

Energy Storage

The 'Holy Grail'

NESEA Building Energy Conference

Mar 11, 2011

Jim Dunn

Future Solar Systems LLC

SOLAR

World Energy Use



Hydro



Biomass



OTEC



Wind



waves



Natural Gas



Petroleum



Uranium



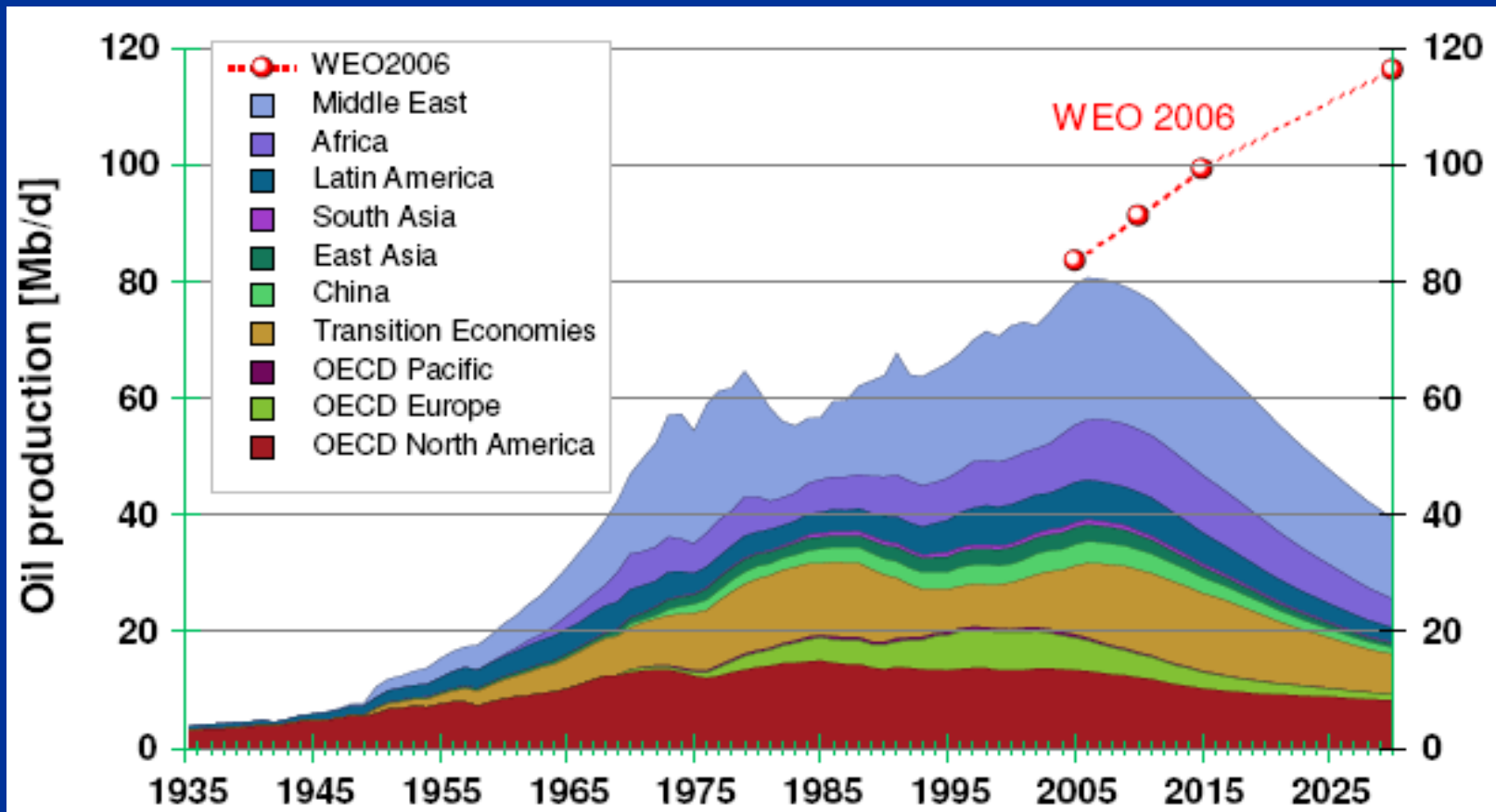
Coal



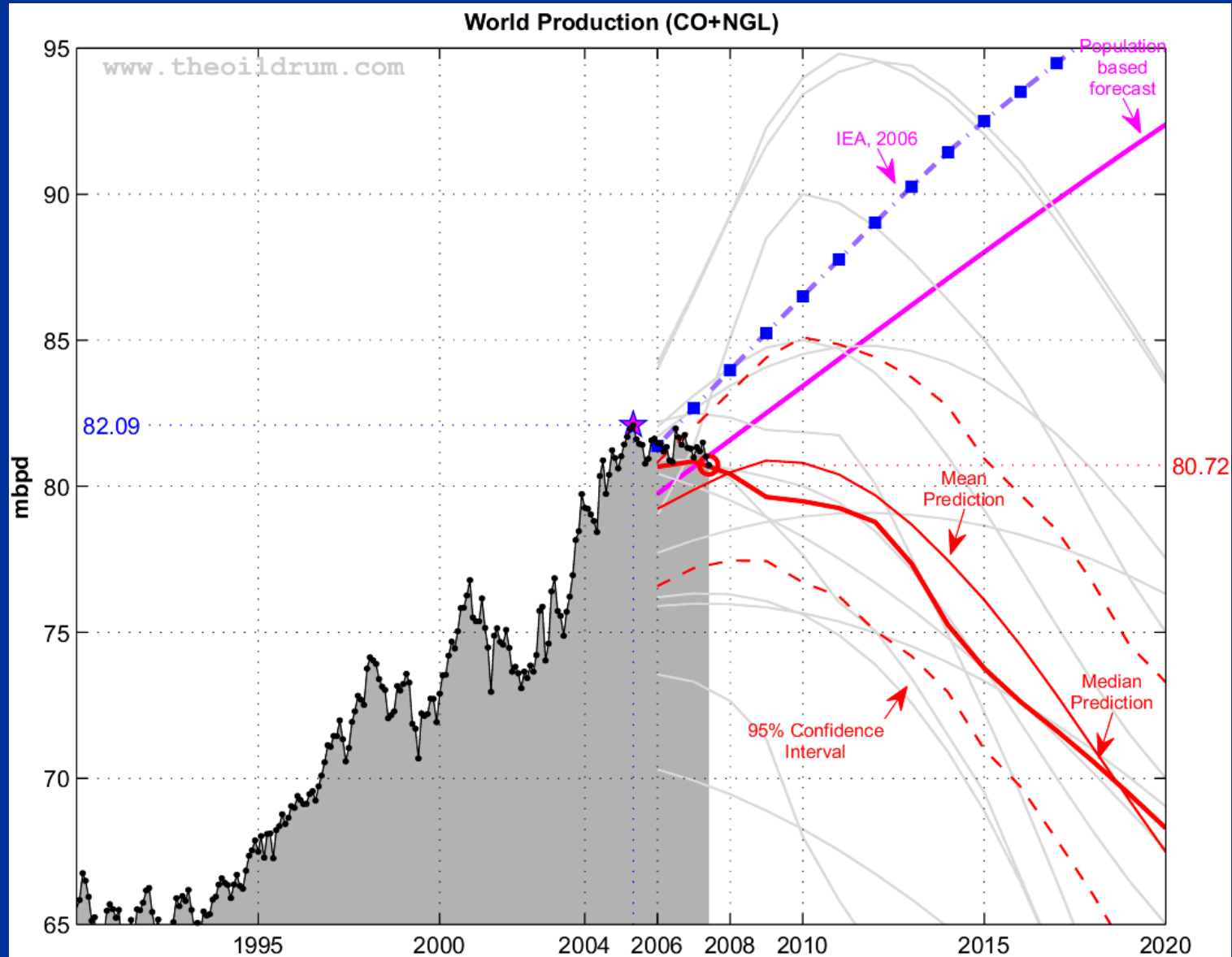
© Richard Perez, et al.

Global Oil Supply Projections

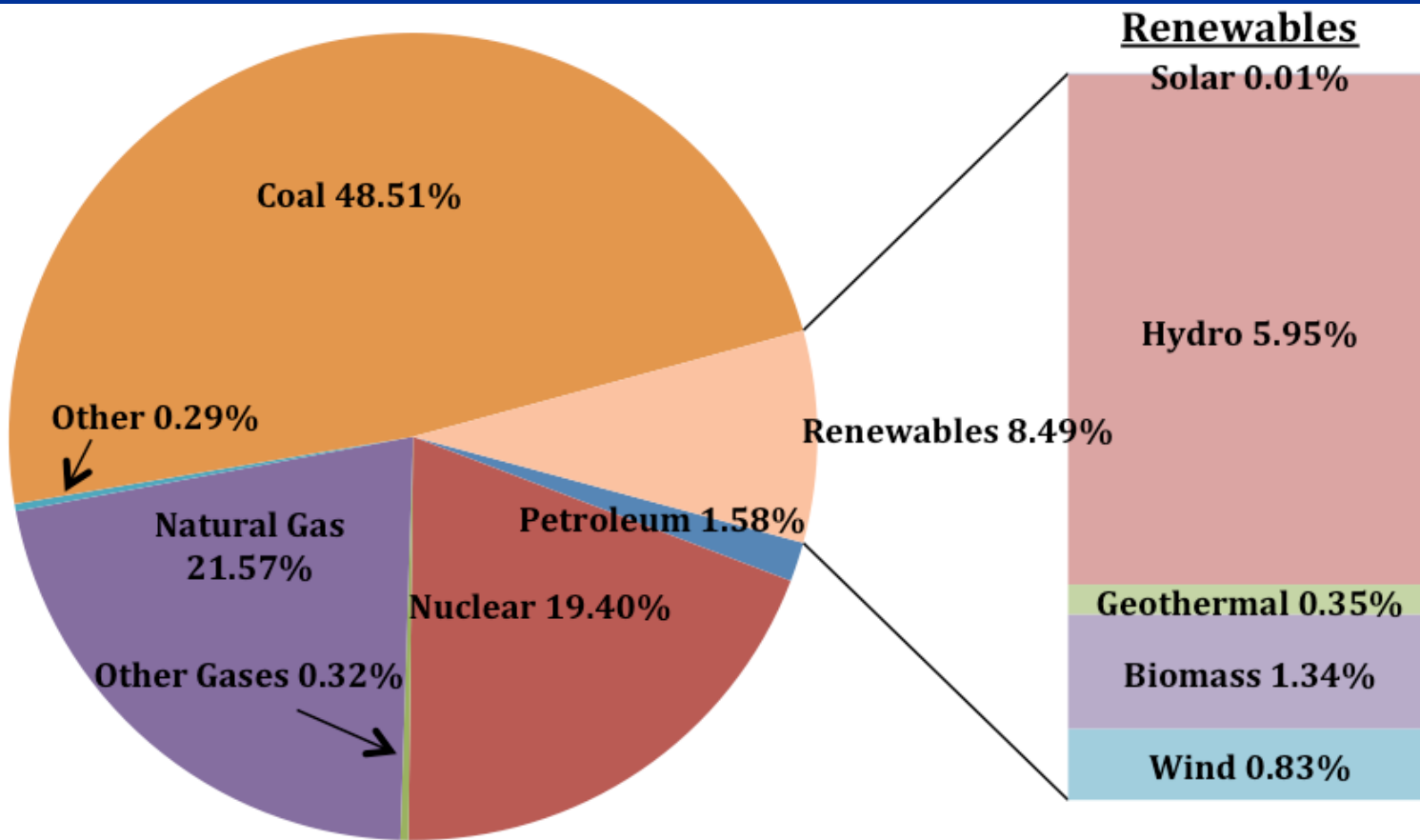
- 2006: 81 Mb/d
- 2020: 58 Mb/d (IEA: 105.1 Mb/d)
- 2030: 39 Mb/d (IEA: 116.2 Mb/d)



Global Oil Supply < Global Demand



US Energy sources - 2007



Renewable Energy Market

Fastest growing Business Sector in World

\$100B investment – 2007, Huge growth in '08

New Fed. and State funding/rebates & REC's

Major Solar and Wind power expansion in
emerging market sectors across the US

Top 10 States Renewable Electricity Gen.

MWh Generated (2007)

Rank	State	MWh
1	Washington	82,559,749
2	California	52,173,008
3	Oregon	35,815,731
4	New York	28,027,638
5	Texas	11,932,049
6	Montana	9,971,057
7	Idaho	9,674,539
8	Maine	7,945,148
9	Alabama	7,936,734
10	Arizona	6,639,310

As % of Total State Elect. Gen

Rank	State	% of Total
1	Idaho	84.2%
2	Washington	77.2%
3	Oregon	65.0%
4	South Dakota	50.0%
5	Maine	49.3%
6	Montana	34.5%
7	California	24.7%
8	New York	19.2%
9	Alaska	19.1%
10	Vermont	19.1%

Issues to overcome

- Grid capacity – Emerging ‘Smart Grid’
- Distributed power – many options
- Demand Balancing – Ltd. Energy Storage *
- Net Metering – Random energy balancing
- Monitoring and local control

Benefits of Alternative Energy

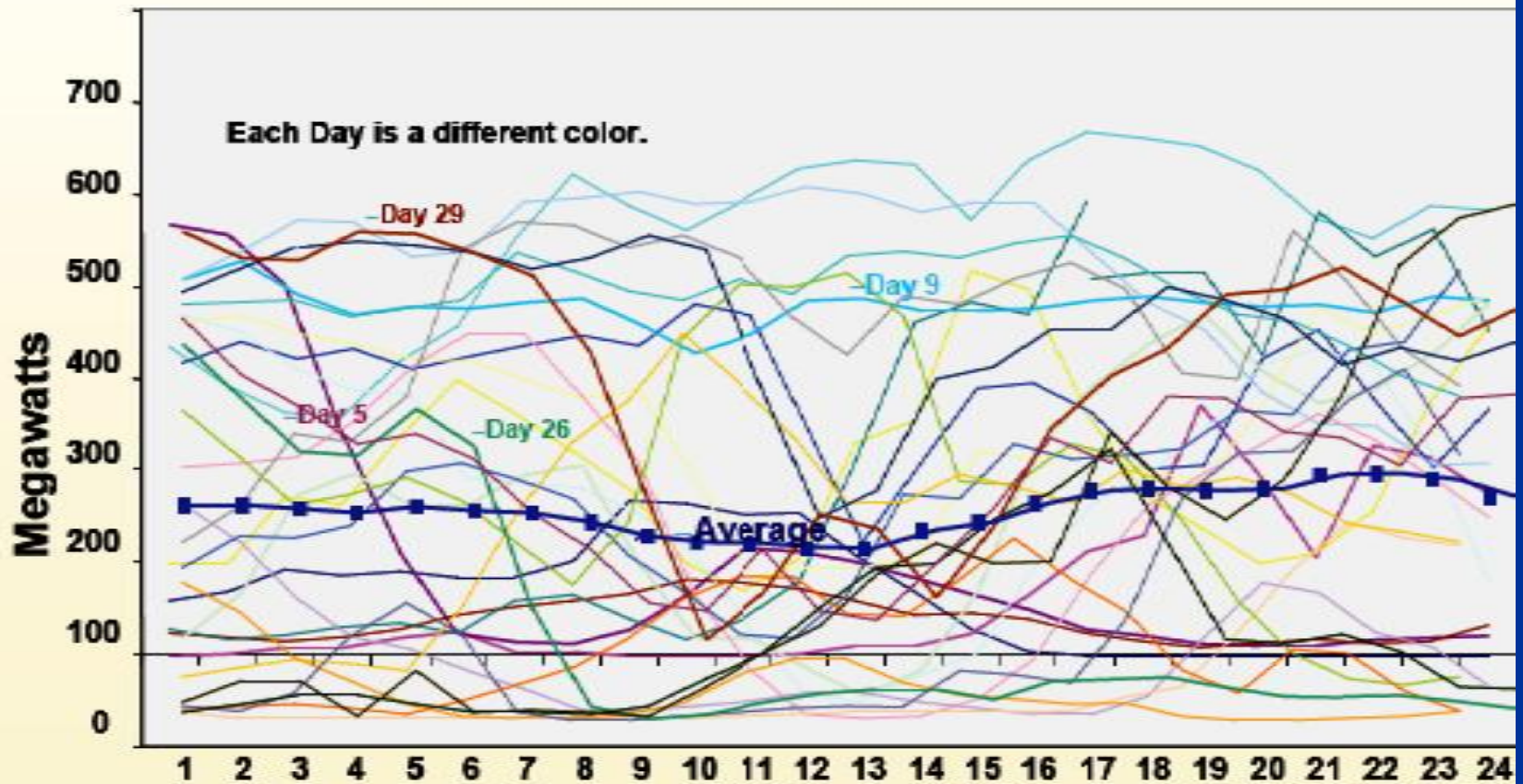
- Reduced dependence on hydrocarbon resources
- Decentralize energy infrastructure
- Deserts blossom
- Elevate lower class
- Social enlightenment
- War over resources less likely
- Geopolitical disruption



Wind power variability

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 – ‘Holy Grail’

Instant – power/freq. correction – 1-5000 ms

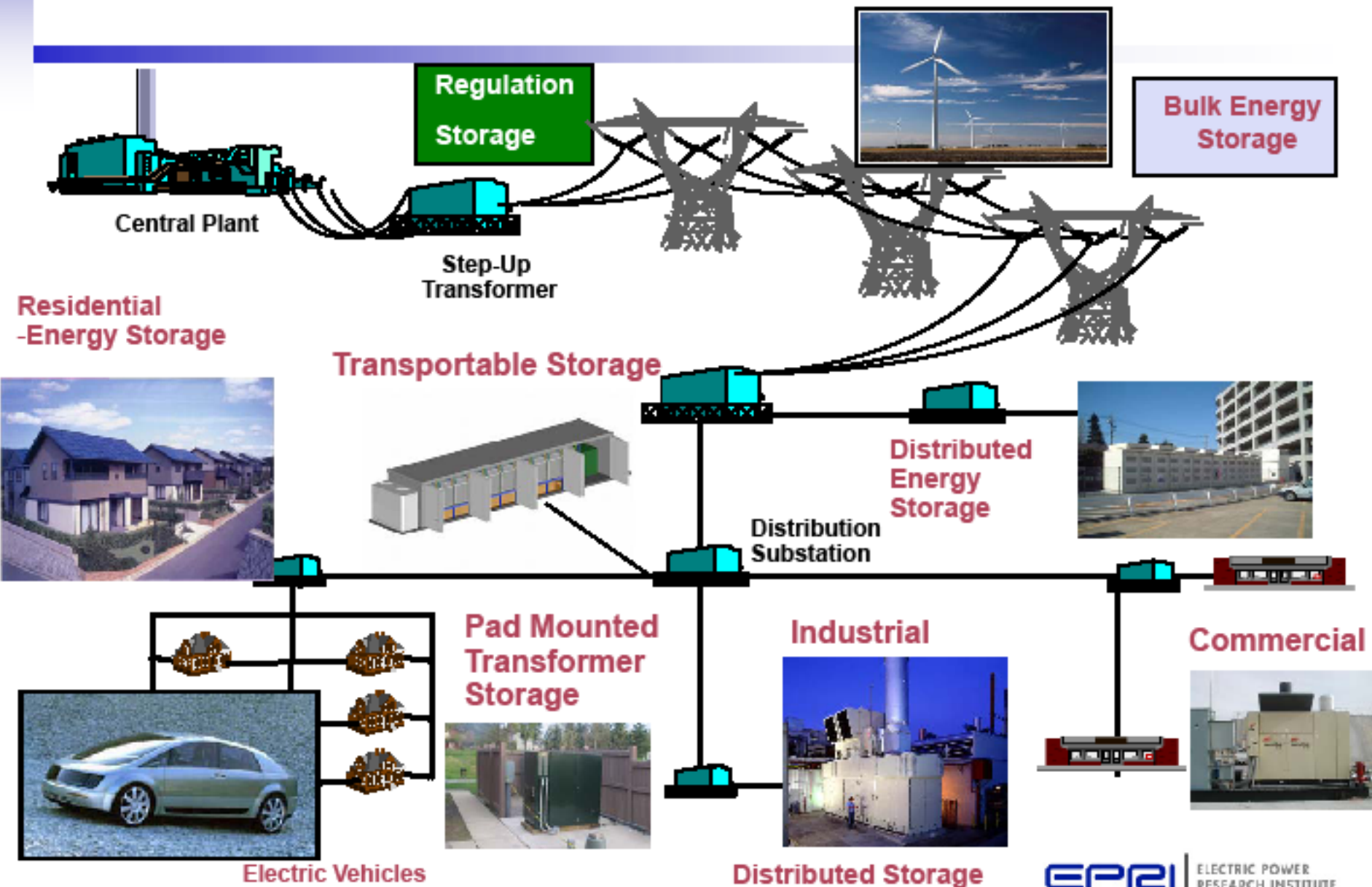
Short Term – 1-15 min. – Brief outages -
Ride Thru

Daily – 1-8 hrs. – Demand balancing - PHEV

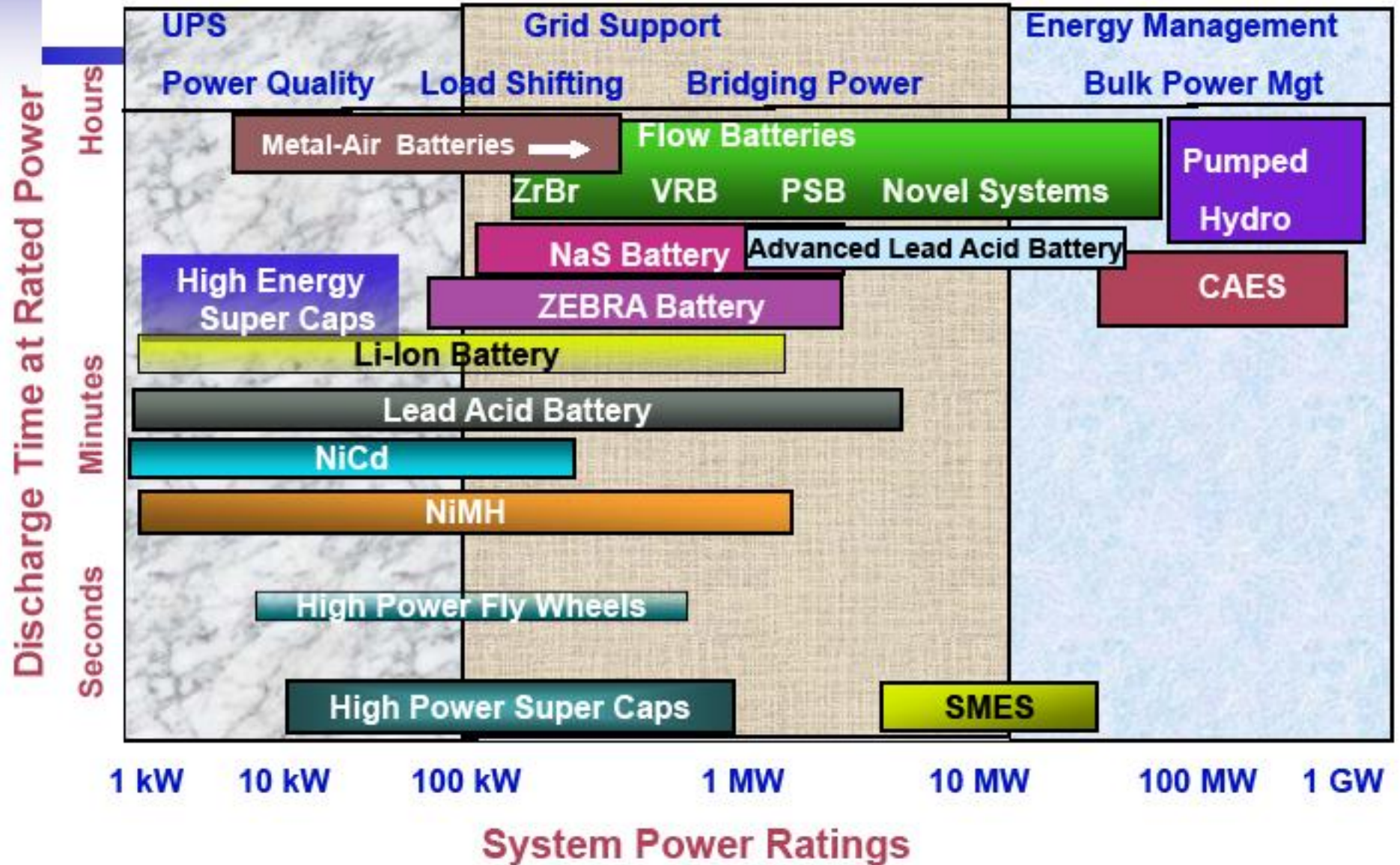
Large Capacity – Pumped Hydro – CAES

Utility Interest in Electric Energy Storage

Locational Opportunities for Energy Storage in the Electric Enterprise



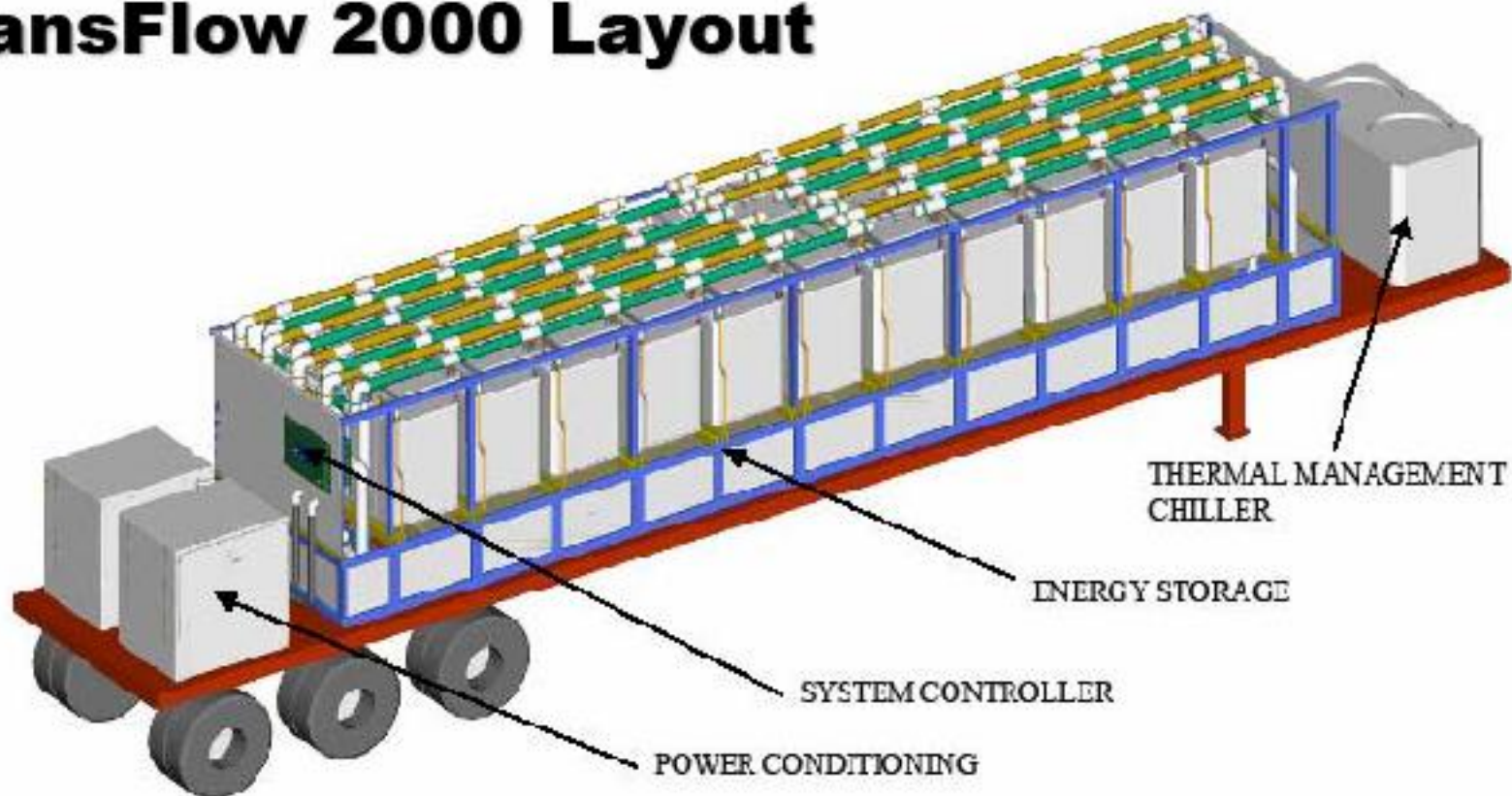
Positioning of Energy Storage Options



Flow Batteries – Zn / Br

Gaining Utility Consideration for Grid Support Applications

TransFlow 2000 Layout



0.5 MW / 2 MWh

Design by Premium Power Corporation

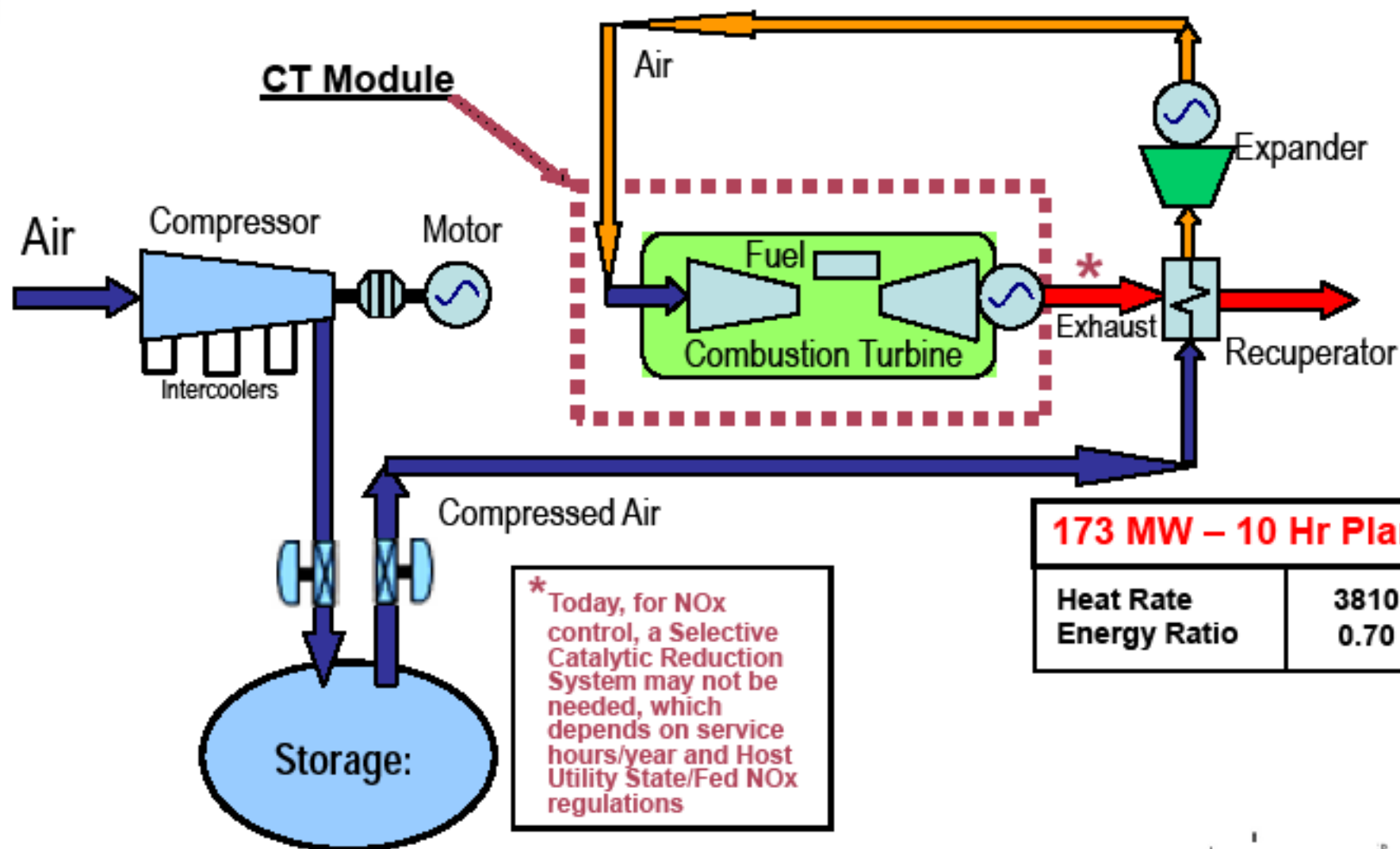
2 MW Lithium Ion System for Frequency Regulation at AES Power Plant



Early Field Trials by

- Altari Nano
- A123

2nd Generation Compressed Air Energy Storage Plant Ready for Field Demonstration and Deployment



Potential Applications

Neighborhood Energy Storage



Source: American Electric Power (AEP)

Categories of Energy Storage Apps

- **Category 1 — Electric Supply**

- Electric Energy Time-shift
- Electric Supply Capacity

- **Category 2 — Ancillary Services**

- Load Following
- Area Regulation
- Electric Supply Reserve Capacity
- Voltage Support

- **Category 3 — Grid System**

- Transmission Support
- Transmission Congestion Relief
- Transmission & Distrib.Upgrade Deferral
- Substation On-site Power

- **Category 4 — End User/Utility Customer**

- Time-of-use (TOU) Energy Cost control
- Demand Charge Management
- Electric Service Reliability
- Electric Service Power Quality

- **Category 5 — Renewables Integration**

- Renewables Energy Time-shift
- Renewables Capacity Firming
- Wind Generation Grid Integration

speakers

- John Kluza
- Harvey Wilkinson
- Roger Faulkner