



**EPRI**

ELECTRIC POWER  
RESEARCH INSTITUTE

# Electric Energy Storage an Essential Asset to the Electric Enterprise

## Barriers and RD&D Needs

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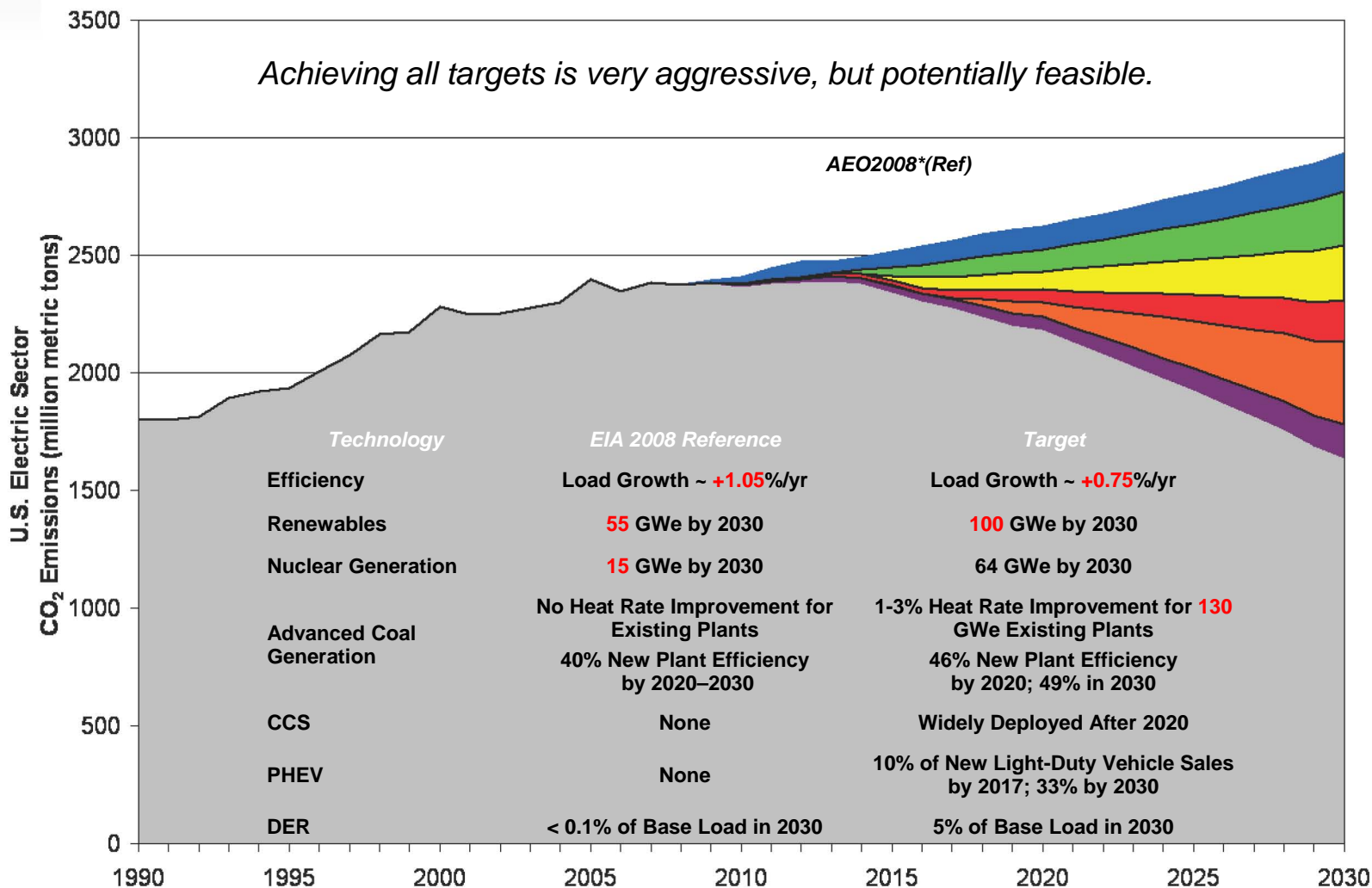
**Dan Rastler**, Program Manager  
Electric Power Research Institute

# Barriers to Deployment of Energy Storage Systems

- Macro Impact of Energy Storage to the State, RTO, Utility
  - Integrated Supply, T&D, Environmental (CO<sub>2</sub>) Analysis
    - EPRI U-Plan Analysis of ERCOT in 2009 ( October 2009)
    - EPRI Merge and Prism Analysis (July 2009)
- Application Solution Cost / Value / Gap Analysis
- Resolve Risks in Deployment of Energy Storage Systems
  - Full Integrated Systems > Cost Reduction > Standardization
  - Technology / Vendor Risks
  - Regulatory treatment
  - >> Increase Demonstrations of Storage; Use Cases Verified
- Energy Storage in Smart Grid – looking beyond bulk storage solutions
  - Demonstrations and Business Case Assessment
  - Advanced Inter-operability and Interconnection Standards
- Market Rules which encourage win-win and easy monetization of numerous value streams
- Increased R&D and in the basic sciences area to bring promising new technology to market

# Full Portfolio of Energy Solutions needed for a Low Carbon Future

## Technical Potential for CO<sub>2</sub> Reductions



\*Energy Information Administration (EIA) Annual Energy Outlook (AEO)

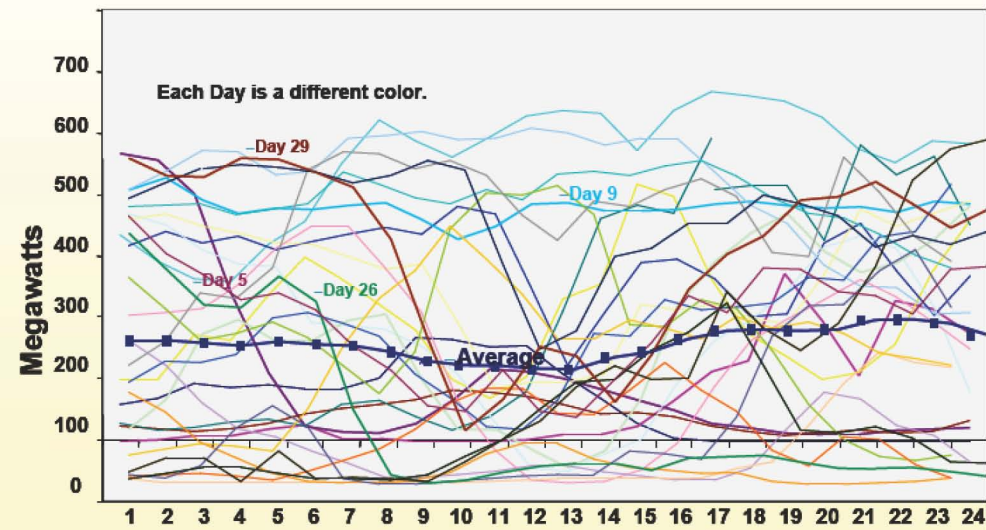
# Wind Power

## Large Power Fluctuations



### Tehachapi Wind Generation in April – 2005

Could you predict the energy production for this wind park either day-ahead or 5 hours in advance?





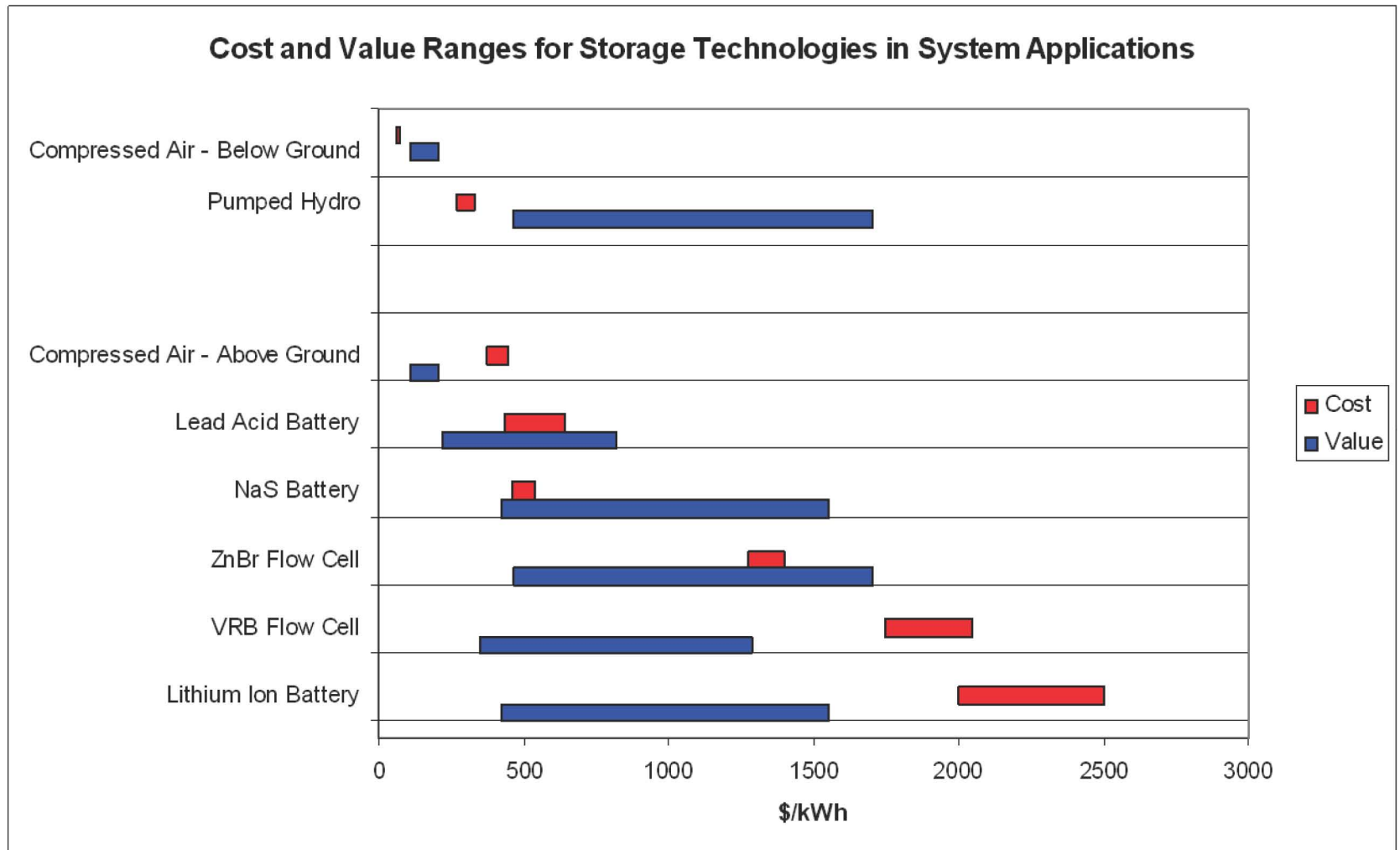
# Energy Storage and Wind Integration

## Key Research Questions

- Can Energy Storage increase the penetration of wind generation ?
- What options and operating parameters are optimal for increased wind penetration?
- What is the underlying economic value proposition of bulk energy storage?

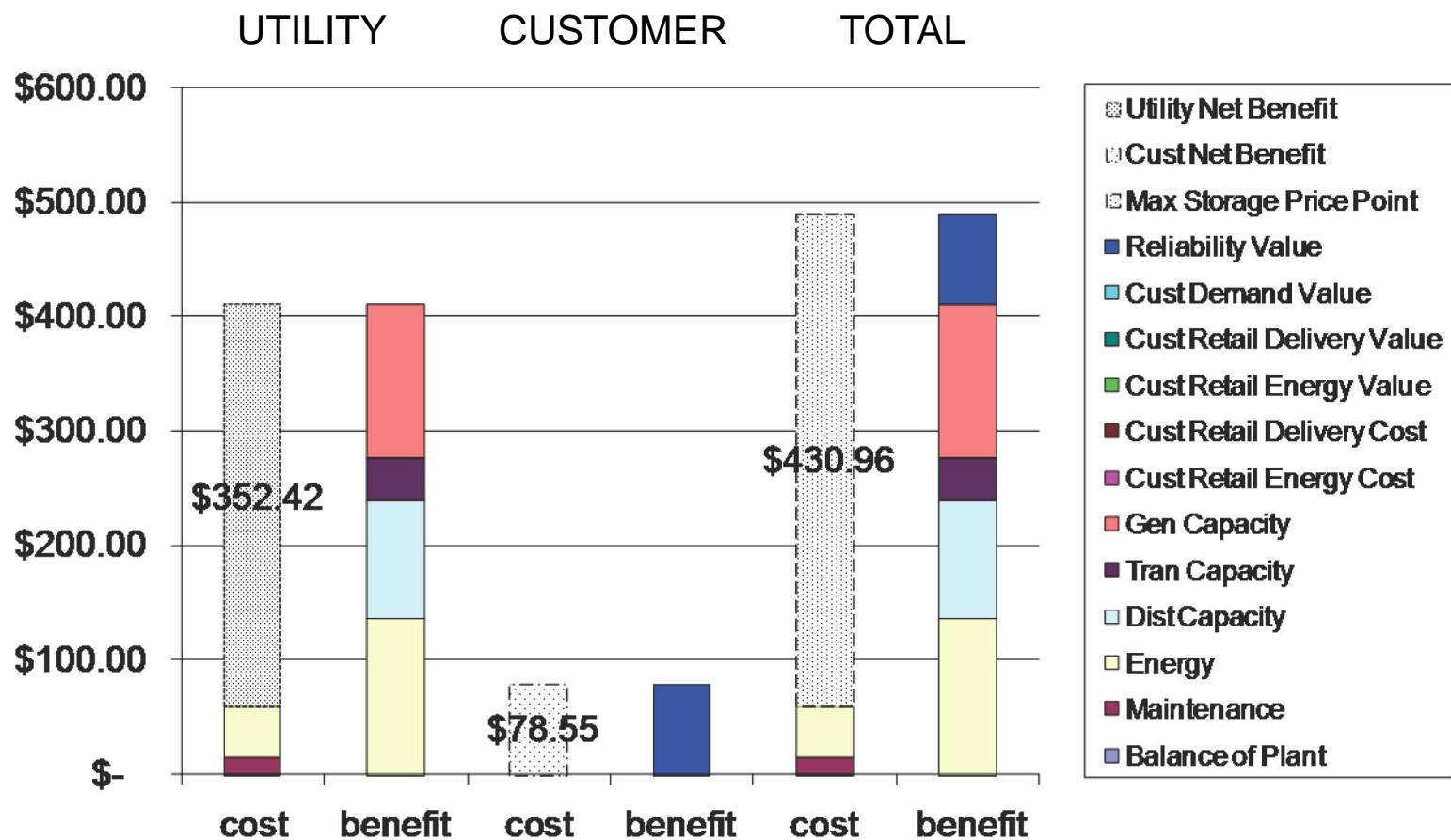


# R&D Needed to Understand Cost and Value in Various Applications – (EPRI work underway in 2009)



# R&D to Understand Cost / Benefits

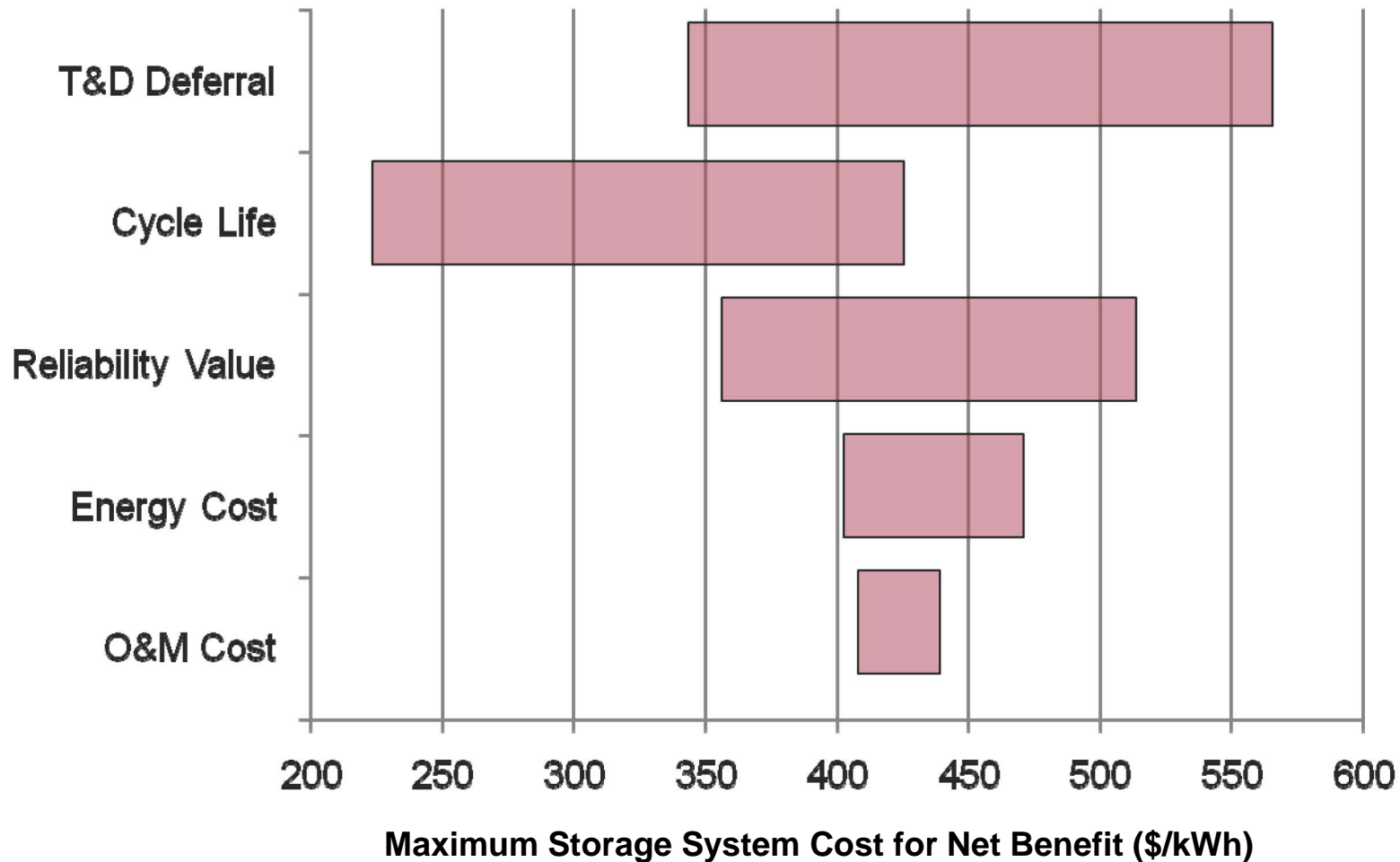
## San Francisco Energy Storage Valuation Tool Results (Hourly Pricing, Utility Dispatch)



Need to Easily Monetize Benefits

# R&D to understand Sensitivity in Cost / Value

## SF Hourly Pricing Sensitivity Analysis: Tornado Diagram



**\$431/kWh**  
**Base Case**



# Projected Regional Technical Potential for Electricity Storage Applications

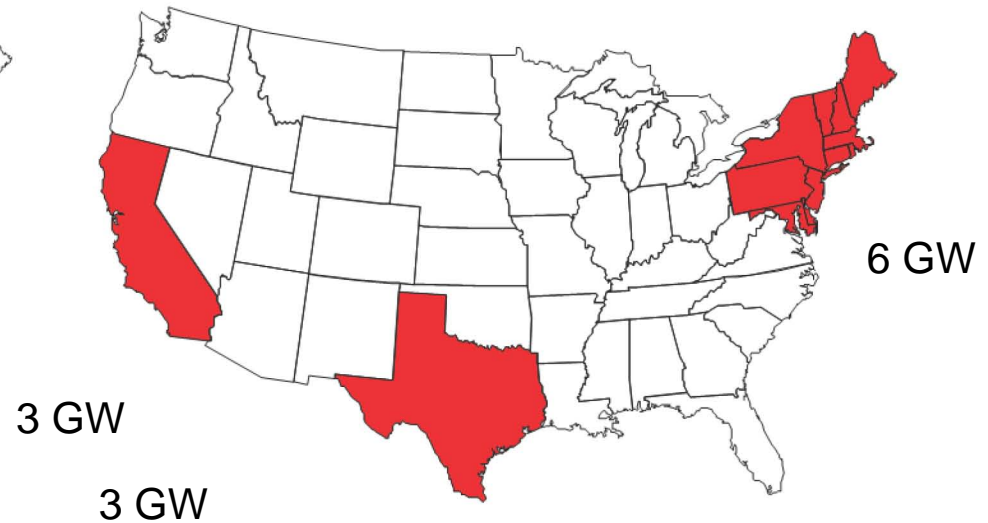
## Near-Term Technical Potential



New York: 2 GW  
California: 3 GW

5 GW Total  
(1,125 GWh @ 225 hrs/yr)

## Mid-Term Technical Potential

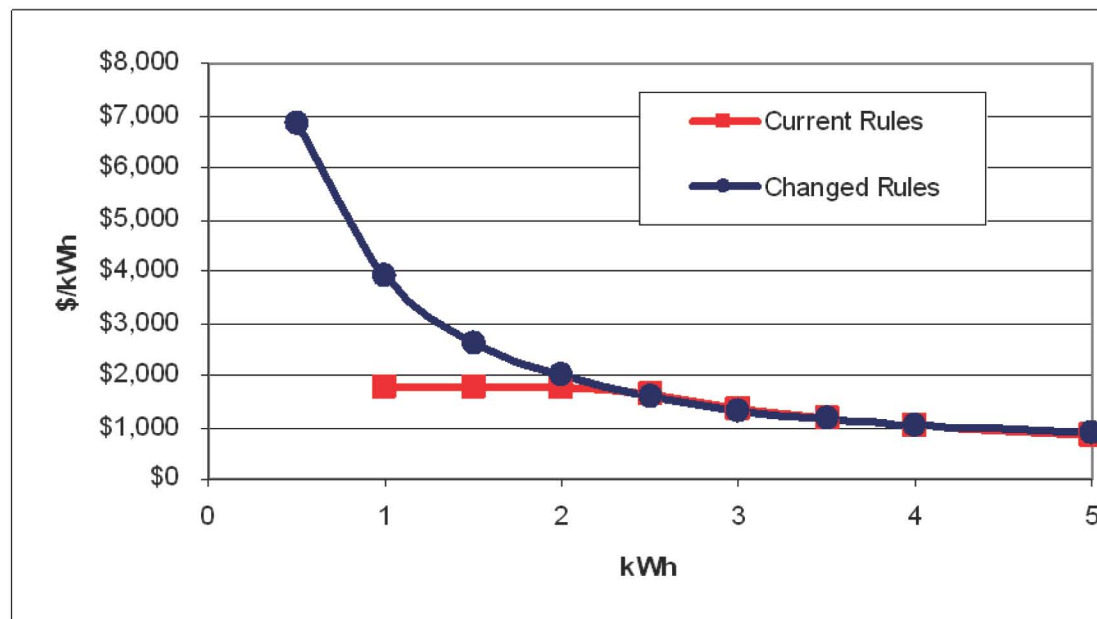


States with average commercial electricity prices greater than 11 cents/kWh:

12 GW Total  
(2,700 GWh @ 225 hrs/yr)

# Changing Market Rules could be a Game Changer for Storage Technologies

## Increase in Energy Storage Value with Changed Rules for Regulation Markets



- Minimum bid duration of 1hr
- Minimum bid size of 1 MW
- Prohibition of asymmetrical bidding (except in CAISO)
- ISO-NE and CAISO in pilots