

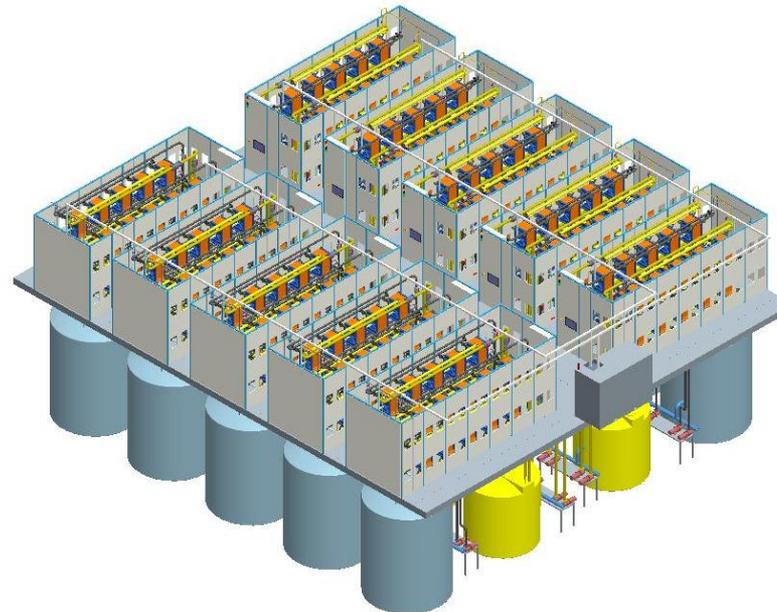


# Energy Storage Systems

The Leader in Global Grid Scale Energy Storage Systems



**5 kW for 8 Hours**  
**40 kWh, 20 Years**  
**Self Contained**  
**24 Square Feet**  
**Launch 2011**



**1 MW for 8 Hours**  
**8 MWh, 20 Years**  
**Complete System**  
**5,000 Square Feet**  
**Launch 2012**



# The Energy Problem in the U.S.A.



**Annual Losses**  
**Foreign Dependence**



**Transmission Limitations**  
**Aging Infrastructures**



**Increasing Demands**  
**Distributed Needs**

**To Fix the U.S.A. Energy Problem: \$7 Trillion\***

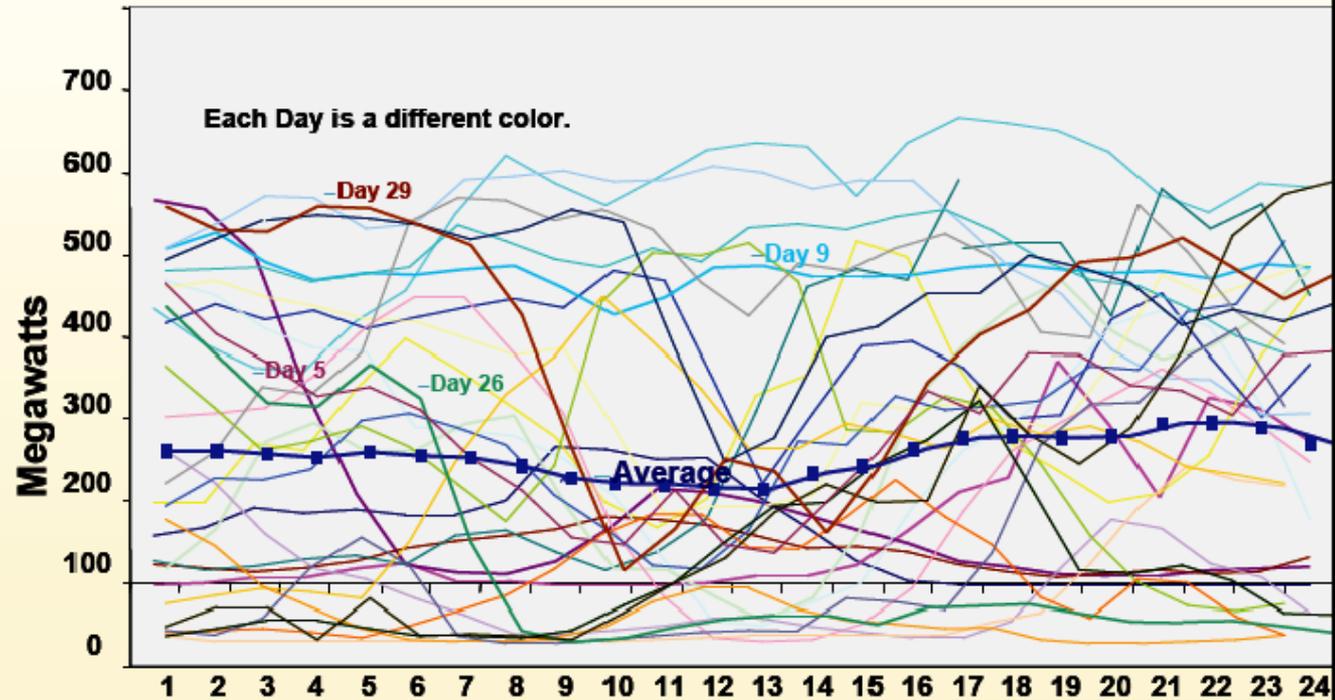
(\*Jefferies Report on Energy 2011)

# The Problem: Variability of Wind Generation



## Tehachapi Wind Generation in April – 2005

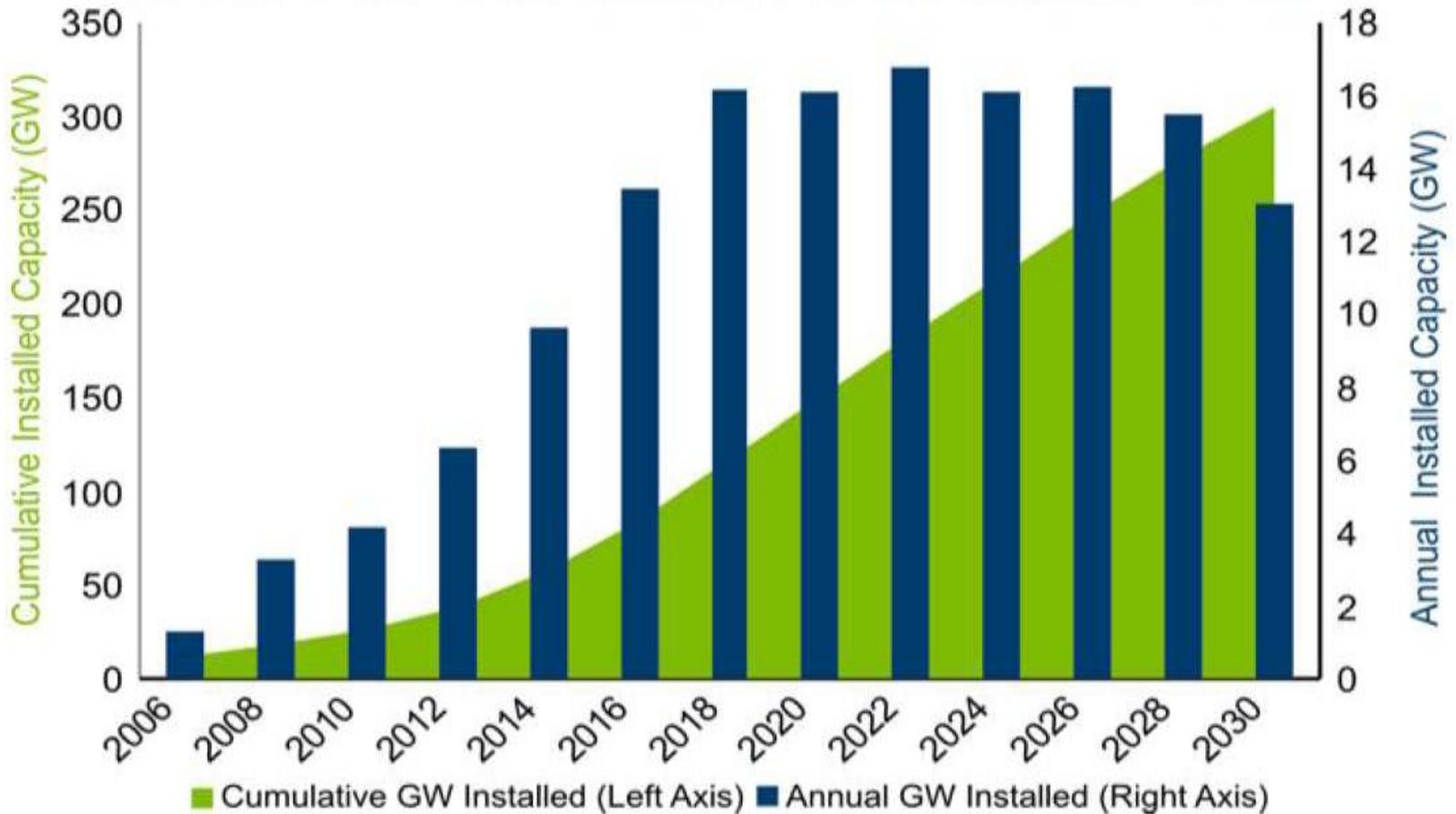
Could you predict the energy production for this wind park either day-ahead or 5 hours in advance?



# The Problem is Growing As Wind Energy Grows



Figure 1-4. Annual and cumulative wind installations by 2030



DOE, NREL and AWEA – July 2008 Report 20% by 2030

# Market Opportunity: Wind Power Load Shifting



## **Grid storage can address problems and add value to 4 key areas:**

- Improving intermittency of renewables
- Enhancing grid reliability
- Optimizing utilization of transmission assets
- Increasing the value of renewable energy generation assets

## **Total Available Market (TAM) Estimated at \$200B**

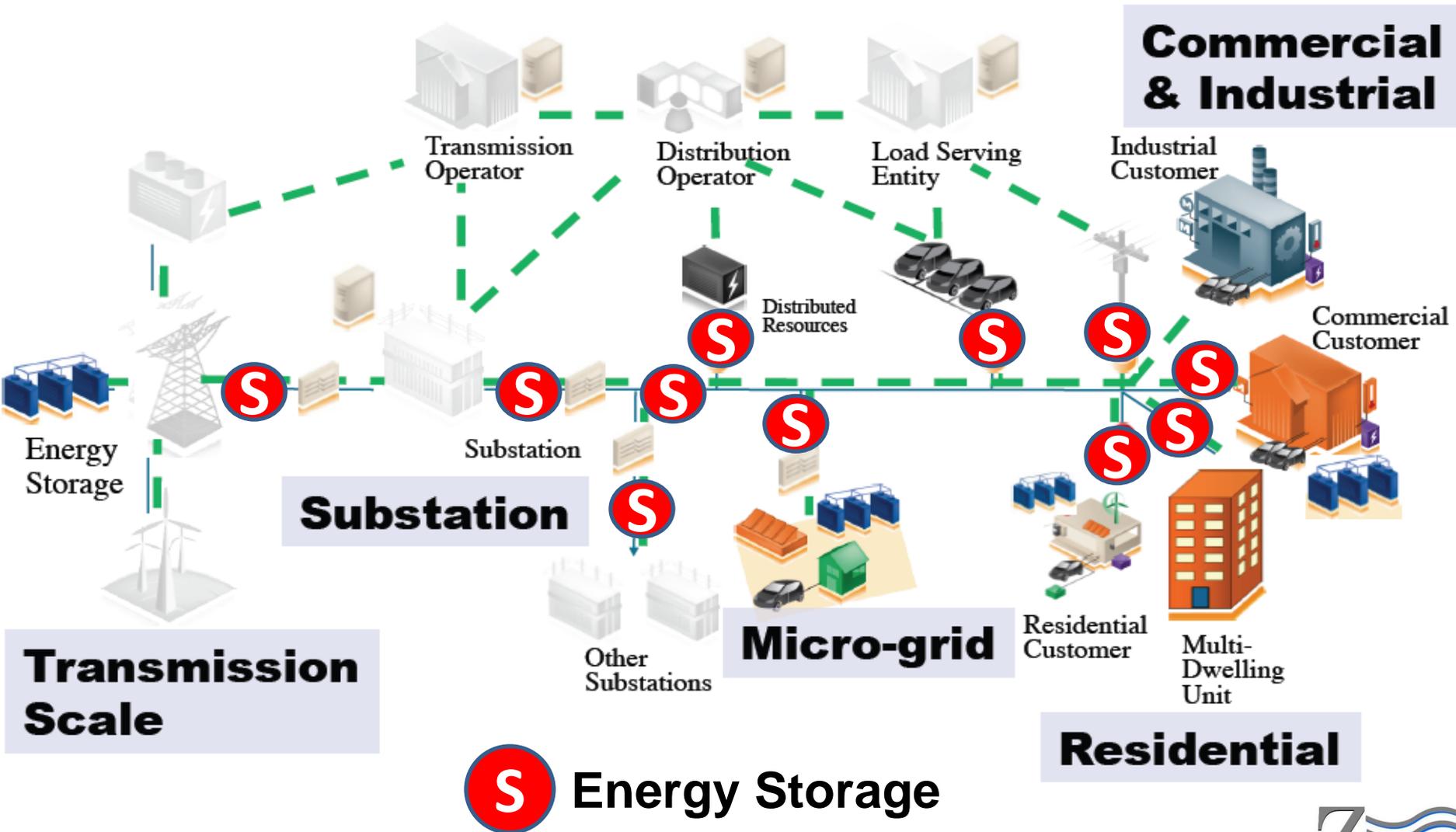
**(U.S. Only - DOE Estimate\*)**

“Hours-to-days of power for daily energy peak shifting. For this application, power capacity on the order of 200 GW and 1,000 GW-hr would be necessary for up to 20% integration of renewables.”

Statement from ARPA-GRIDS Grant

# Energy Storage Opportunities – Market Segments

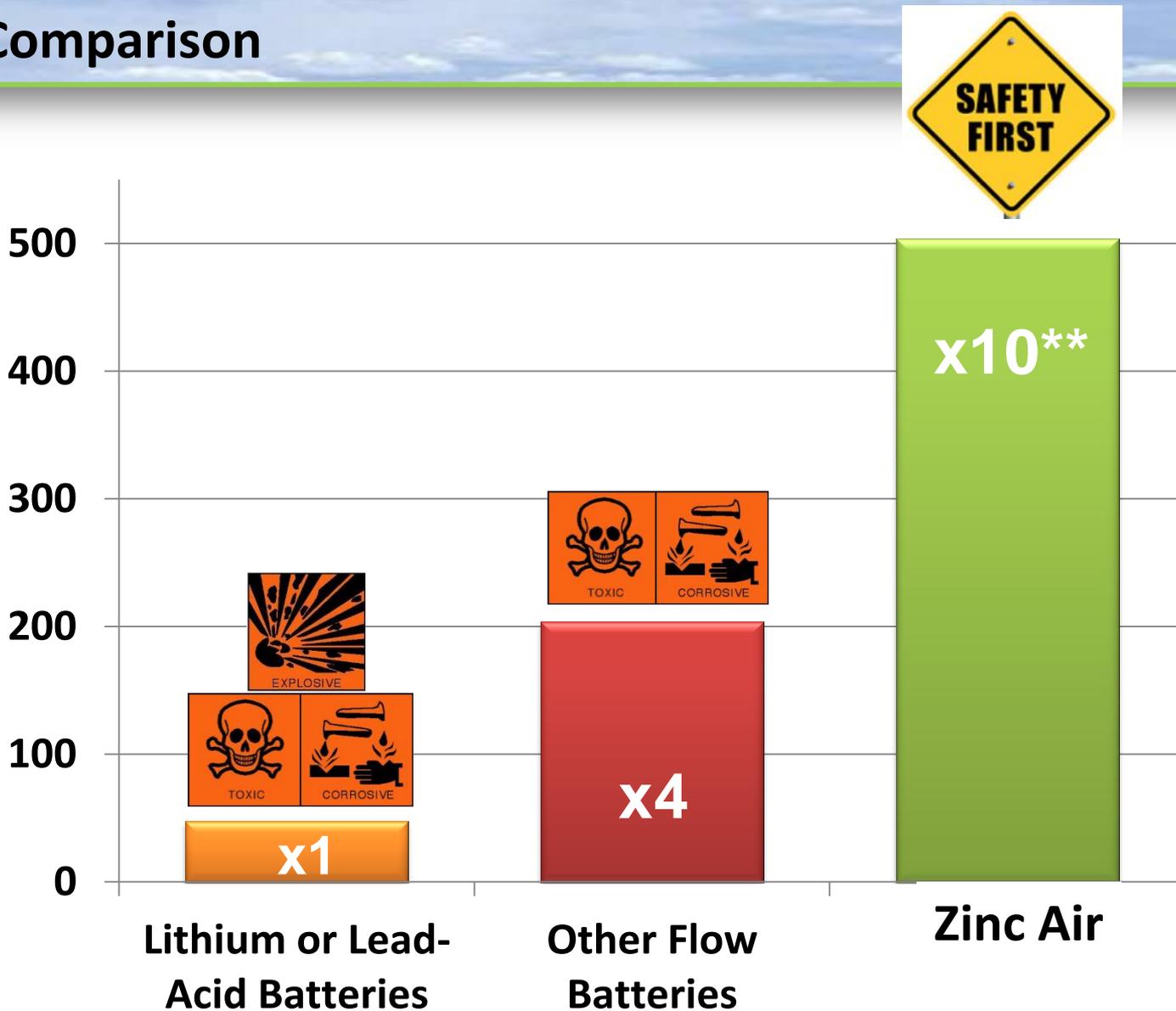
## Smart Grid



# Why Flow Batteries?

## Performance Comparison

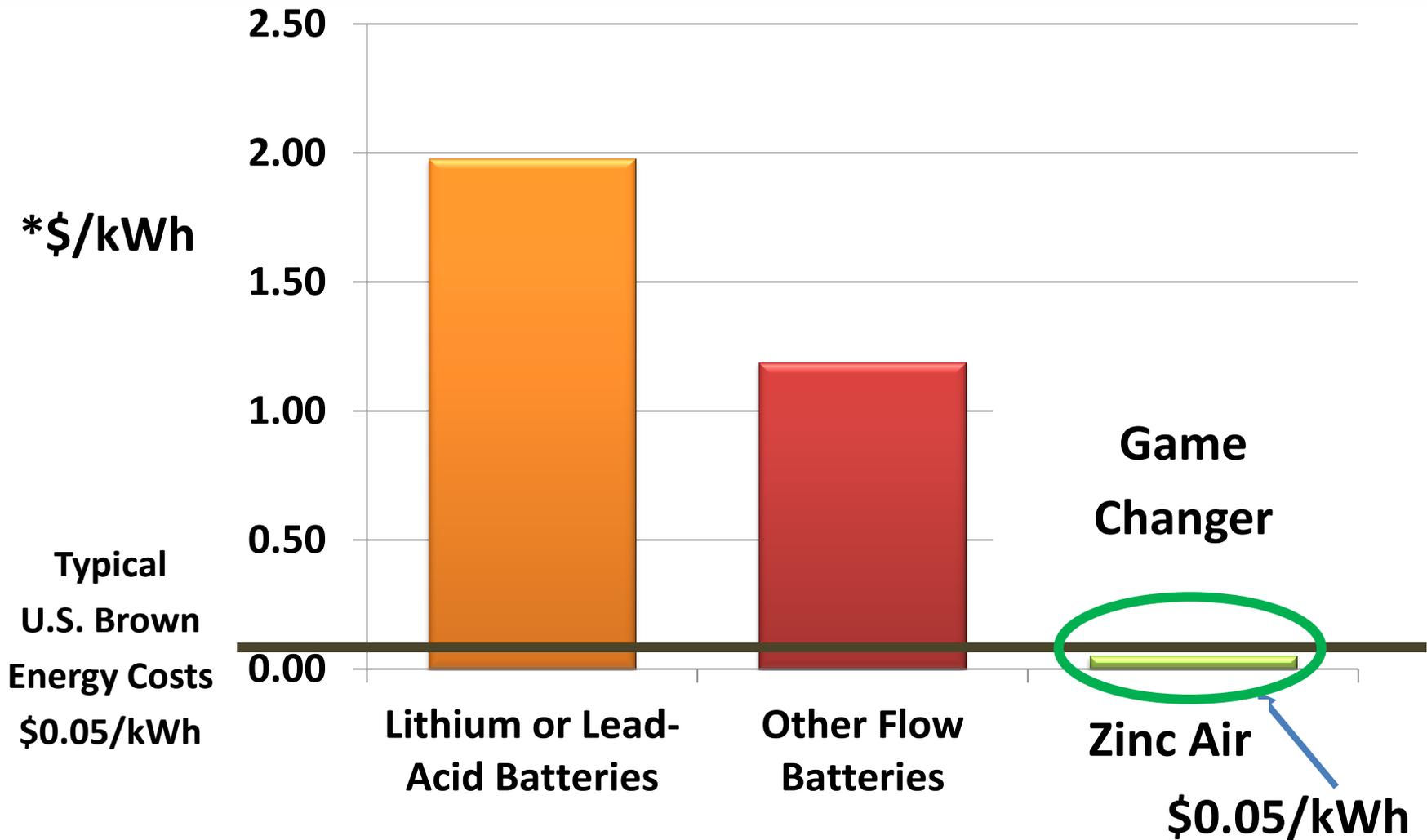
**\*Economic Performance**



\*\*x11 measured in the lab

\*Discharge Time x Depth of Discharge x Total Efficiency

# Net Cost of Usage



\*Deferred cost by net revenues of \$0.25/kWh

# Zinc Redox Unique Advantages



## Low Cost: Simplicity in Design & Operation

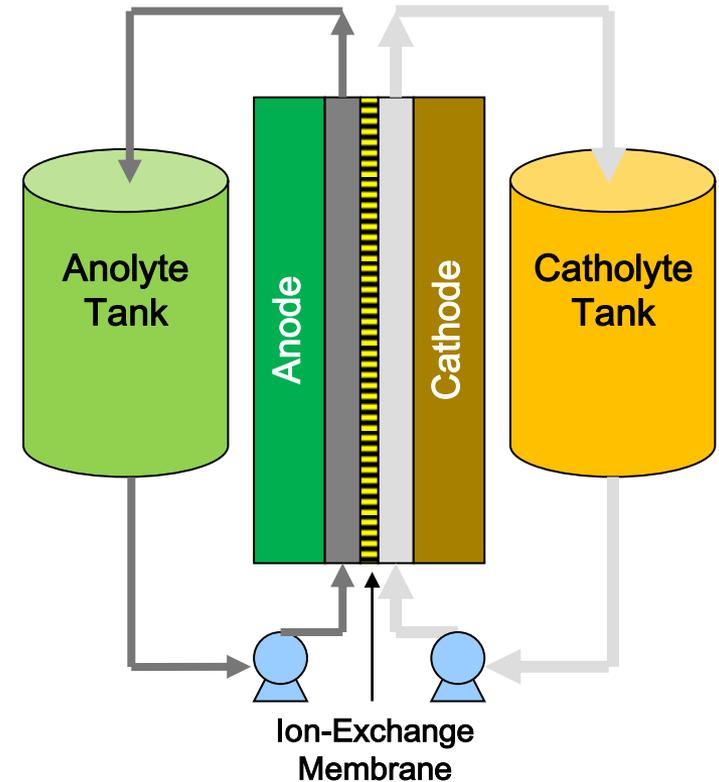
- Material selection for performance & cost
- System design is modular & scalable
- Technology maturity: +8 years

## Best-in-Class Performance

- Electrochemical efficiency at +74%
- Designed for durability
- Millisecond response time

## Environmentally Friendly: Safe & Green

- Safe/non-hazardous/non-toxic chemistry
- Not pressurized
- Ambient temperature



# Basic Features and Applications

## Features

- Environmentally safe system
- Long full power discharge times up to 8 hours
- Scalable from 5kW to 100 MW
- Long life and refurbishment > 20 years
- Deep discharge cycles > 95%
- Standard control interfaces to grid
- Battery control system for multiple applications
- Standard field proven components
- Multiple revenue based applications
- Short payback periods
- Round trip efficiency > 70%
- Standard ISO manufacturing
- Standard ambient temperature operating conditions
- Non-pressurized

## Applications

- Islanding
- Peak shaving
- Frequency regulation
- Ancillary services
- Arbitrage
- Load shifting
- Renewables firming
- Backup power systems
- Deferment of Transmission
- Integrated systems
- VAR support
- Black start

# Thank You for Your Consideration



## Contact Information

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