# Participation of Energy Storage in CAISO's Ancillary Services Market

Meeting with Donald Tretheway, CAISO  January 12, 2010


**The California Energy Storage Alliance (CESA)**

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# About The California Energy Storage Alliance (CESA)

Our Goal: *Expand the role of storage technology to promote the growth of renewable energy and create a more stable, secure electric system*











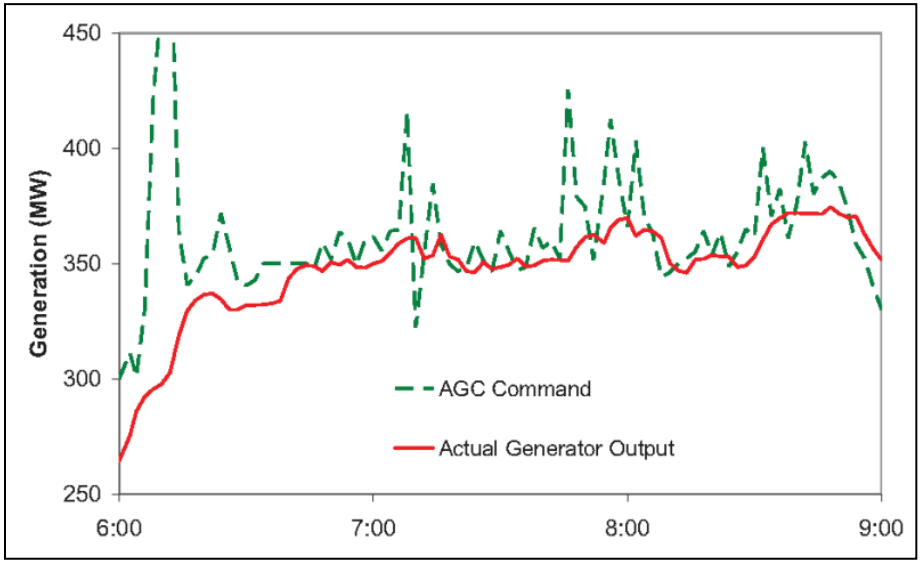


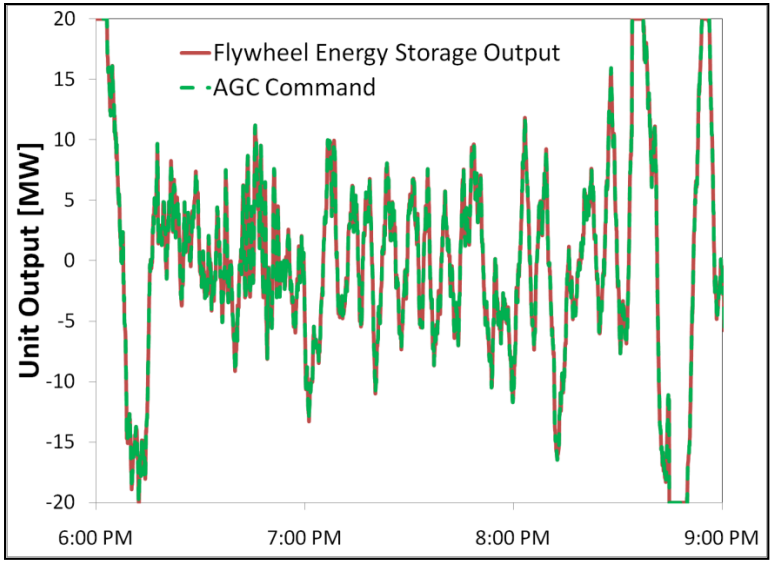



# Energy Storage Advantages

- Up to 100x faster than current regulation providers
  - Fast response to errors can reduce overall A/S procurement
  - More effective and tighter control (CPS1 & CPS2)
- Assists integration of intermittent renewable resources (wind, solar)
  - Ability to quickly and precisely respond to the control issues caused by frequent and unpredictable changes in wind output
  - Available separately; no need to add generation to control off-peak wind
- Zero direct greenhouse gas, particulates or other air emissions
  - Recycles electricity
  - Over 80% reduction in $CO_2$ emissions vs. present methods
- Lowers cost to ratepayers
  - New competition displaces high cost traditional generation
- Generators can cycle less frequently
  - Frees up generation capacity, less O&M, fewer emissions

# Fast Regulation: Speed Matters…



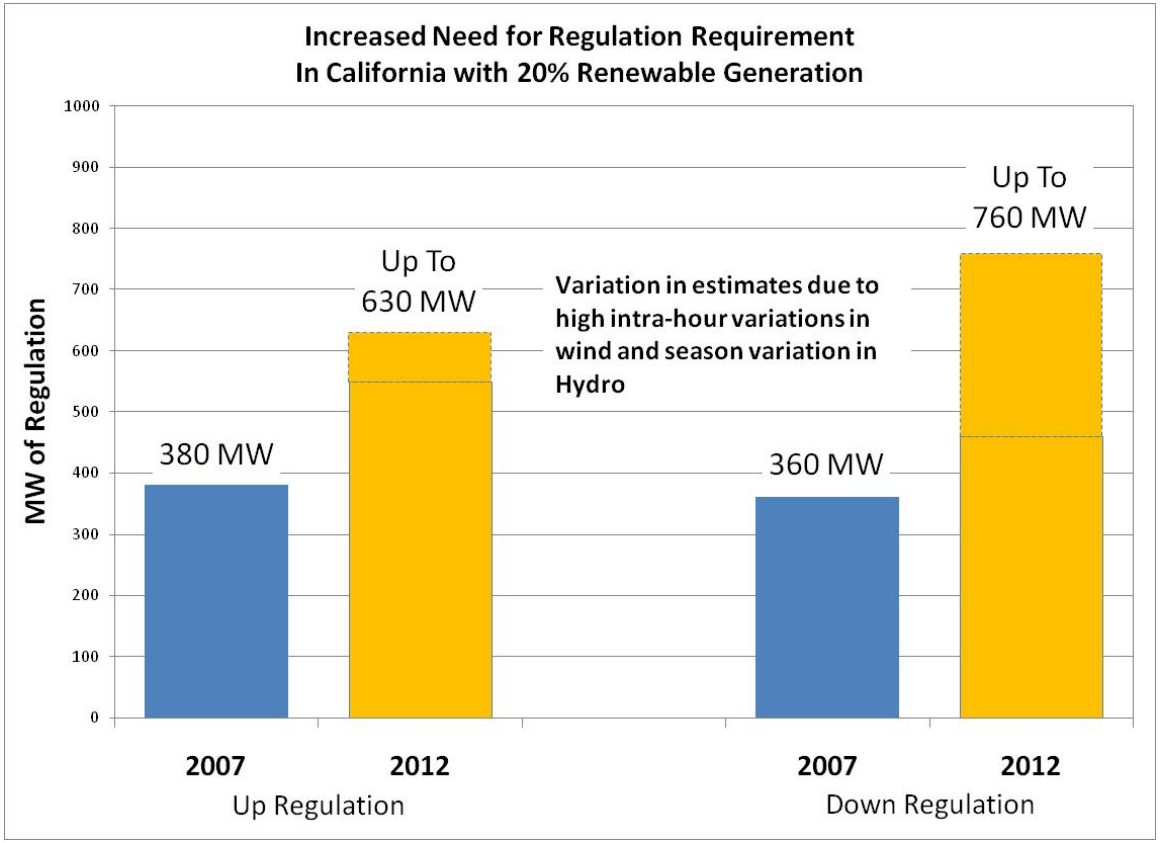




Slow ramping Generator vs. Advanced Energy Storage

Advanced energy storage provides near instantaneous response to a control signal

# Renewables Create Need for More Regulation

- Frequent and unpredictable changes in wind/solar creates need for **greater regulation capacity** and **faster regulation ramping capability**
- Nov '07 CAISO report identifies significant additional regulation requirements with 20% renewables
- RPS target is now 33%




**Advanced storage will be required to achieve California's renewable energy goals**

*Source: "*Integration of Renewable Resources*" CAISO, Nov 2007

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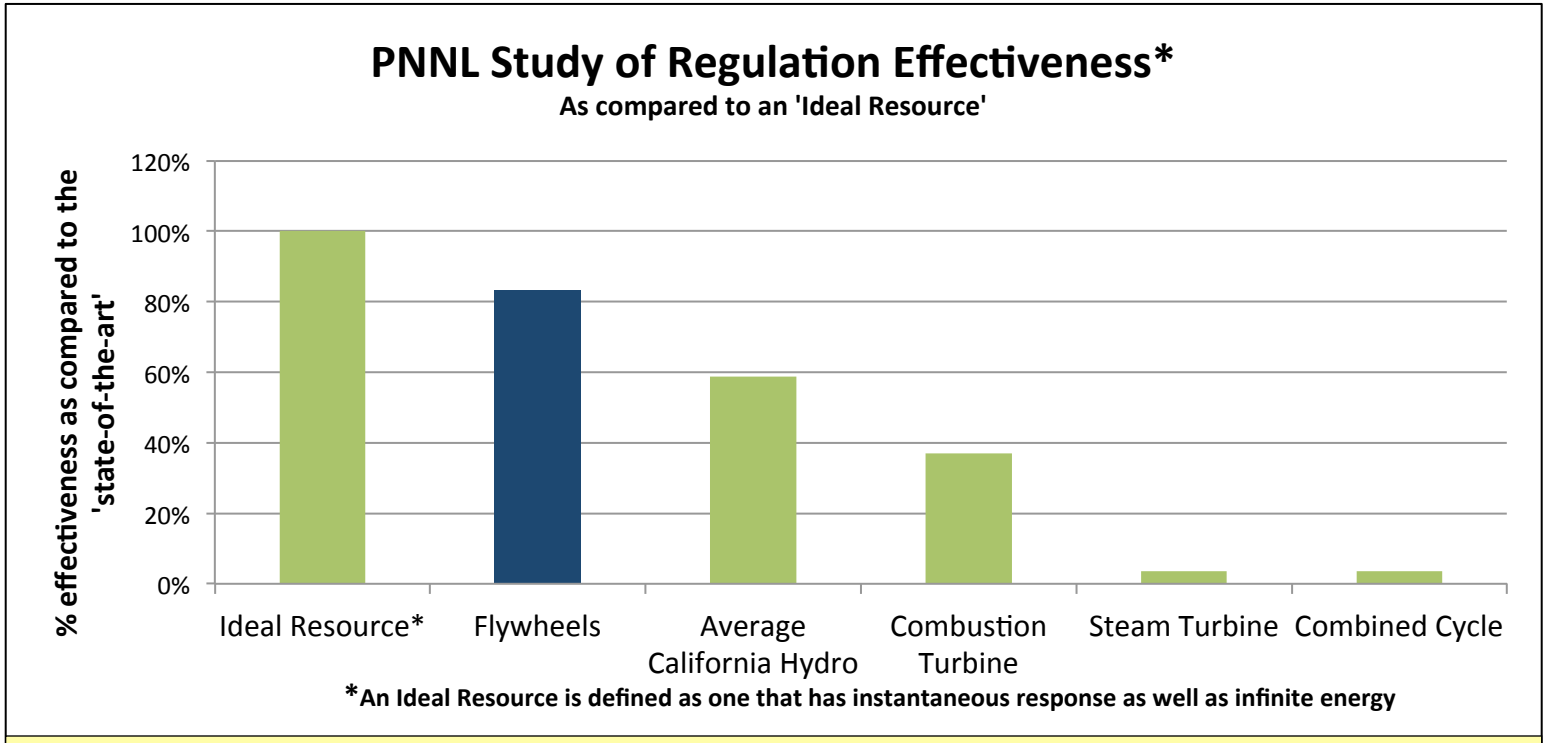
# System Benefits of Fast Regulation

- Frequency error is function of the amount (MW) of imbalance and the time it takes to correct the imbalance
  - The sooner ACE is corrected the less amount of regulation that is needed




**Fast response technologies can reduce the amount of regulation procurement required – Up to 40% in CAISO**

*Source: Makarov, Y.V., et al. "Assessing the value of Regulation Resources Based on Their Time Response Characteristics." Pacific Northwest National Laboratory, PNNL – 17632, June 2008.

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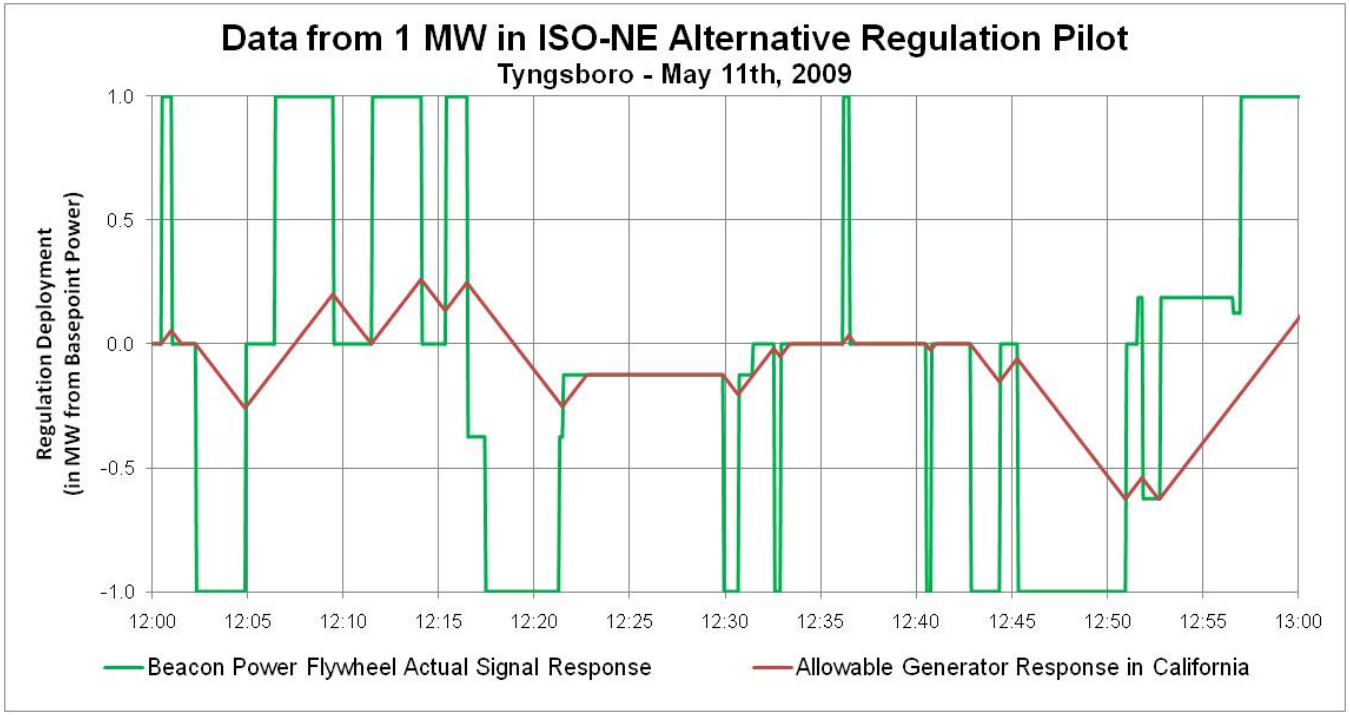
# Empirical Data from Storage in ISO-NE Pilot Program

- Based on ISO-NE empirical study results 1 MW of Regulation capacity from a Generator produces 10 MW of Regulation Service miles
- Empirical data from Beacon Power's flywheels in the pilot show 1MW of fast-response flywheels produces 30 MW of Regulation Service miles




Empirical data shows fast response storage provides ***3 times*** more regulation service than an average generator

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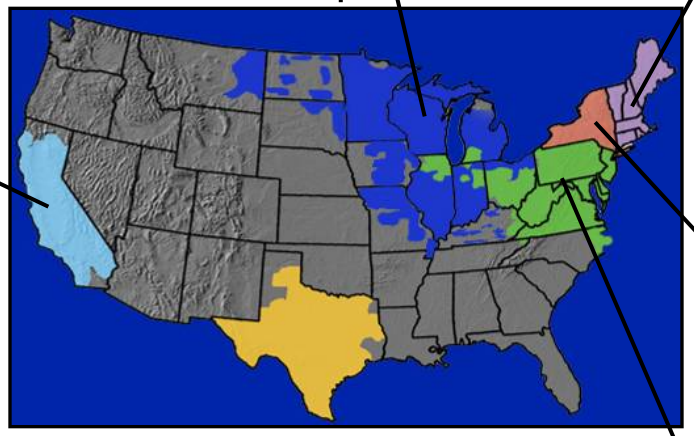
# Energy Storage in A/S Markets

## Midwest ISO

Demonstrated:
- 2 MW AES Altairnano batteries



## ISO New England

Operating:
- 3 MW Beacon Flywheels

## California ISO

Demonstrated:
-100 kW Beacon Flywheel

Interconnected:
- 2 MW AES A123 batteries


## New York ISO

Demonstrated:
- 100 kW Beacon flywheels

Planned:
- (2) 20 MW Beacon flywheel plants (Stephentown, Glenville)
- (3) 20 MW AES battery plant

## PJM

Operating:
-1 MW AES Altairnano batteries at PJM HQ

Planned:
-20 MW Beacon flywheel plant (Chicago)


**Limited Energy Storage Resources are successfully providing Regulation Service in ISO-NE and PJM; successfully demonstrated in NYISO, Midwest ISO and CAISO**

*The LESRs demonstrated and/or currently running in the ISO markets operate at a maximum charge from a fully discharged state or maximum discharge from a fully charged state for a maximum of 15 minutes

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# Progress of Market Entry

- **NYISO** created new market rules and dispatch method for Limited Energy Storage Resources (LESRs) to provide Regulation
  - Approved by FERC May 15, 2009
- **Midwest ISO** created tariff for Stored Energy Resources (SERs) based on NYISO proposal
  - Approved on December 31, 2009
  - Allowed short-term SERs in 60-minute Day Ahead market
  - FERC rejected all protests from Stakeholders***, including rejecting utility proposal to pro-rate compensation to SERs based on their maximum capability to provide continuous MWhs of single direction Regulating Reserves***
- **PJM** implemented a frequency-based signal for energy storage resources in March 2009; allow resources to self-manage energy base-point and capacity delivered in real time
- **ISO-NE** Alternatives Technologies Regulation Pilot Program
  - Commenced November 2008 for Energy Storage and Demand Response
  - Working group formed to develop permanent rules February 2010

# NYISO and Midwest ISO: Energy Storage Tariff

- Allows LESRs to utilize the energy market to manage its state-of-charge (SOC) so that it can continuously provide regulation
  - LESRs may supplement or empty the energy in its "tank" in order to continue to provide regulation
  - ISO schedules energy into / out of the resource to maximize regulation capacity

- Energy basepoint changes made every 5 minutes based on measurement of SOC 10 minutes prior to change, i.e. 10 minute lag between measurement of SOC and change in energy base point

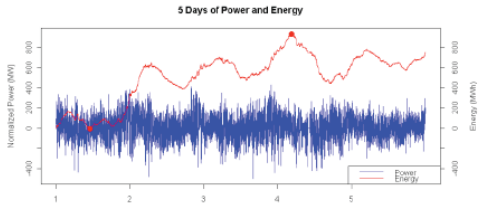
- **FERC agreed that an "energy management" mechanism allows LESRs to provide regulation on a comparable basis to generators**
- **The amount of regulation capacity a LESR can offer is based on its capability to provide Regulation with the "energy management" mechanism in place, i.e. not what an LESR could provide in one-direction without "energy management"**

# EPRI Study of Regulation by LESRs

- EPRI studied LESRs ability to sustainably provide Regulation
- Determined that LESRs with minimal storage can provide Regulation as long as it can use the energy market to manage the energy bias in the AGC signal

## Power and Energy Requirements

- Energy Bias (MWh) varies over each day
- Over the week, the energy bias reaches a maximum of 929 MWh




**Total Power and Energy Statistics across 5 days (MWh)**

| | Min | Max | Mean | Std Dev |
|---|---|---|---|---|
| Power (MW) | -495 | 431 | 6 | 106 |
| Energy (MWh) | -4 | 929 | 506 | 240 |
| Ramp (MW/2s) | -147 | 75 | 4.4e-4 | 9 |
| Approx. Loss* (MWh/day) | 133 | 195 | 176 | 24 |
| Mileage (MW/day) | 311,574 | 402,933 | 370,174 | 34,965 |

* Based on 9% losses during charging and discharging.



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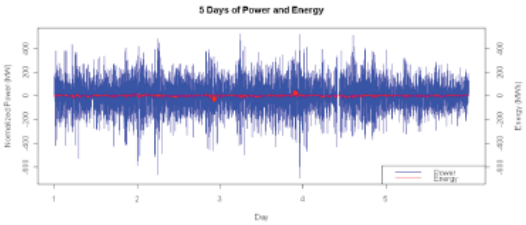
**Up Reg = 929 MWh / 431 MW = 2.1 hrs**

## 5-Minute Correction Results

- The 5-minute correction greatly reduces the energy bias
- Average daily mileage across the five days is 382,182




**Total Power and Energy Statistics, after Five-minute Correction (MWh)**

| | Min | Max | Mean | Std Dev |
|---|---|---|---|---|
| Power (MW) | -693 | 522 | 1.4e-1 | 123 |
| Energy (MWh) | -26 | 28 | 4.9e-1 | 6 |
| Ramp (MW/2s) | -147 | 78 | -8.8e-4 | 9 |
| Approx Loss* (MWh/day) | 155 | 228 | 202 | 29 |
| Mileage (MW/day) | 320,425 | 413,829 | 382,182 | 36,049 |

* Based on 9% losses during charging and discharging.



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**Up Reg = 28 MWh / 522 MW = 0.05 hrs (3 mins)**

**The energy correction allows short-term storage to provide continuous Regulation at its full MW storage capacity**

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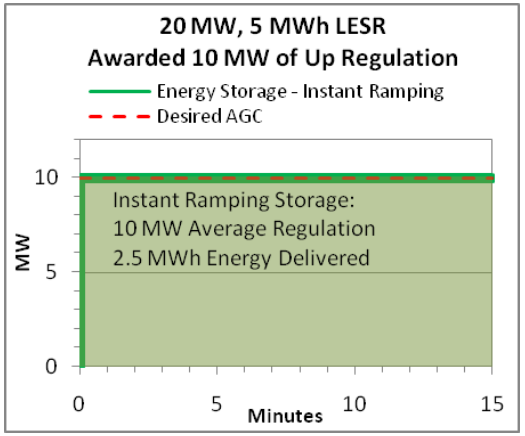
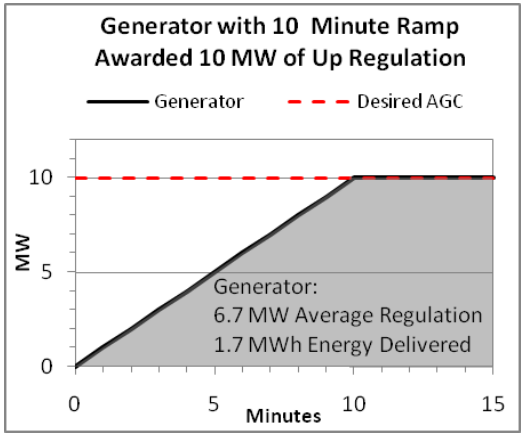
# CAISO proposal: Ramp-rate

» December 1st proposal limited LESRs to the amount of MWs they could provide at a constant output over 15 minutes:
  – 20 MW,5 MWh resource may only bid 10 MW Up and 10 MW Down Reg
  – Not comparable to allowing generators 10 minutes to achieve their Regulation Dispatch Operating Point (DOP)




» After comments, CAISO adjusted allowable bid amounts for LESRs

$$Maximum\ Regulation\ MW = \frac{2.5\ MWh\ Energy}{\left({}^{15}/_{60}\right)\ Hours}\ x\ \left(\frac{10\ MW\ Assigned}{6.7\ MW\ Allowed} = 150\%\right)\ =\ 15\ MW$$

**While improved, this only allows a 20MW/5 MWh LESR to bid in 15 MWs which is economically unfeasible and therefore bars LESRs from the market**

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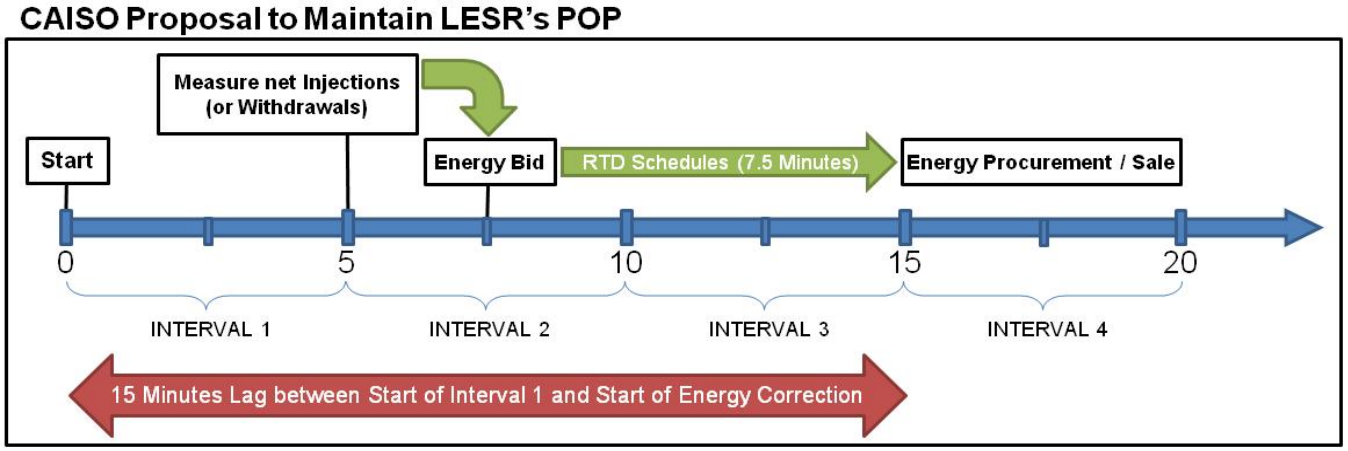
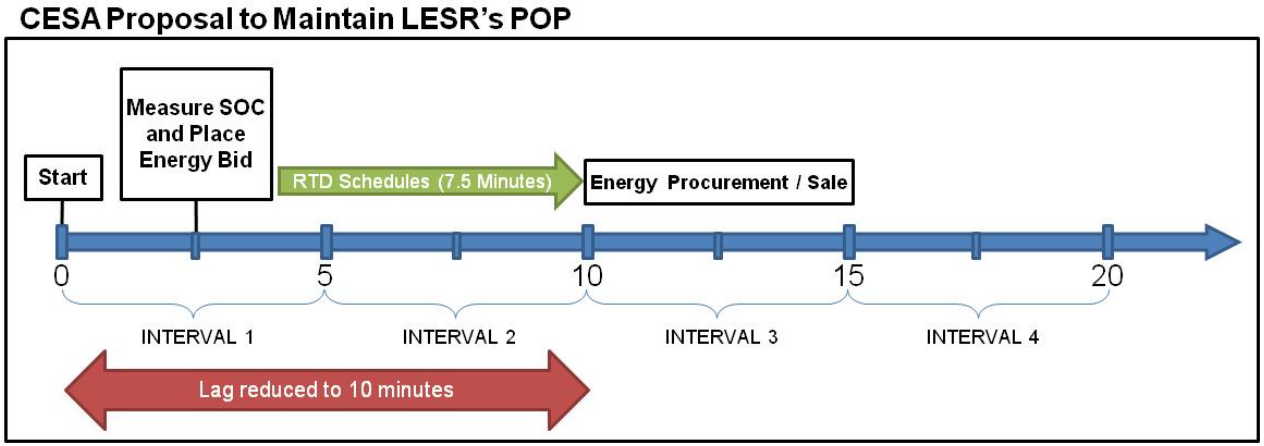
# CAISO proposal: Energy Management




- "Energy management" is the recognized mechanism to enable a 20 MW, 5 MWh LESR to bid its full capacity
- However, while similar to EPRI and FERC-approved NYISO and MISO tariffs, there are key differences to CAISO's proposed "Energy Management" that make it ineffective:
  - CAISO's "energy correction" time of 15 minutes is too long
  - CAISO's energy market dispatch is based on previous injections/withdrawals instead of state-of-charge
    - This will not account for energy losses or comparable ramp rates

# CESA proposal: Energy Management

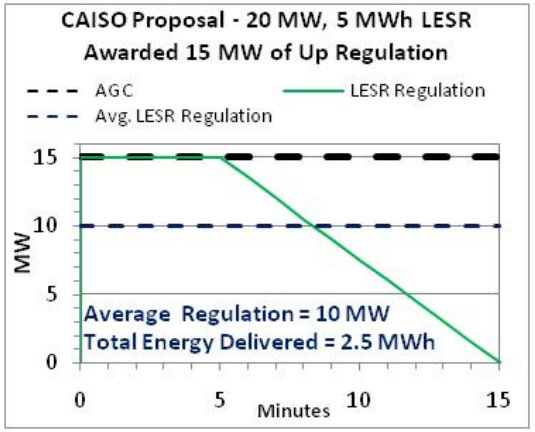


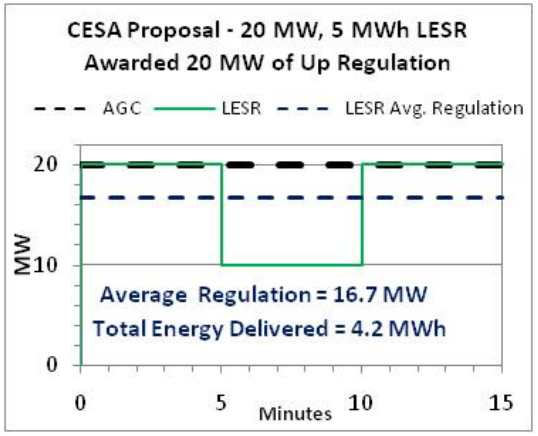

- Instead of basing LESRs energy bid on the amount of net energy injected/withdrawn at the end of the interval, base the energy bid on the LESR's SOC at the midpoint of the interval (SOC at 2.5 minutes)
  - Can also factor in CAISO knowledge of trends in load and ACE
- RTD schedules 7.5 minutes in advance, resulting in energy procurement/sale in Interval 3 instead of interval 4 reducing the lag-time to 10 minutes
- Consistent with FERC-approved NYISO, MISO method

**This method reduces the continuous energy requirement for an LESR to 10 minutes**

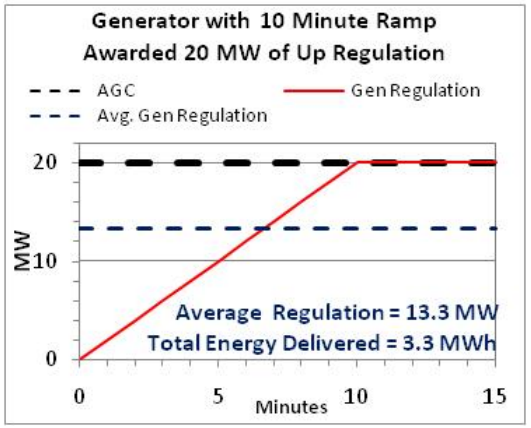
# CESA proposal: Examples

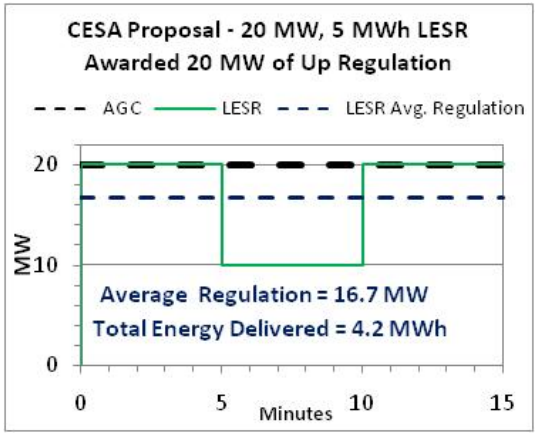
» CESA proposal results in a 67% better utilization of same-sized LESR




» CESA proposal results in 26% more power and energy from a 20 MW award to an LESR than a Generator with a 10 minute ramp



# CESA Recommendation

- The maximum amount of Regulation Capacity a LESR is allowed to bid should be based on both ramp-rate comparability ***and*** additional capacity enabled by "energy management"
- CAISO should implement the CESA "Energy Management" proposal which reduces the continuous energy requirement for a LESR to 10 minutes and is consistent with FERC-approved NYISO and MISO methods
- Change formula to reflect 10 minute continuous energy requirement

Current CAISO formula:

$$Maximum\ Regulation\ MW = \frac{2.5\ MWh\ Energy}{(15/60)\ Hours} x\ (150\%) = 15\ MW$$

Proposed CESA formula:

$$Maximum\ Regulation\ MW = \frac{2.5\ MWh}{(10/60)\ Hours}\ x\ 150\% = 22\ MW$$

- 20 MW, 5 MWh resource would be capped by its nameplate capacity:

$$Maximum\ Regulation\ MW = Max\left(20\ MW,\ \frac{2.5\ MWh}{\left(\frac{10}{60}\right)\ Hours}\ x\ 150\% = 22\ MW\right) = 20\ MW$$

# Additional recommendations

- CAISO must address additional market and operation barriers to energy storage as identified in its January 16th discussion paper ***Participation of Limited Energy Storage Resources (LESRs) in CAISO Electricity Markets***
  - Inability of a storage facility to specify a negative minimum operating point ($P_{min}$) in the CAISO Master File;
  - Inability for storage resources to submit bids that match their operating characteristics (i.e. a +/- operating range around a zero Preferred Operating Point);
  - Inability to be sent a negative dispatch signal; and
  - Lack of a settlement provision to allow LESRs to net their energy at wholesale

# Additional Recommendations: Value Fast Regulation

- Regulation payments should be based on both the amount of MWs offered and resource speed of response
- ISO-NE proves the benefits this type of compensation for Regulation.
  - ISO-NE procures the least amount of regulation as a % of load than any other ISO (0.8% of load vs. 1.35% of load)
  - ISO-NE dispatches regulation based on ramp rate and has a "pay-for-speed" component (known as "Mileage") in its regulation settlement
- Compensate resources utilizing a formula similar to ISO-NE

**"Regarding compensation, some storage technologies appear able to provide a nearly instantaneous response to regulation signals, in a manner that is also more accurate than conventional resources. These two characteristics can reduce the size, and hence overall expense, of the regulation market. Most existing tariffs or markets do not compensate resources for superior speed or accuracy of regulation response, but such payment may be appropriate in the future ..."**

- FERC Chairman Wellinghoff, Testimony, Senate Hearing on Energy Storage, Dec. 10, 2009