



**2012 Integrated Resource Plan  
Emerging Technologies Stakeholder Meeting  
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**Energy Storage Technologies**

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# Safe Harbor Statement



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# Beacon Power Overview



- Manufacturer and developer of flywheel energy storage plants
- Provide vital grid reliability service
- November 2008 started commercially operating up to 3 MW in ISO-NE Alternative Technologies pilot
- First 20 MW Merchant plant operating in NY in 2011
- Next 20 MW plant to be built in Hazle Township, PA (PJM)
- 1 MW lease with utility in Montana



20 MW plant in Stephentown, NY

# Flywheel Storage Technology



- Proven grid technology
- Extremely fast accurate response
- Low operating cost: Recycles electricity
- Low O&M: 20-year design life – 125,000 cycles
- Zero CO<sub>2</sub> or other emissions

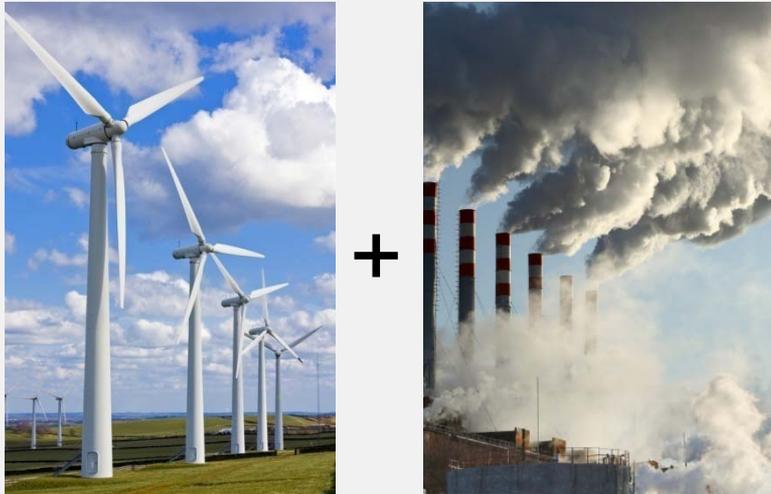


# 1<sup>st</sup> 20 MW Flywheel Plant



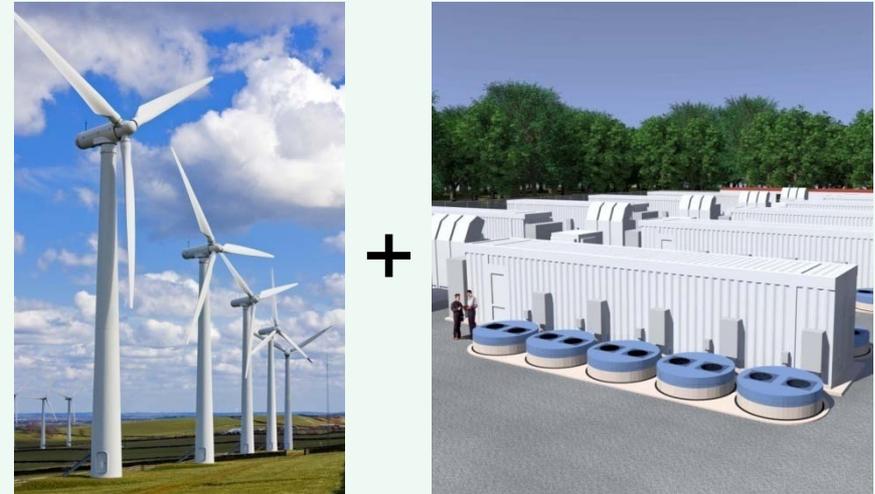
***Highlighted by the White House as one of the  
100 Recovery Act Projects that are Changing America***

## Conventional Regulation



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

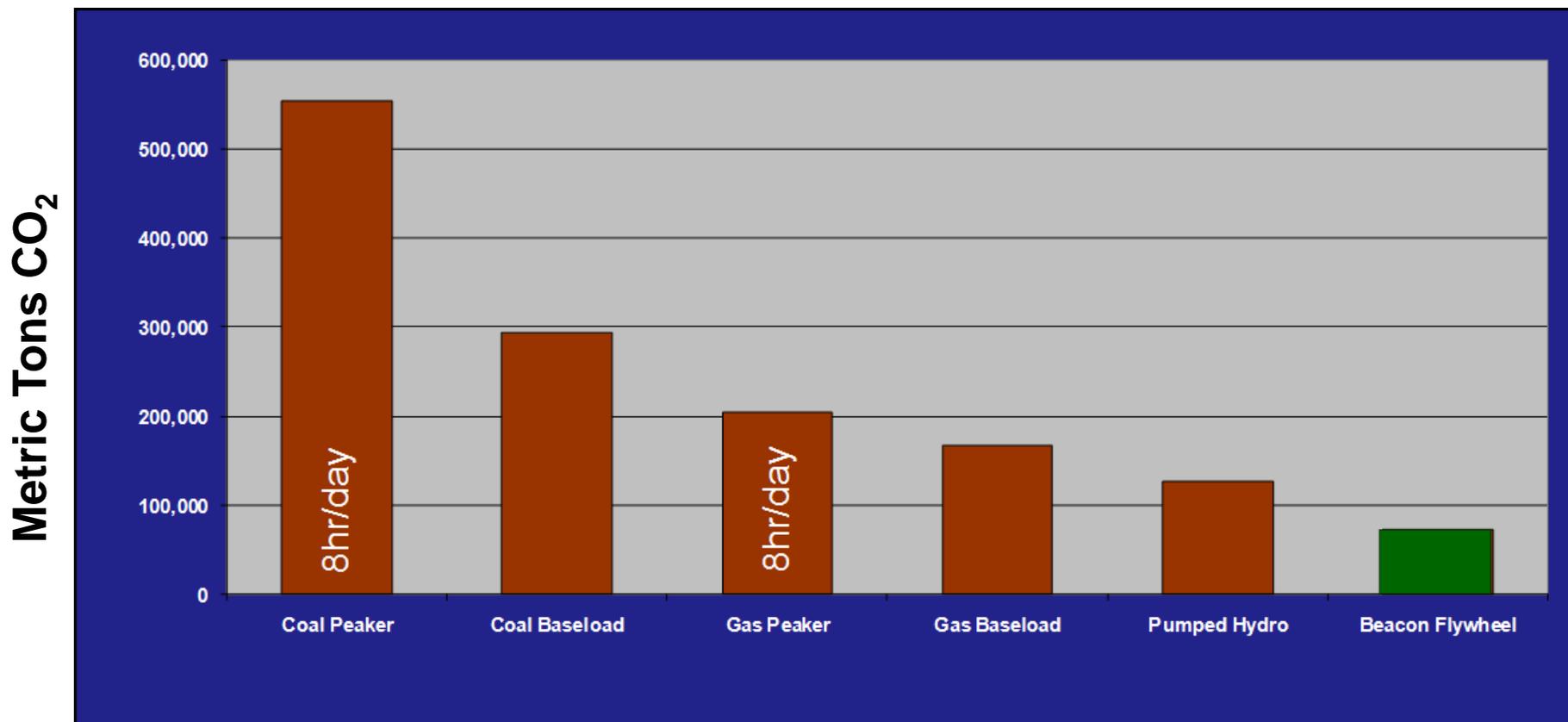
## Smarter Solution: Storage



- 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

# Storage Emissions Advantage

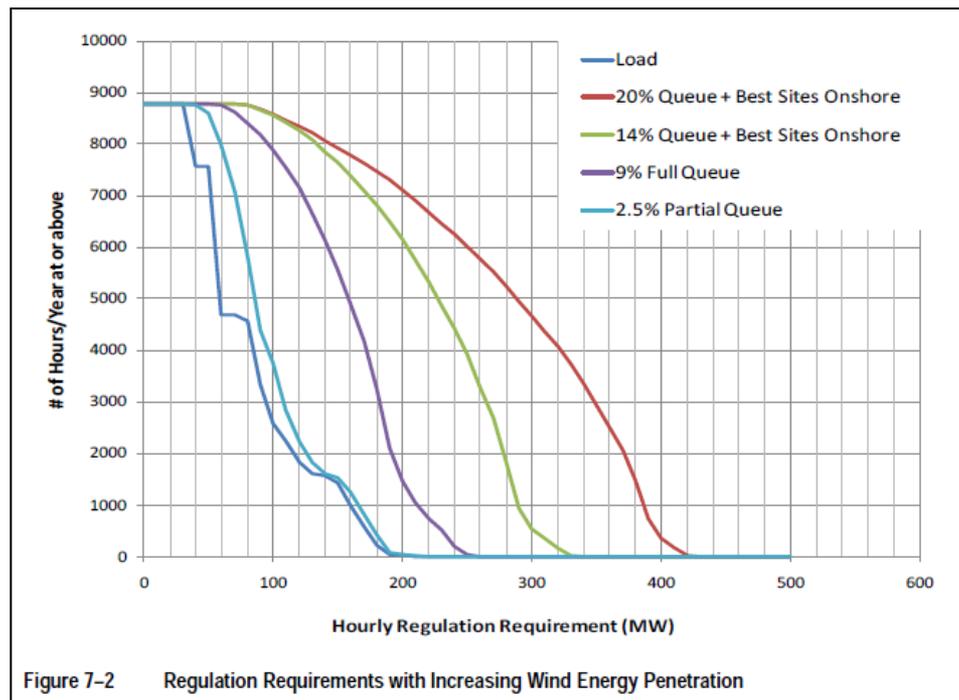
From KEMA study: 20 MW of Regulation over 20-year operating life



**Dramatically Lower Emissions**

# ISO/RTOs forecast need for more Regulation with increased Renewables

- Additional need for Regulation with more wind:
  - ISO-NE increase by 282% with 20% wind
  - CAISO increase by 300% with 33% wind
  - NYISO increase by 60% with 10% wind
  - PJM increase by 200% with 20% wind

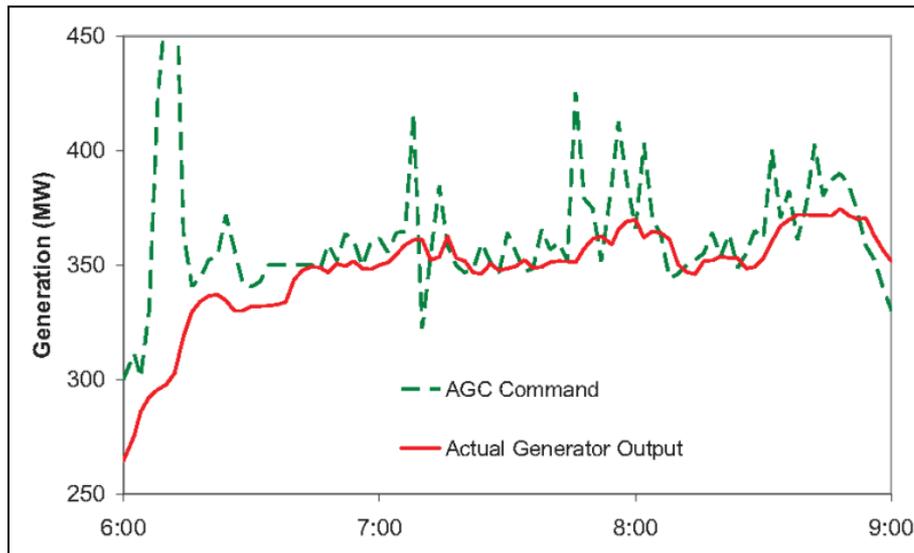


New England Wind Integration Study  
December 5, 2010

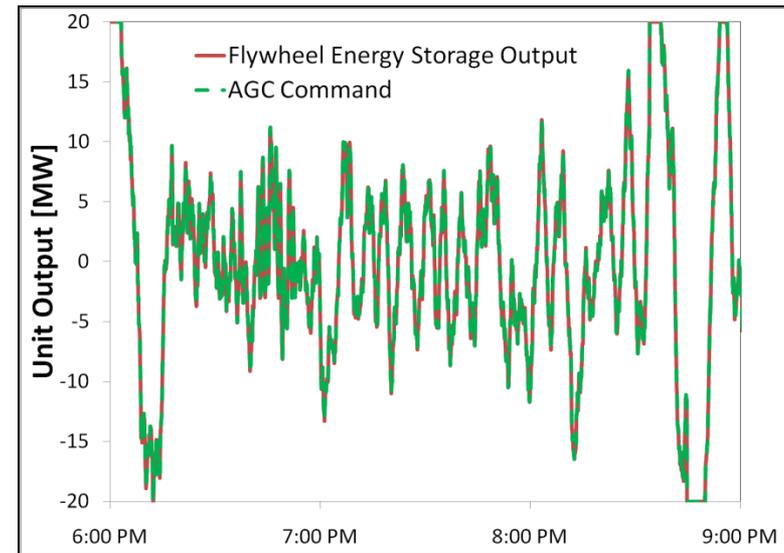
**“Wind plants ...make it imperative to look for new sources and new technologies for these services.”**

-NYISO Integration of Wind into System Dispatch, October 2008

# Fast Regulation: Speed Matters...



Slow ramping  
Generator

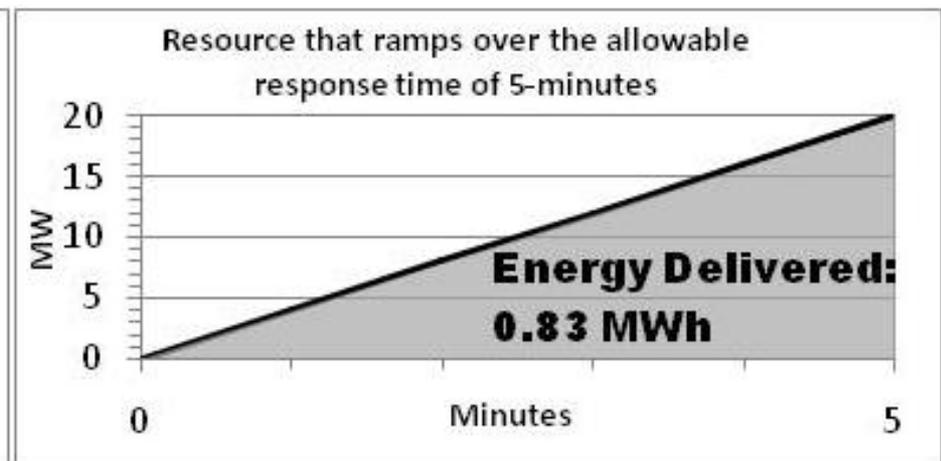
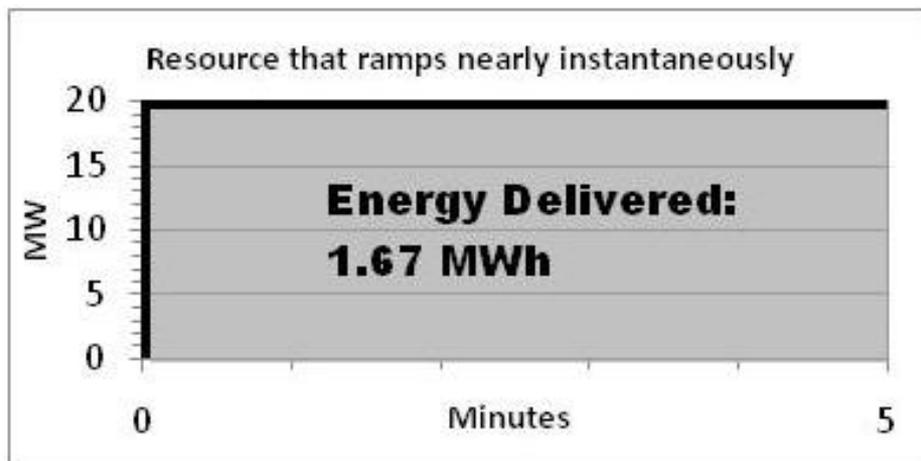


Fast response  
Flywheel Energy Storage

**Advanced Storage provides fast accurate response  
Provides Reliability and Cost Benefits**

# 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 ACE is corrected the less amount of regulation needed
- Faster response can lower regulation procurement
  - Faster ramp will **reach target more quickly**
  - Faster ramping resources will recover more **quickly for re-dispatch**
  - Will **not be caught in wrong direction** requiring another resource to be dispatched to counteract it

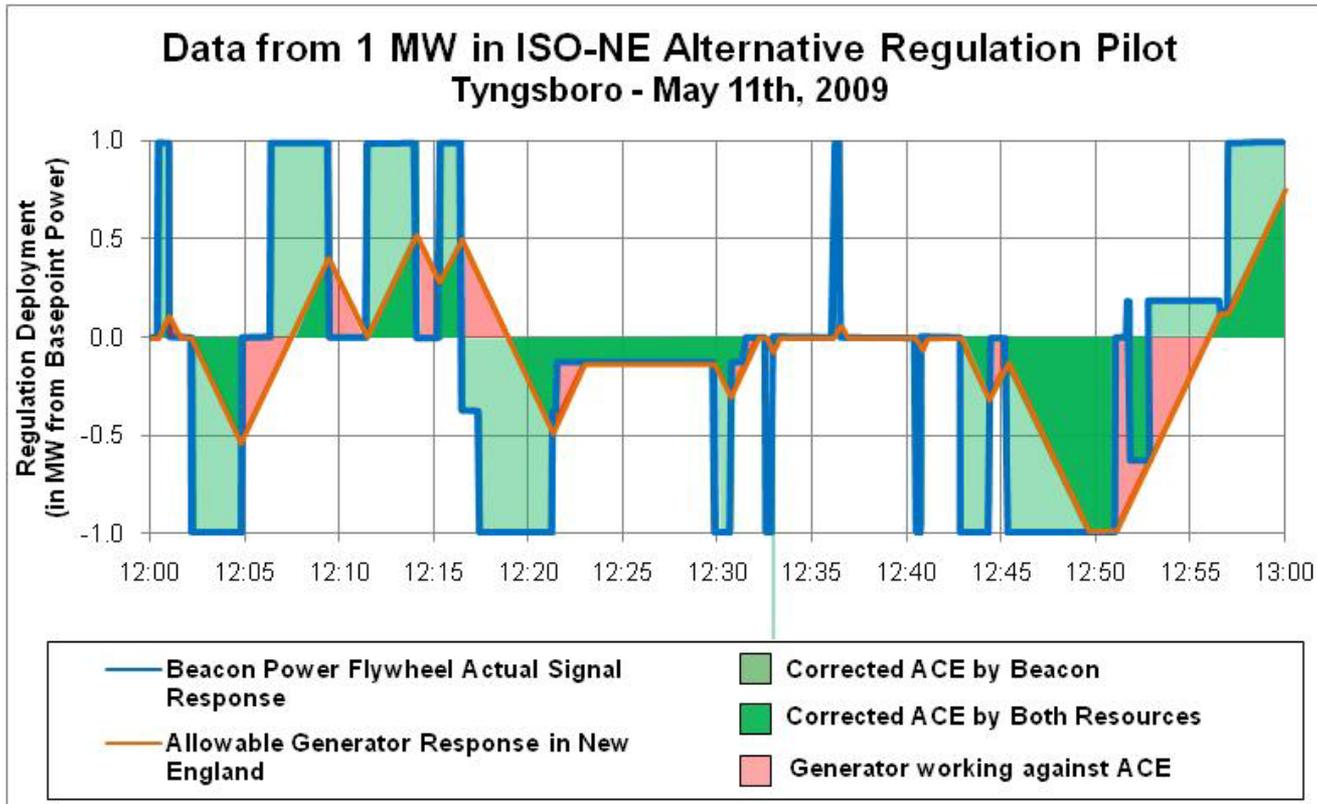


# Fast Regulation: Speed Matters

## Empirical Data from Beacon Power's ISO-NE plant



- Fast responding flywheels provide 4x more Regulation Service per MW



1 MW of Regulation		
	Flywheel	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

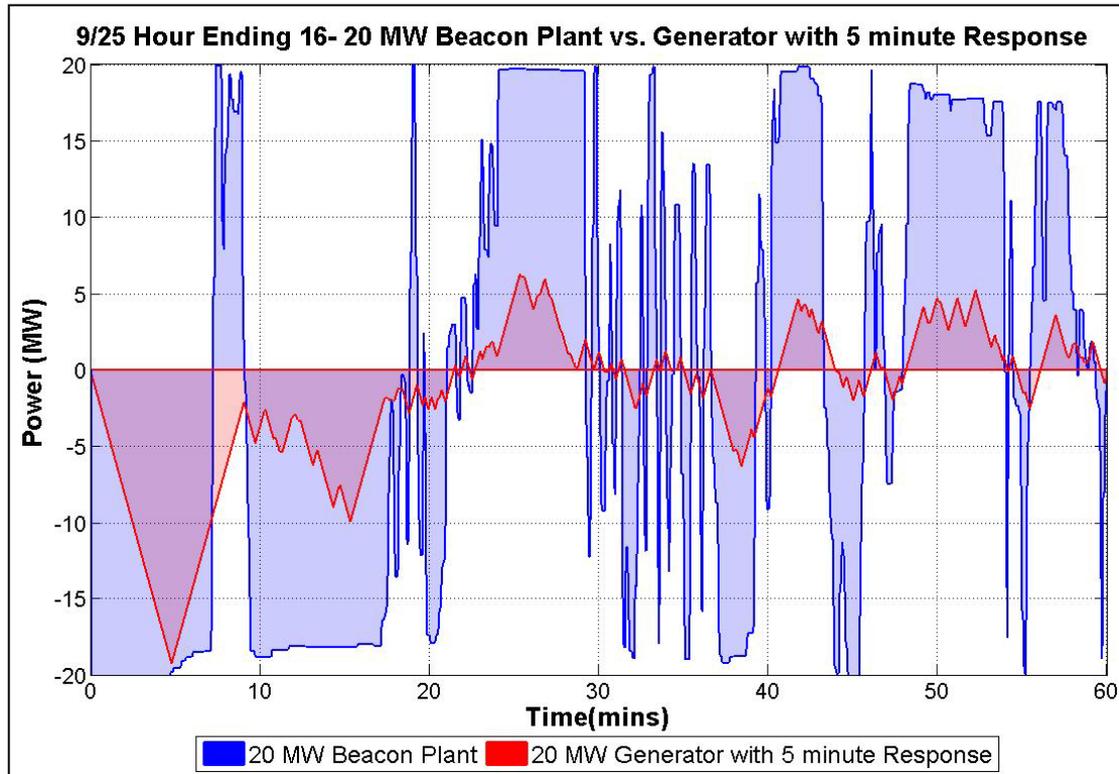
**Flywheels provide more Regulation Service per MW;  
Enabling less total procurement and cost**

# Fast Regulation: Speed Matters

Data from Beacon Power's NYISO plant



- NYISO utilizing advanced storage as “first responders” to Area Control Error (ACE)



Regulation Market Data*	ACE Correction (MWh)	%
20 MW Generator	3.7	8%
20 MW Flywheel	14.2	32%

**Storage provides 2 - 4x more Regulation Service per MW**

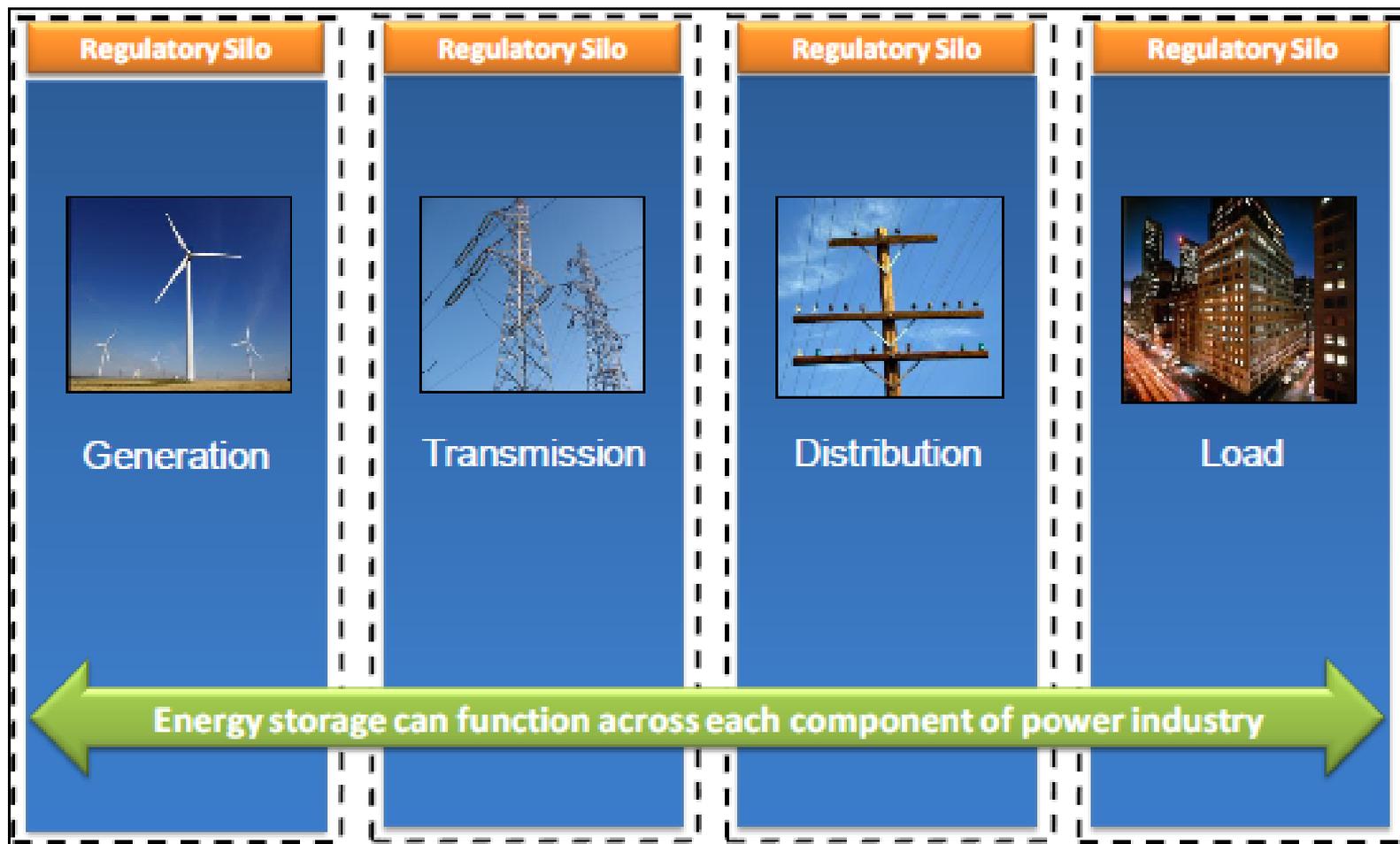
**On average Beacon's 20 MW flywheel plant provides 25% of NYISO's ACE Correction with only 10% of the market capacity**

# Benefits of Advanced Storage



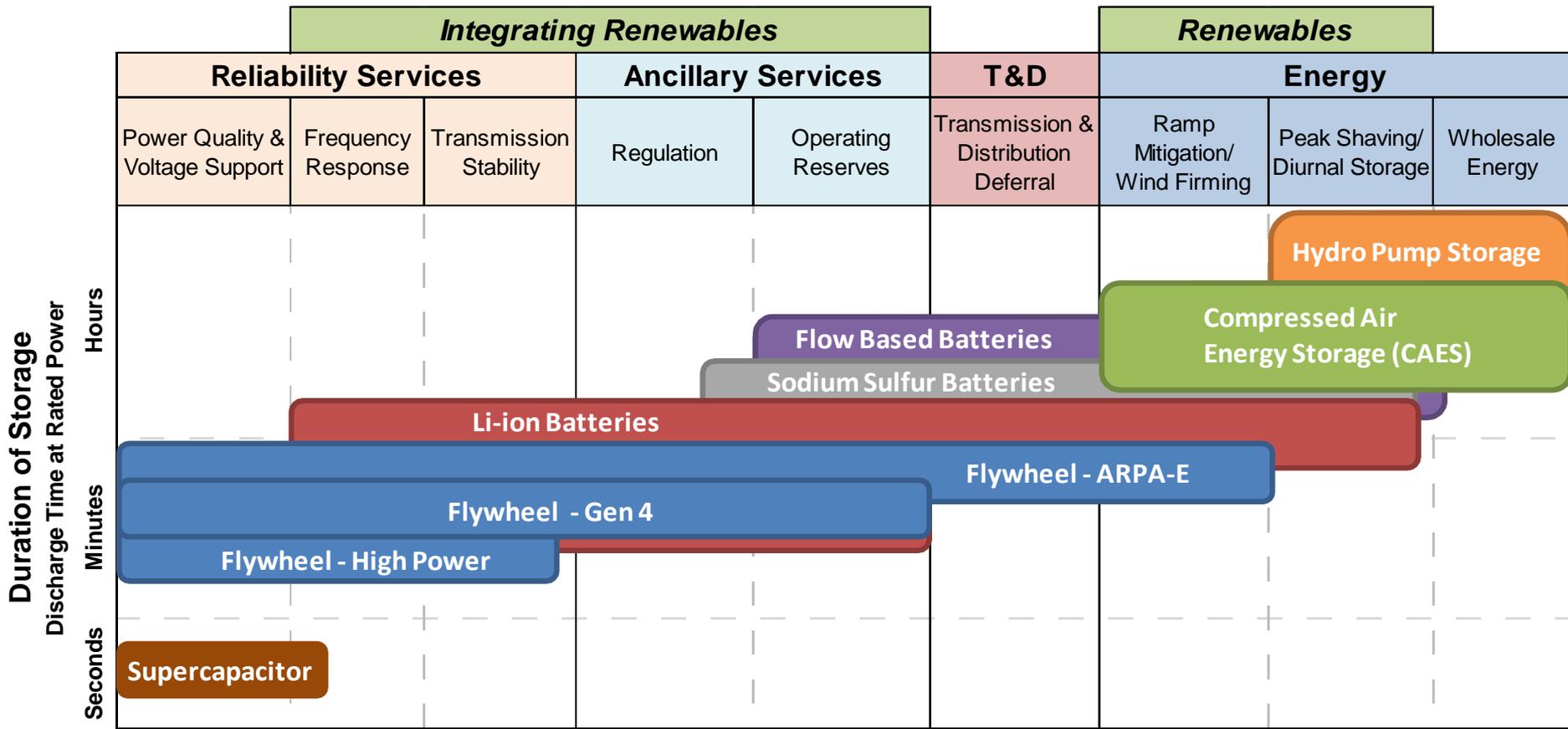
- **Reduces the cost of electricity**
  - Reduce overall Regulation procurement cost
    - » New capability; up to 100x faster than traditional regulation
  - Secondary benefit of lowering energy market prices
    - » Allows generators to operate at more stable output, improving efficiency and reducing costs
- **Proven technology**
  - 60+ MW of Storage providing regulation service today
- **Economic solution for a cleaner power grid**
  - Available to provide frequency regulation at night when generation fleet is mostly inflexible baseload and wind
  - Zero direct emissions and reduces emissions of generation fleet

# Energy Storage's Grid Diversity



Source: Cleantech Group

# Storage: Power Grid Applications



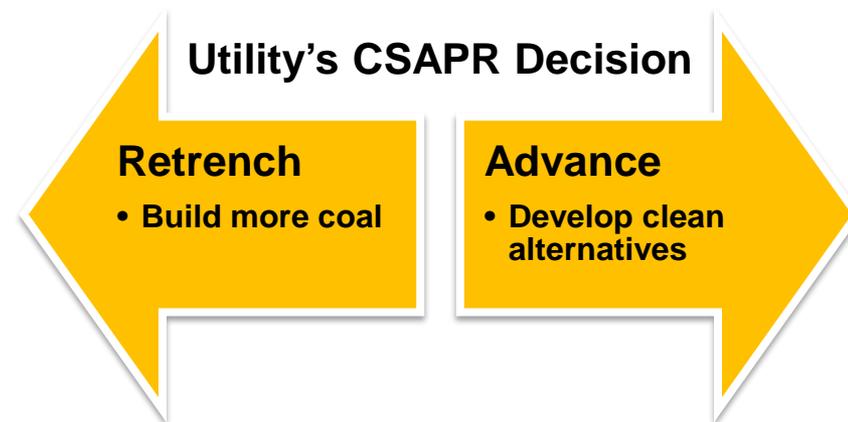
# Advanced Storage Projects



U.S. Grid Storage Projects				
Technology	Owner/ Technology Provider	Operating Capacity	Commercial Operation Date	ISO/RTO
Flywheel	Beacon Power	Up to 3 MW	November 2008	ISO-NE
Battery	AES/A123	8 MW	December 2010	NYISO
Flywheel	Beacon Power	20 MW	January 2011	NYISO
Battery	AES/Altairnano	1 MW	May 2009	PJM
Battery	AES/A123	32 MW	2011	PJM
Flywheel	Beacon Power	20 MW	2012	PJM
Battery	AES/A123	2 MW	2008	CAISO
Battery	Prudent Energy	Up to 750kW	Q4 2012	CAISO
Battery	AES/Altairnano	1 MW	In Operation	ERCOT
Battery	Xtreme Power	36 MW	Q3 2012	ERCOT
Battery	Xtreme Power	15 MW	March 2011	Hawaii
Flywheel	Beacon Power	1 MW	Q4 2011	Montana
Battery	AES	400 MW	Proposed	Long Island, NY
<i>Total</i>		<i>540 MW</i>		

## Replace coal with clean, flexible capacity resources

- EPA CSAPR will force coal retirements
- Coal  $\neq$  Reliability
  - Slow (limited ramp rate)
  - Inflexible (12-24 hour start time)
- Transmission takes a long time
- Storage is an ideal reliability solution
  - Fast resources free up thermal generation (AES, Beacon, Xtreme demonstrations)
  - Long duration storage can replace peakers (AES proposal to LIPA)
  - Can be manufactured and installed in months
- **Recommendation: include storage when studying solutions to CSAPR-related retirements**



- **With Order No. 890 in 2007 FERC began opening wholesale electricity markets to energy storage**
  - Continued progress to remove barriers to storage
    - NYISO, Midwest ISO, PJM are open; have revised tariffs
    - CAISO tariff filed at FERC August 2011
    - ISO-NE has pilot program; developing permanent rules
  - FERC now focusing on compensating the value of fast regulation, i.e. “pay-for-performance”
    - Sends right market signals and reduces overall procurement
- **FERC reviewing policies for storage in non-ISO/RTO markets and for use as transmission**
- **DOE loan guarantee program, stimulus grants, ARPA-E**
- **Senator Wyden Storage Bill: Investment Tax Credit for Storage**

# State Storage Policy Initiatives



- **MA Green Communities Act, July 2008**
  - Energy storage included as an eligible technology to meet the Alternate Energy Portfolio Standard
    - Beacon has been earning renewable credits since 2009
  - Storage is eligible for “grants” or “other financial incentives”
- **California Energy Storage Bill AB 2514 , September 2010**
  - California Public Utility Commission (CPUC) is to open a proceeding to determine appropriate targets for each load-serving entity to procure energy storage
  - 1<sup>st</sup> state to consider storage procurement targets
- **State grants for Storage projects**
  - \$2 million NYSERDA grant for Beacon NY project
  - \$5 million PA Redevelopment Assistance (RACP) grant for Beacon

# Policy Recommendations



- **Support ISO-NE permanently opening market to storage**
- **Allow storage to qualify as a capacity resource**
  - Clean form of capacity
  - Frees up thermal generation
- **Allow storage to qualify for renewable energy credits**
- **Consider Storage Portfolio Standard (SPS) = 25% of RPS**
  - Storage assists with the integration of renewables
- **Long-term procurement contracts for storage**
  - Provides revenue certainty to attract private capital
  - Example, California Energy Storage Bill AB 2514
- **Include storage in long-term utility planning**
- **Allow cost recovery for storage in transmission and distribution rates**
- **Investment Tax Credit**
- **State incentives/loans**



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