



CUSTOMIZED
ENERGY SOLUTIONS

***“The case for an economic
deployment of energy storage
technology – and lessons learned”***

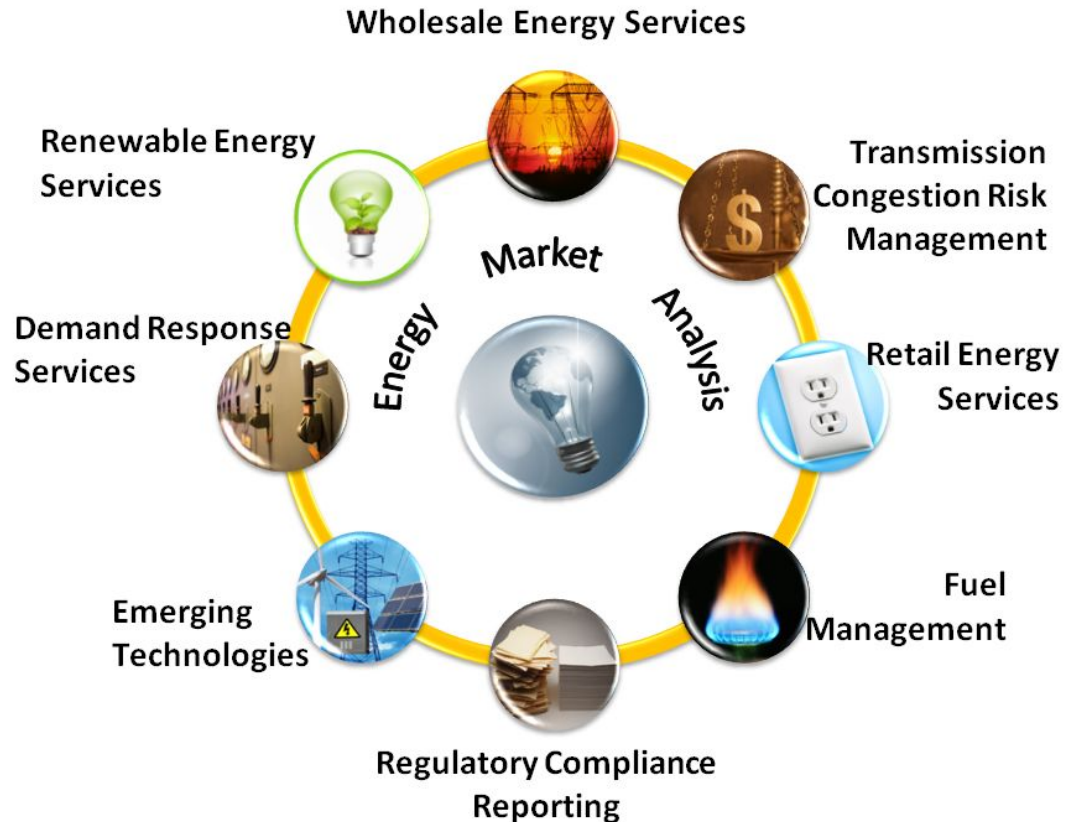
Judith Judson McQueeney

Director of Emerging Technologies – U.S., Customized Energy Solutions
Chair, U.S. Electricity Storage Association Advocacy Council

Customized Energy Solutions Introduction

Customized Energy Solutions is at the forefront of competitive energy markets. Through consulting services and financial analysis, we enable competitive suppliers, technology providers, marketers, and utilities to prosper through change.

- Founded: 1998
- Main Office: Philadelphia, PA, USA
- 70+ staff members located across North America and 10 members located in India
- Customized helps over 300 clients across all competitive electricity markets in North America and India



Advocacy Case Study: FERC Order 755

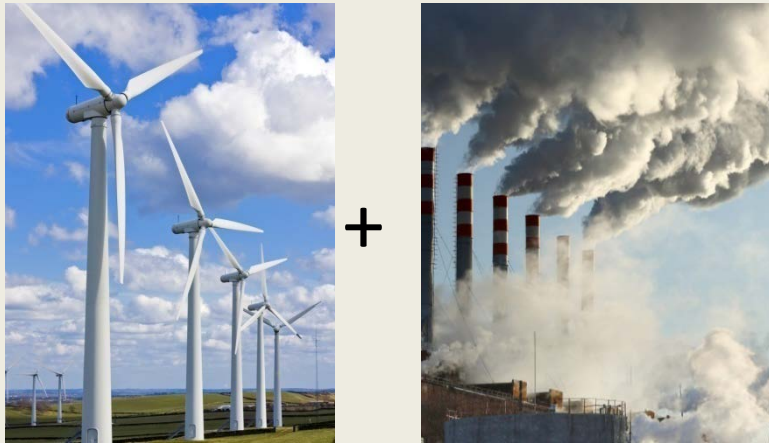


On October 20, 2011 FERC issued new rules for paying frequency regulation resources

- Current compensation method for Frequency Regulation is unjust, unreasonable and unduly discriminatory
- Acknowledged inherently greater amount of frequency regulation service being provided by faster-ramping resources
- Required RTO and ISOs to pay resources based on the actual service provided
- Results in improved revenue for storage plants providing frequency regulation

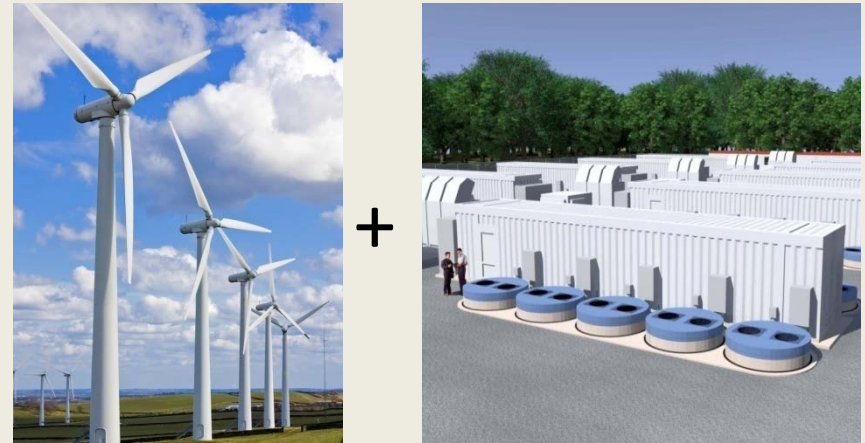
Frequency Regulation

Conventional Regulation



- Regulation provided by generators varying output
 - Decreases efficiency
 - Increases fuel consumption
 - Requires more maintenance
 - Increases emissions

Smarter Solution: Storage



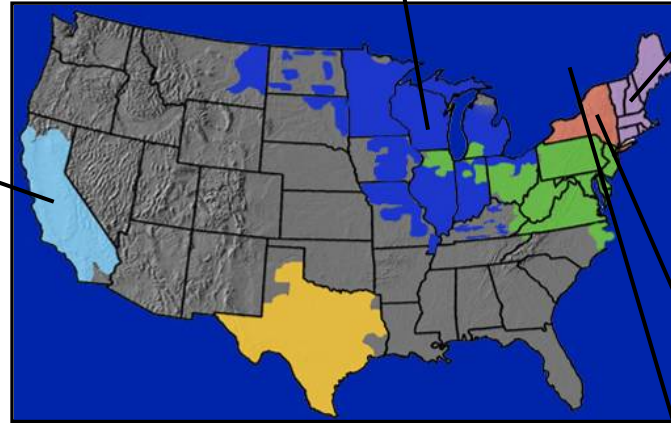
- Store energy when supply exceeds load; inject energy when load exceeds supply
 - High round trip efficiency
 - Low operating cost
 - Near instantaneous response
 - Zero direct emissions

Frequency Regulation Storage Projects



Midwest ISO
Demonstrated:
 2 MW Battery plant

ISO New England
 3 MW flywheel pilot project
 2 MW battery pilot



California ISO
Demonstrated:
 100 kW flywheel
Interconnected:
 2 MW battery



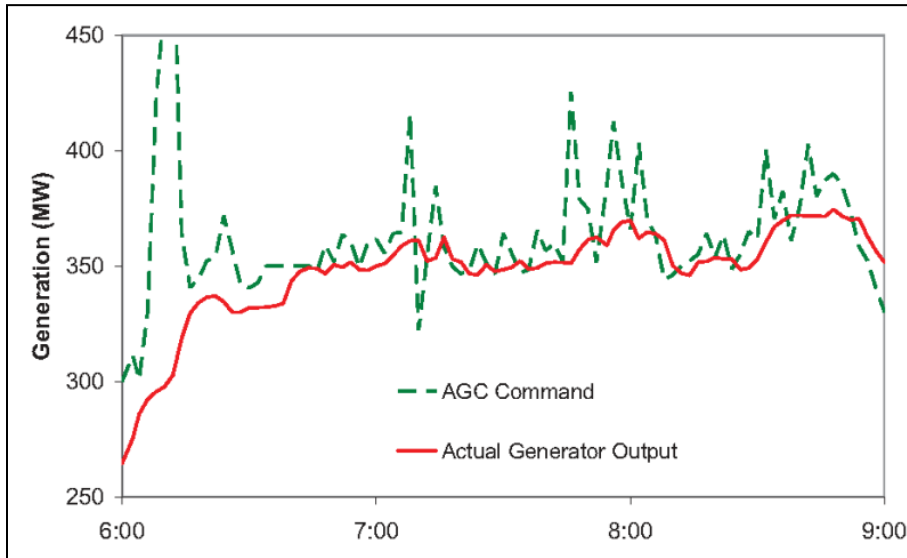
New York ISO
 20 MW flywheel plant
 8 MW battery plant



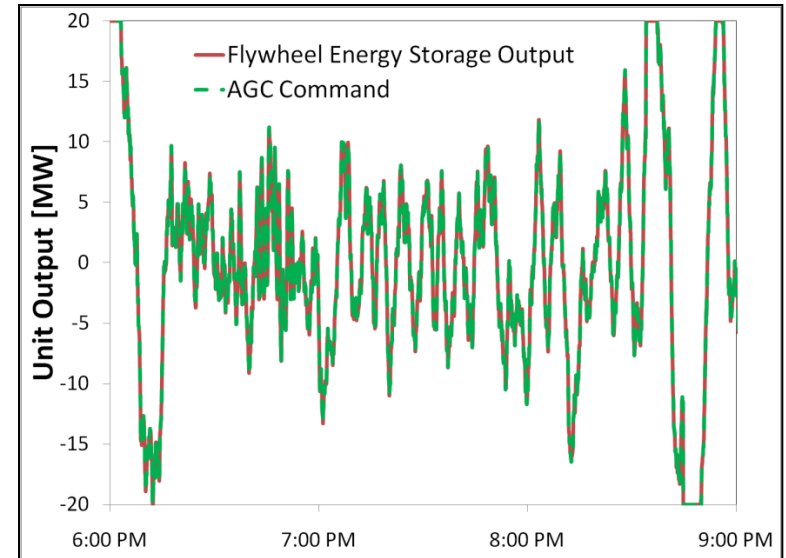
PJM
 1 MW battery at PJM HQ
 32 MW battery plant at wind farm
 3 MW battery plant



For Frequency Regulation... Speed Matters



Slow-ramping Generator



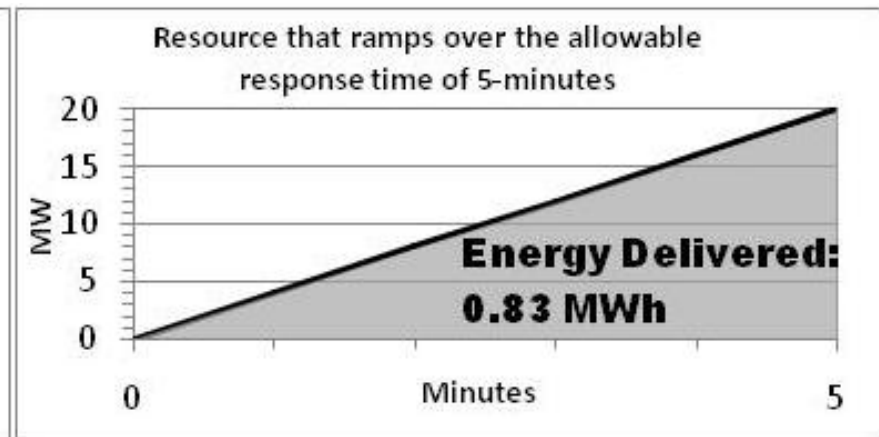
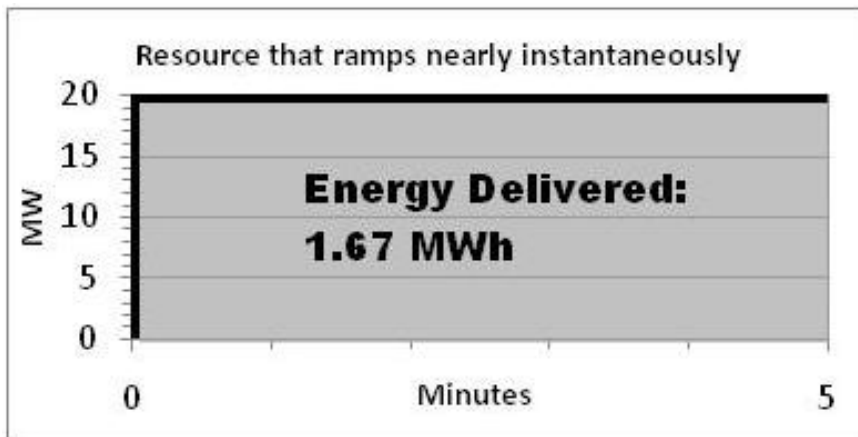
Fast-ramping Storage

Superior speed and accuracy
Significantly more effective at responding to system imbalances

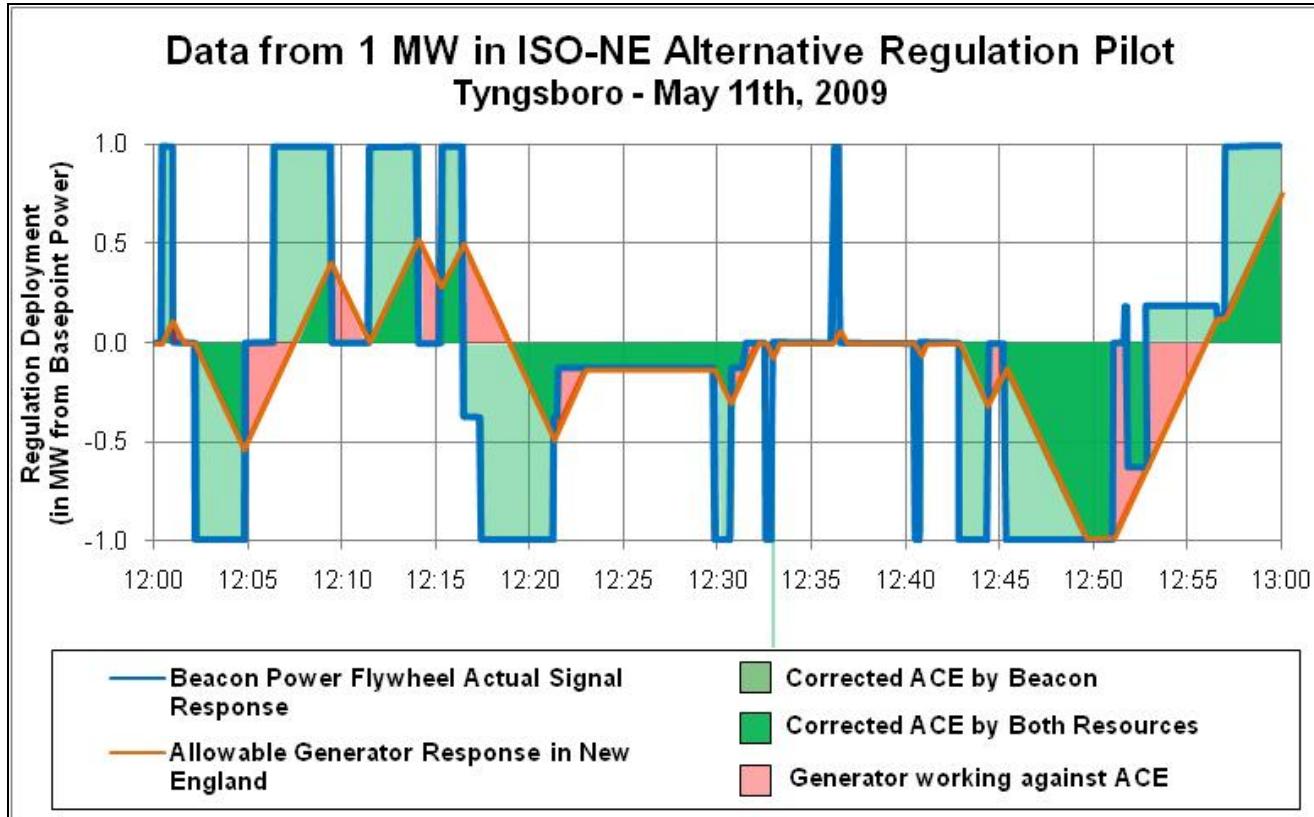
Source:
- Kirby, B. "Ancillary Services: Technical and Commercial Insights." Wartsilla, July, 2007. pg. 13

Value of Fast Regulation

- Frequency error is function of the amount (MW) of imbalance and the time it takes to correct the imbalance
 - The sooner corrected the less amount of regulation needed
- Fast-ramping storage can lower regulation procurement
 - Reach dispatch target faster; Provide more energy in real-time



Fast Regulation: Speed Matters



1 MW of Regulation		
	Storage	Generator
ACE Corrected	0.48 MWh	0.18 MWh
Against ACE	0 MWh	-0.07 MWh
Net ACE Correction	0.48 MWh	0.11 MWh
Mileage	25 MW miles	8 MW miles

**Fast storage providing 2 – 4x more Regulation Service per MW;
In all RTOs (except ISO-NE) both resources are compensated the same**

Source:

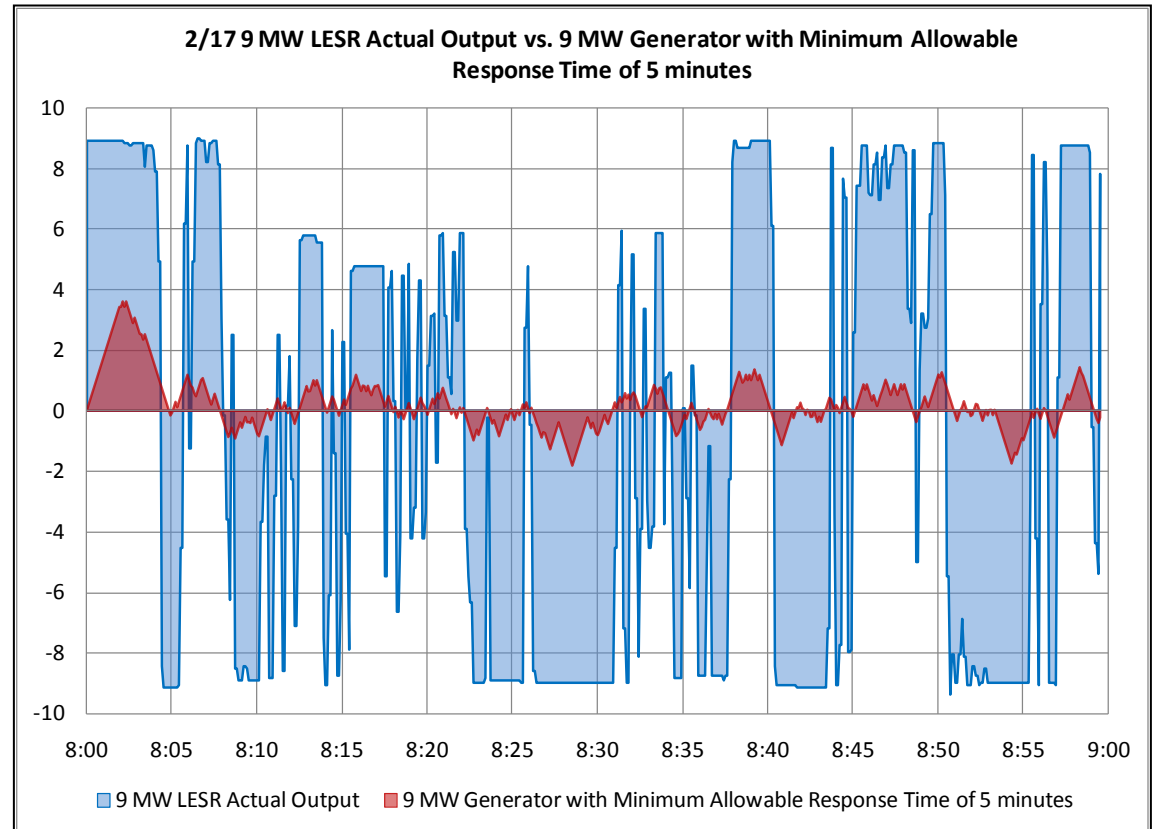
- Beacon Power Comments on Technical Session Docket No. AD10-11-000 "Frequency Regulation Compensation in Organized Wholesale Power Markets"; and FERC Notice of Proposed Rulemaking RM11-7-000/AD10-11-000, Appendix A.

Advocating for Compensation Reform

- **May 26, 2010 FERC Technical Conference**
 - How should Regulation be valued? Based on number of MWs capacity or on how effective it is in correcting ACE?
 - Advocated for payments based on both capacity and performance, i.e. resource speed and accuracy of response
- **February 17, 2011 FERC issued Notice of Proposed Rulemaking (NOPR) to Pay-for-Performance**
 - *ESA AC submitted written comments, follow-up meetings with FERC*
 - Compensates all resources based on value provided
 - Sends right market signals
 - Ensures rates are just and reasonable and not discriminatory
 - Should reduce the total cost of electricity
- **October 20, 2011 FERC issued Final Order No. 755**
 - *ESA AC active participant in ISO/RTO stakeholder meetings*

Making the Case for Compensation Reform

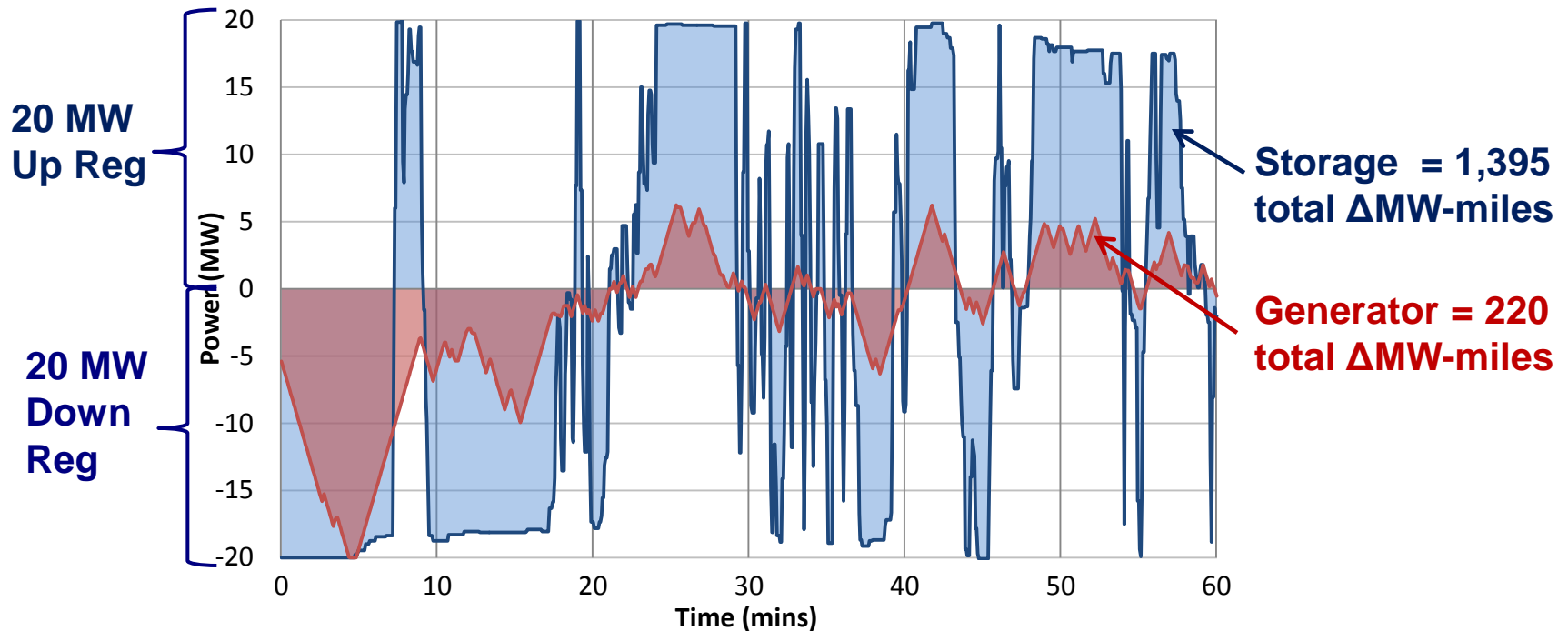
- **ESA AC comments on NOPR included following data:**
- Two 9 MW resources, each 3% of the Regulation Capacity
- Regulation Service (ACE Correction) provided:
 - Storage Plant: 23%
 - Traditional: 2%
- **Both resources paid THE SAME**



NYISO Data – February 17, 2011 Hour 8

**Actual data showed payments based only on Capacity unfair
Need compensation based on performance**

Two-Part Payment: Capacity and Performance



Capacity Payment

- Amount set-aside
- Including Opportunity Cost

Performance Payment

- Sum of up and down movement “mileage”
- Adjusted by accuracy

Market Design Details

	PJM	NYISO	MISO	CAISO	ISO-NE
Bidding	Two-part bid	Two-part bid	Two-part bid	Two-part bid	Two-part bid
Market Clearing and Selection	Rank Summed Bids + OC <ul style="list-style-type: none"> • Resource mileage with benefits factor • Adjusted by historical performance 	Rank Summed Bids + OC <ul style="list-style-type: none"> • System Mileage multiplier 	Rank Summed Bids + OC <ul style="list-style-type: none"> • System Mileage multiplier 	Algorithm to determine lowest cost combination of resources <ul style="list-style-type: none"> • Adjusted by historical performance 	Algorithm to determine lowest cost combination of resources
Mileage Price	Highest	Marginal unit	Highest	Marginal unit	Bid + System benefit
Capacity Price	Combined less Mileage	Marginal unit + OC	Marginal unit + OC	Marginal unit + OC	Bid + Unit OC + System benefit
Dispatch	Two-signals (fast & slow)	Fast-first <ul style="list-style-type: none"> • Submit 6-second rate 	Fast-first <ul style="list-style-type: none"> • 5 dispatch groups 	Fast-first	Fast-first
Implement	<i>Oct. 1, 2012 – partial implement</i> Compliance filing Jan. 15, 2013	Oct. 27, 2012 Compliance filing Dec. 6, 2012	Dec. 17, 2012	April 9, 2013 Jan. 1, 2013	Jan. 1, 2014 Compliance filing due Feb. 6, 2013

Payment Example

Assumptions

- 5 MW storage project
- Based on PJM Clearing prices pre- and post-Order 755
- Fast storage resources provide ~ 3.5x mileage than traditional resources

		Capacity		Performance				Total Revenue	
	MW Capacity (MW)	Capacity Price (\$/MW)	Hourly Capacity Payment (\$/hour)	Hourly Movement "Mileage" (ΔMW)	Movement Price (\$/MW)	Accuracy %	Hourly Movement Payment (\$/hour)	Total Hourly Revenue (\$/hour)	Extrapolated Annual Revenue (\$/year)
Pre-Order 755	5	\$14	\$70	---	---	---	---	\$70	\$0.6 million
With Order 755	5	\$35	\$175	3.5x mileage	\$8	95%	\$133	\$308	\$2.7 million

Substantial Revenue Improvement Potential for Storage Projects with Performance-based Frequency Regulation Tariffs

Lessons Learned

- Market Data!
 - *Examples and Charts*
 - *“A picture is worth a thousand words”*
- Value of ESA Advocacy Council
 - *Common message from Storage industry*
 - *Power in numbers*
- Tailor arguments to FERC’s ability to take action
- Propose a solution to the problem
- Utilize ISO/RTO best practices

Regulatory Reporting & Market Analysis



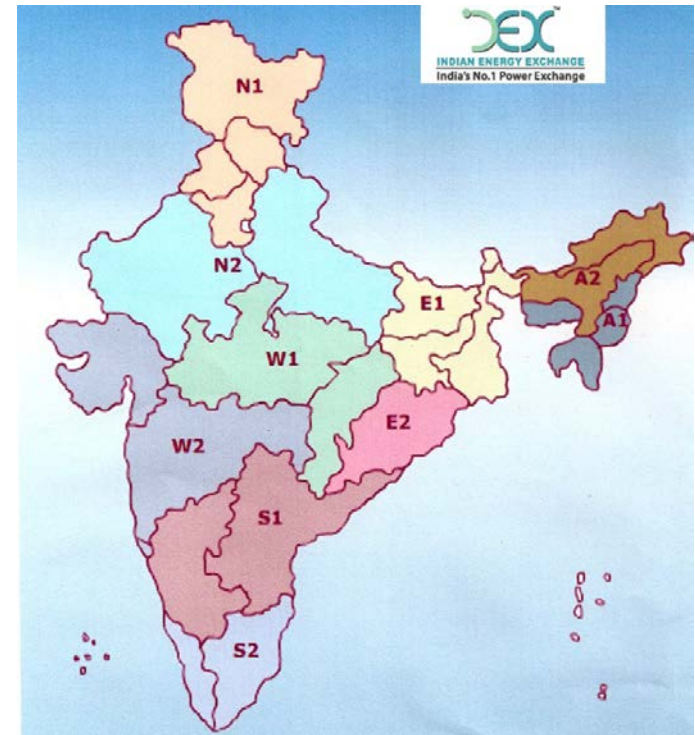
***New Offering:
Storage and Emerging
Technologies Cross-
Market report***

- Stakeholder Meeting Summaries
 - Time Saving: Key information with expert analysis
 - In-depth: Expert analysis provided on key items
- Market Update Conference Calls
 - One-on-one calls to provide client specific analysis
- Subject Matter Experts on Speed Dial
 - Our Subject Matter Experts are available to answer questions and assist with client specific issues

Up-to-date information and analysis on the market rule changes and tariff developments that are taking place in the ISO/RTO regions

India Energy Storage Alliance

- In 2010, Customized launched India operations and is currently working with over 40 clients across India
- India Energy Storage Alliance
- Recently conducted Technical Tour
 - October 28 – November 3
 - New Delhi, Mumbai, Pune



Contact US



Customized Energy Solutions Ltd.

1528 Walnut Street, 22nd Floor
Philadelphia, PA 19102 USA

Phone: +1-215-875-9440
Fax: +1-215-875-9490
info@ces-ltd.com

Judith Judson McQueeney

Director,
Emerging Technologies – U.S.
jjudson-mcqueeney@ces-ltd.com
Phone: 978-314-3776

Customized Energy Solutions India Pvt. Ltd.

A 501, GO Square
Aundh - Hinjewadi Link Rd, Wakad
Pune, Maharashtra 411057 India

Phone: 91-20-32407682
info@ces-ltd.com