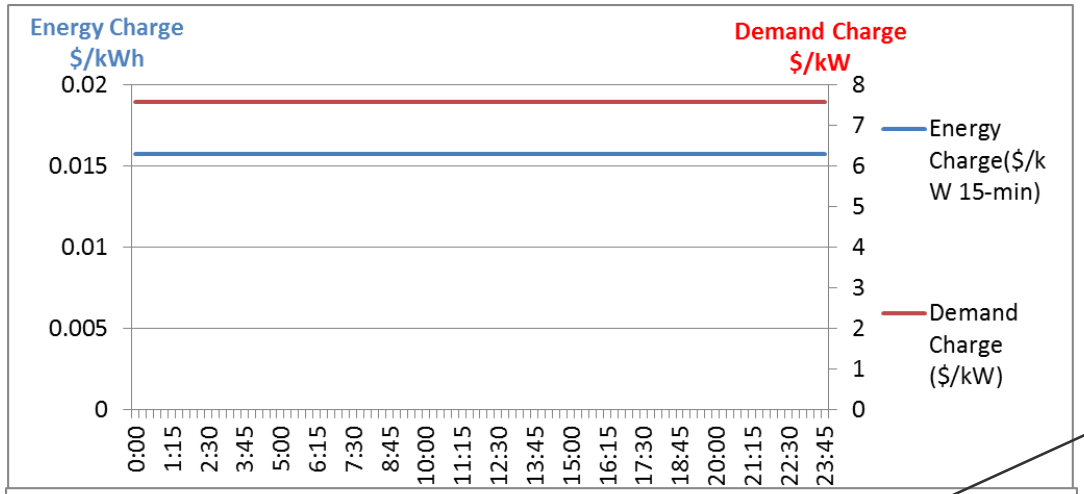
- FERC recently opened Docket No. AD16-25 to investigate storage compensation for bundling applications in wholesale, transmission and BTM markets
  - *"…FERC's announcement also recognizes the importance of distributed energy storage in wholesale markets. The Commission is seeking input on how distributed 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

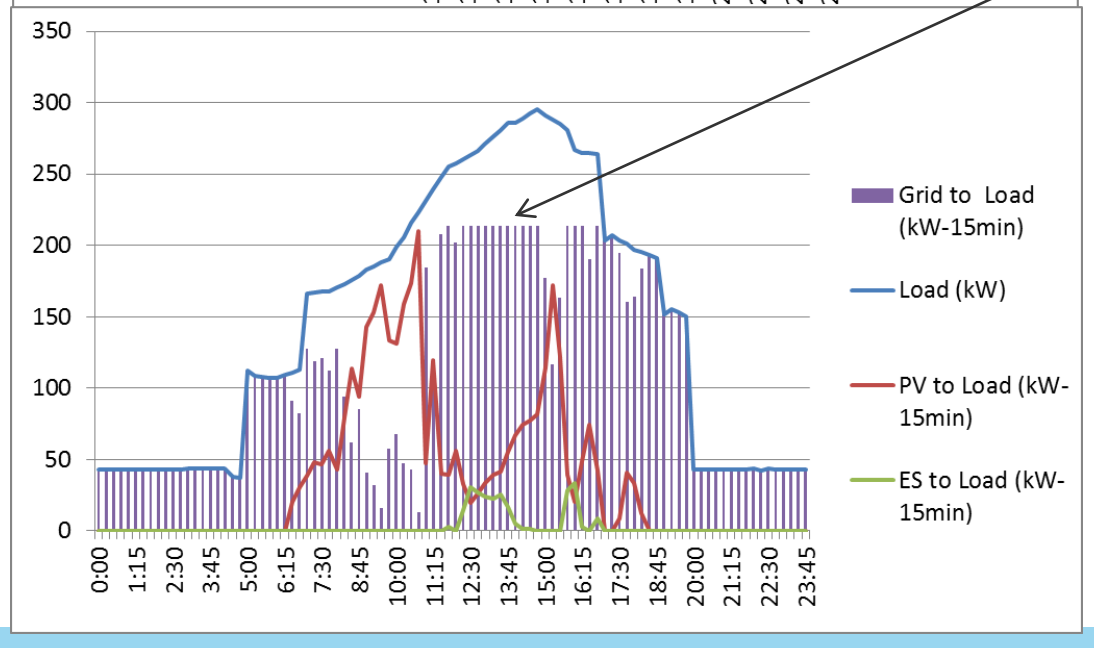
- Customer bill management application is assigned priority
- Available capacity after bill management is then committed to regulation
- Regulation participation performed while minimizing impact on customer quality of service
  - Controls need to manage SoC so regulation participation does not impact bill management
  - SoC offsets result from lack of a net-zero regulation signal

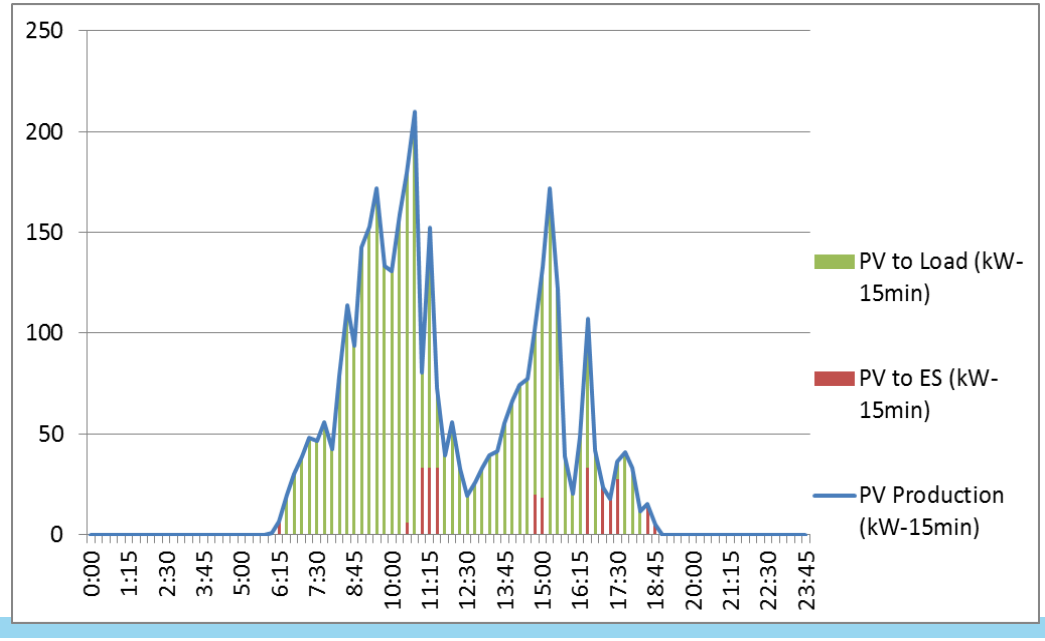
# Demand Charge Reduction Operation – Secondary School




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

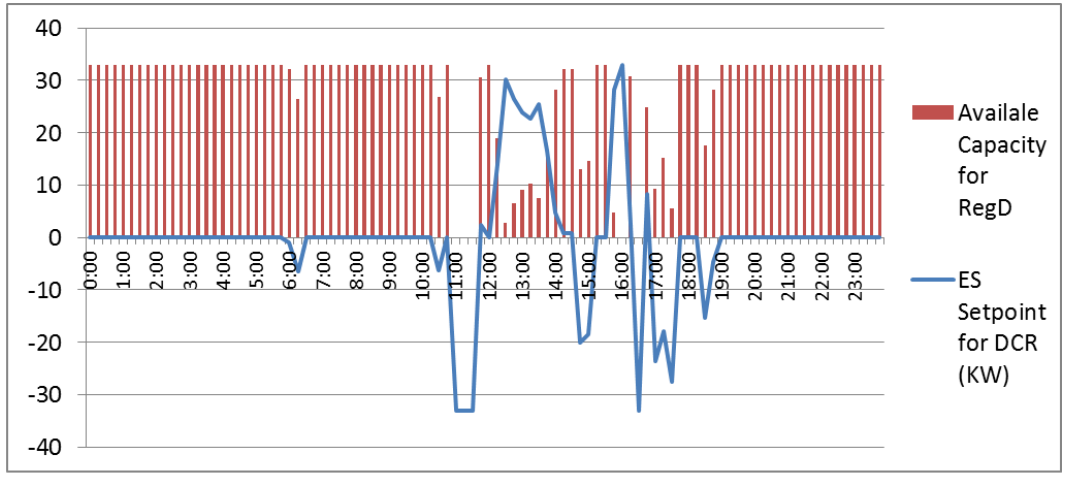
*Storage compensates PV intermittency and flattens load*

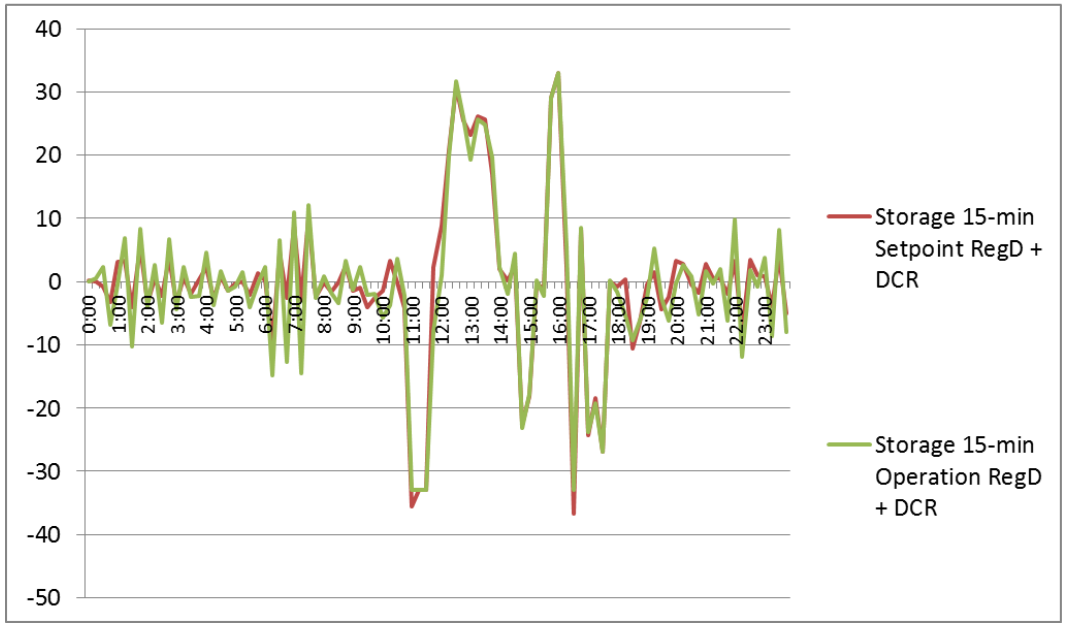


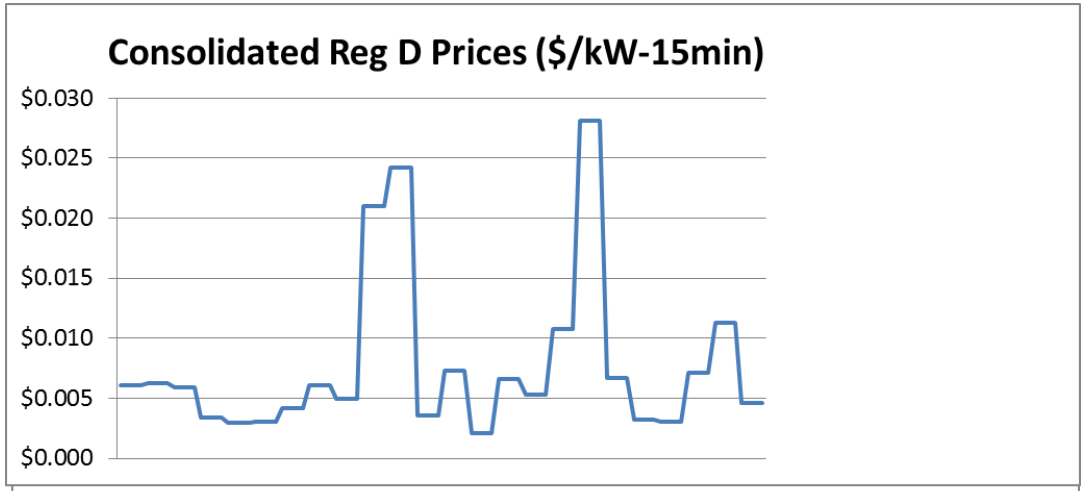
# Storage Setpoints and Regulation Commitment

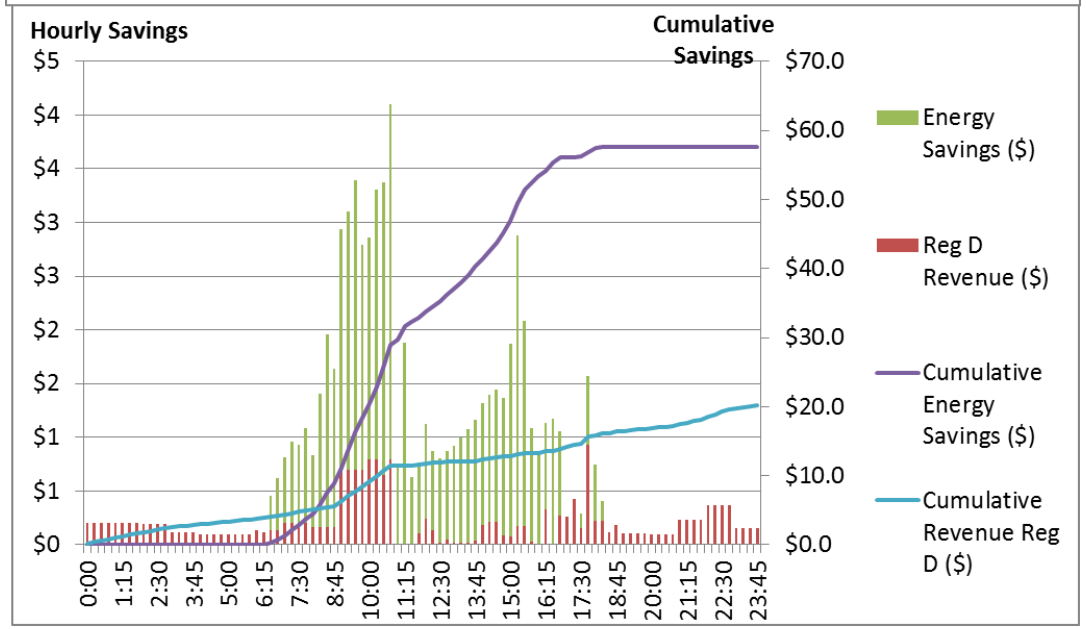



- Regulation commitment is based on capacity availability after bill management.
- Reg-D set-points calculated every 15-mins based on energy compensation requirements
- Actual operation shows energy transaction while following RegD signal during the 15-min interval from set-point.

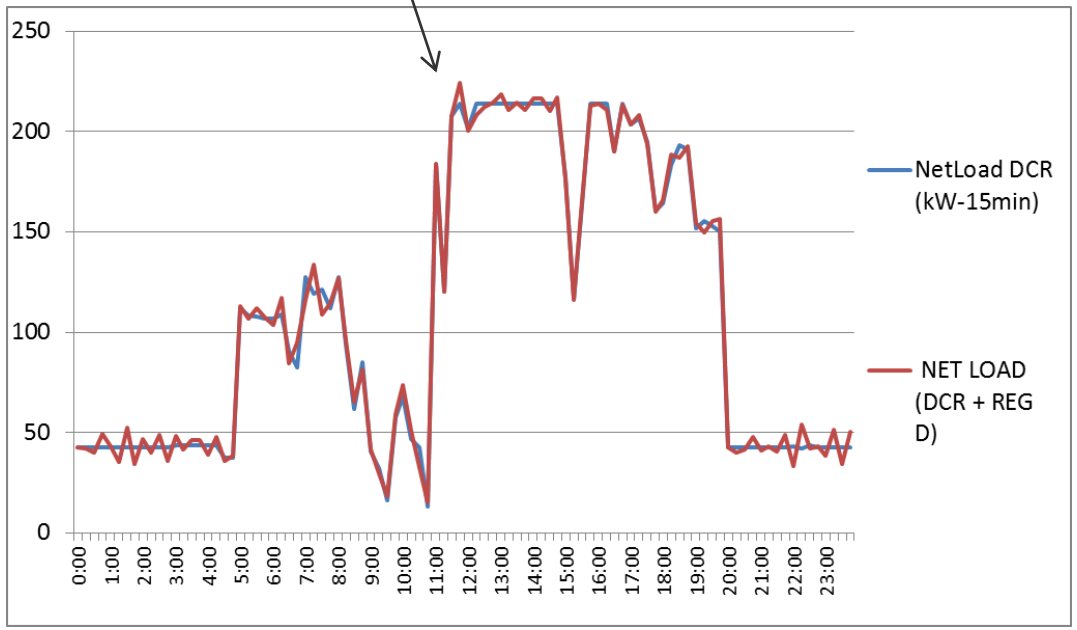
# Daily Operation Results




- 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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