



**CUSTOMIZED
ENERGY SOLUTIONS**

Analyze.
Simplify.
Implement.

Electric Energy Storage Technologies in ERCOT

Presented by

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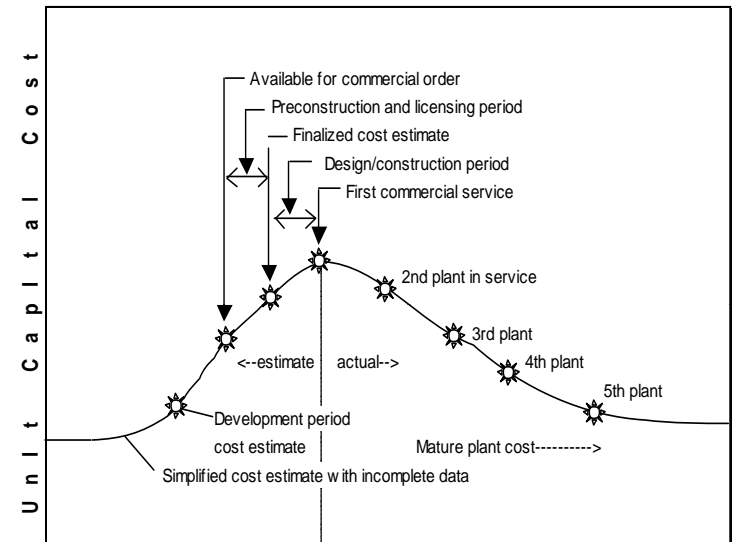
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Energy Storage for Grid Applications

- Pumped Hydro Energy Storage
- Compressed Air Energy Storage
- Sodium Sulfur (NAS)
- Flow Batteries (VRB/ZBB)
- Flywheels (Beacon)
- Li-Ion Batteries (Altairnano/ A123)



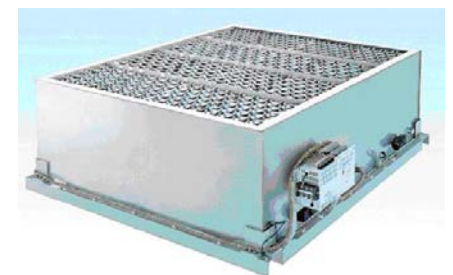
Altairnano
ESS



Flow Batteries



NGK - NAS





Traditional Applications for EES for utility applications

- **Energy Arbitrage**
- **Grid Stabilization**
- **Transmission and Distribution Upgrade Deferral**
- **Grid Operational Support**
 - ❖ **Frequency Regulation**
 - ❖ **Contingency Reserves**
 - ❖ **Voltage Support**
 - ❖ **Black Start**
- **Power Quality and Reliability**
- **Load Shifting**

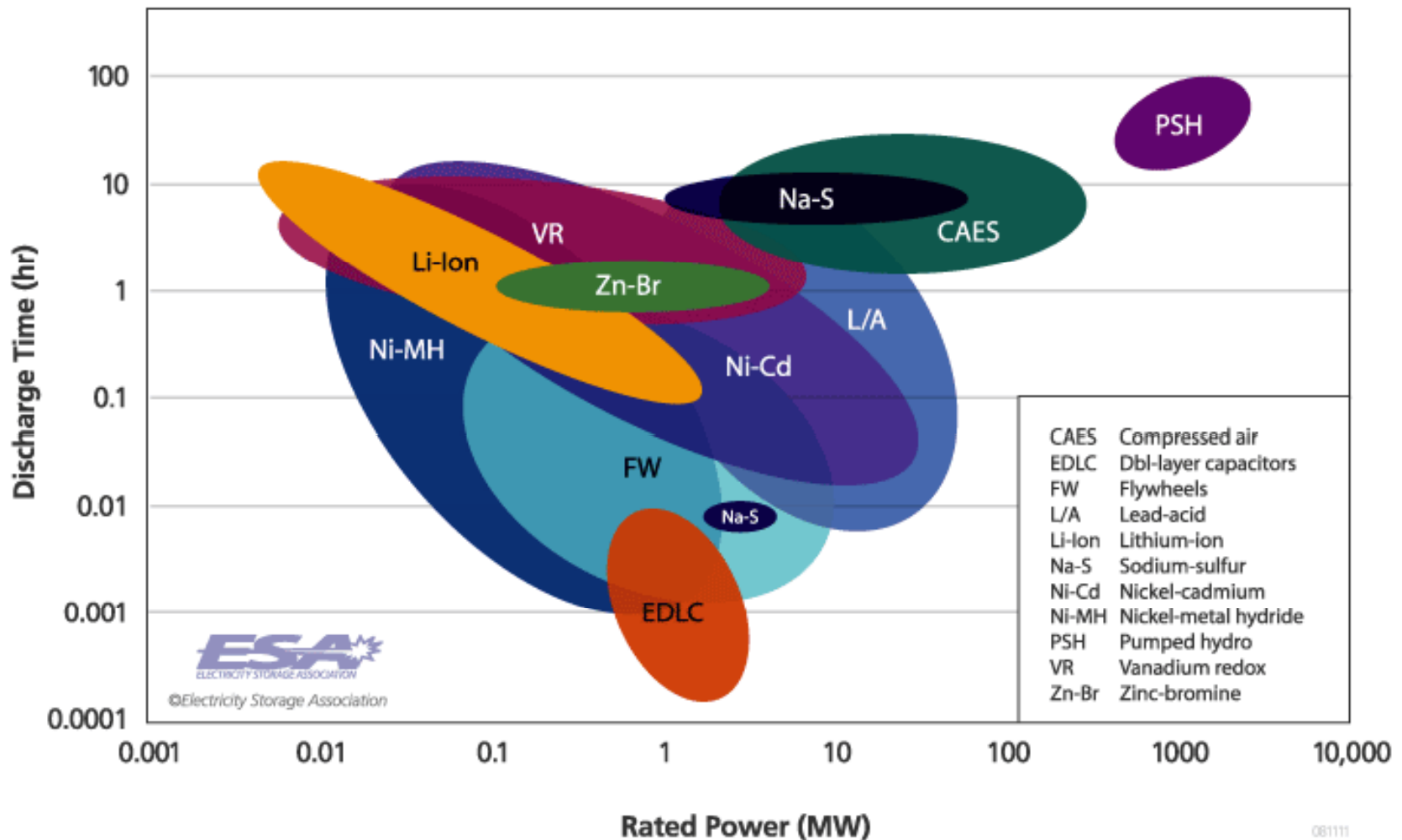


Selecting Energy Storage Technology

- Design, Performance & Capabilities
 - ❖ Technology selection
 - ❖ Power & Energy rating
 - ❖ Life expectancy
 - ❖ Round Trip Efficiency
 - ❖ Response rate & any other operating considerations
 - ❖ Footprint & any special permitting requirements
 - ❖ Capability to meet requirements for different markets

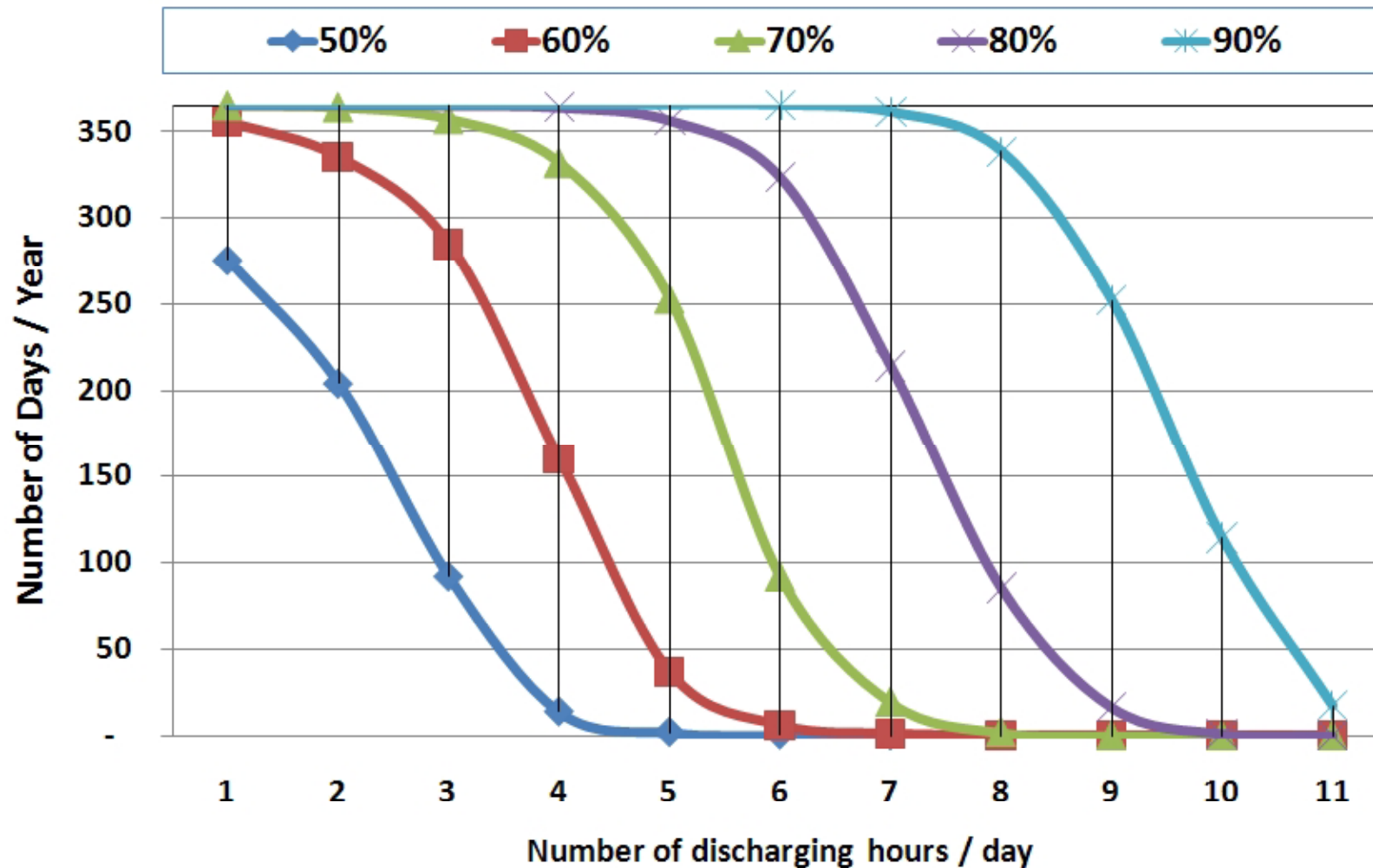


EES Selection: Discharge Time & System Power Rating





Round Trip Efficiency & EES Utilization





Factors Affecting EES Economics

➤ Market Design

❖ Access to various markets for

- ❖ energy,
- ❖ ancillary services
- ❖ capacity

❖ Generation Supply mix & Demand Curve

❖ Market size

❖ Locational factors

❖ Electric transmission network & interconnection

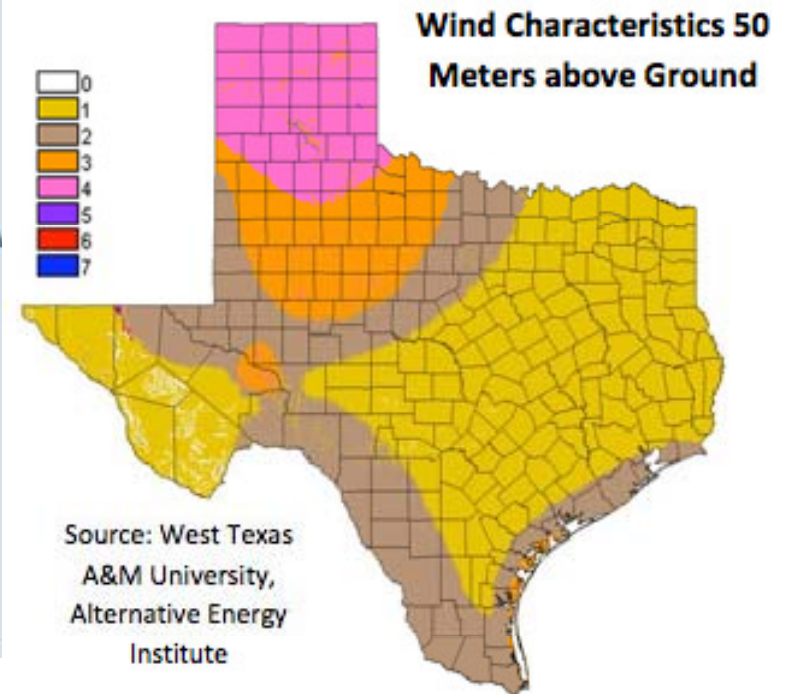
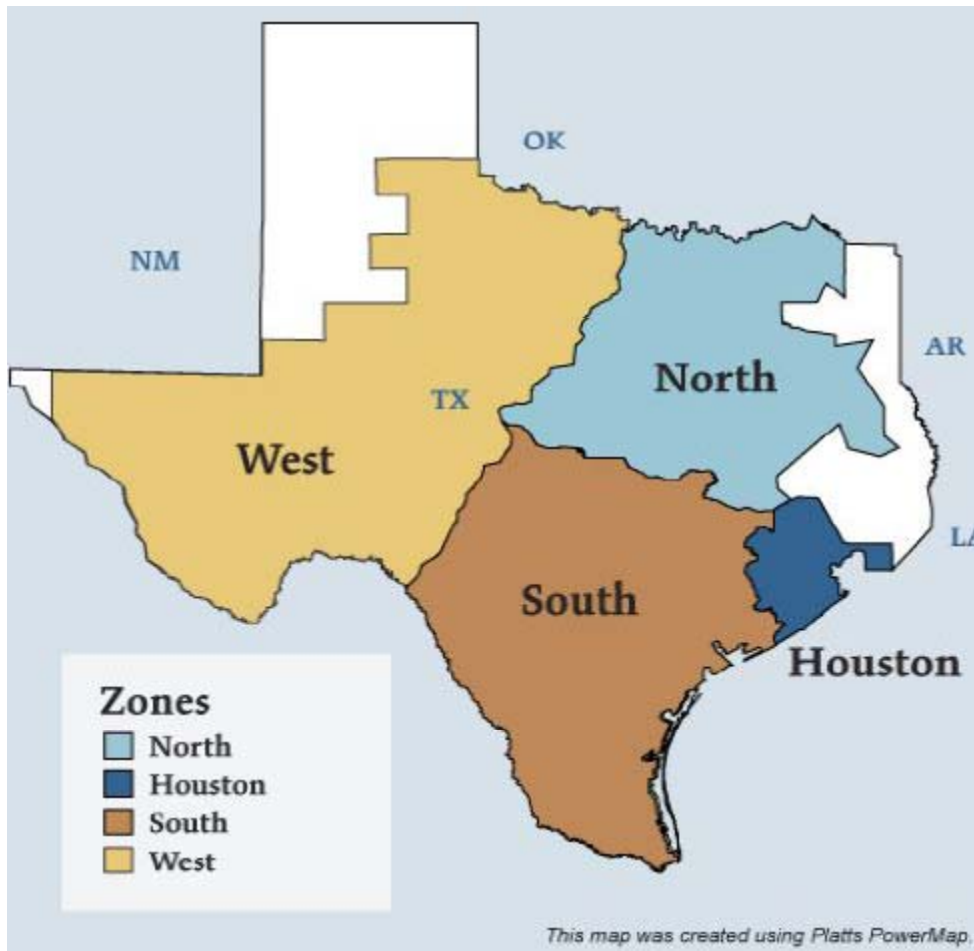


Recent changes in Market Designs in other ISOs

- FERC Orders
 - ❖ 890: open regulation markets to non-gen resources
 - ❖ 719: demand response and long term power contracts
- PJM & NYISO opened up ancillary service markets for demand side resources during 2007-08
- ISO-NE initiated pilot program for alternative technologies participation in regulation market
- Creation of a new category for ancillary services to remove barriers for energy limited resources
 - ❖ NYISO: Limited Energy Storage Resources (LESR)
 - ❖ MISO: Stored Energy Resource (SER)
- CAISO has initiated a stakeholder process for integrating non generation resources

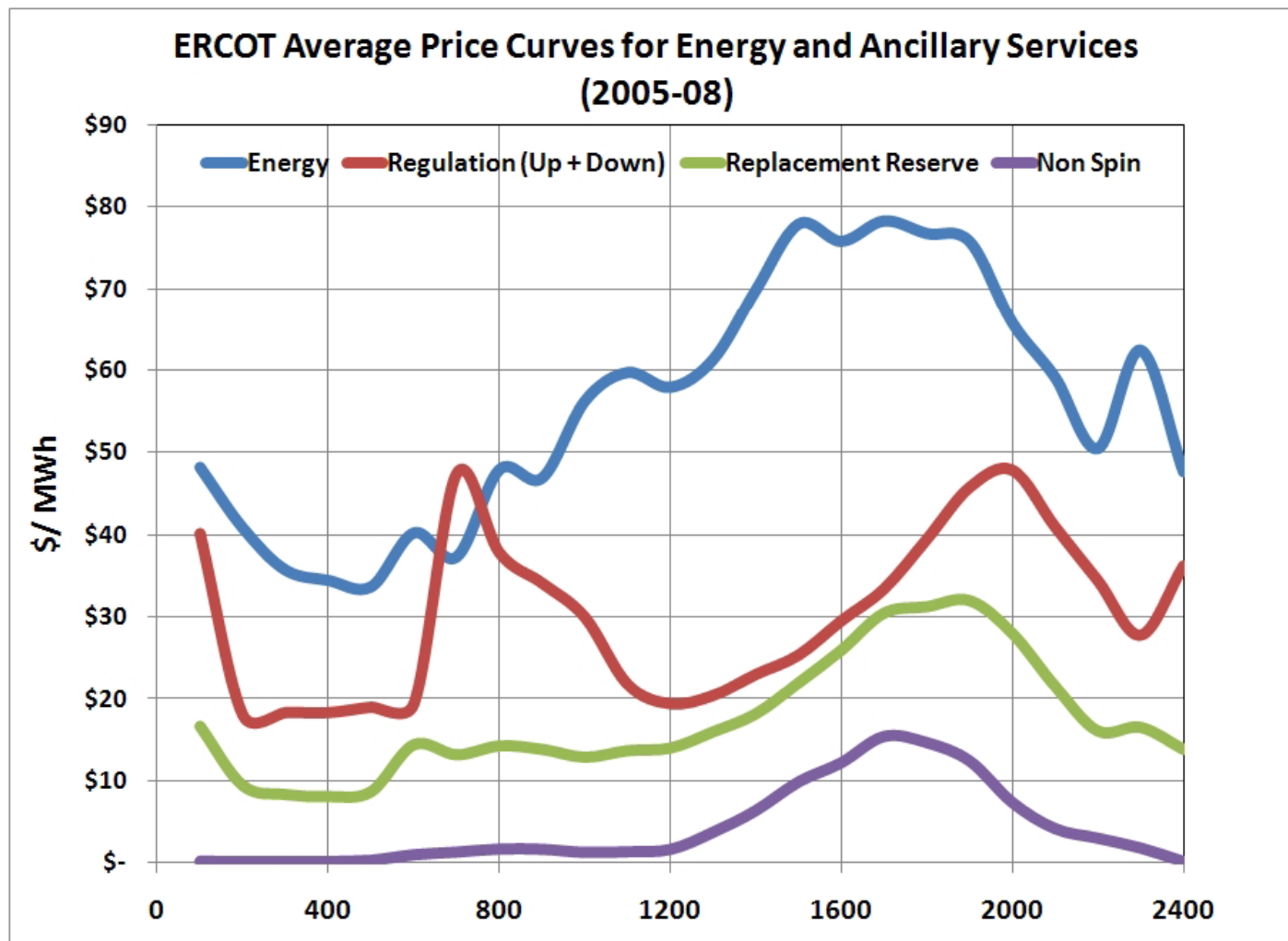


ERCOT: Location, Location, Location



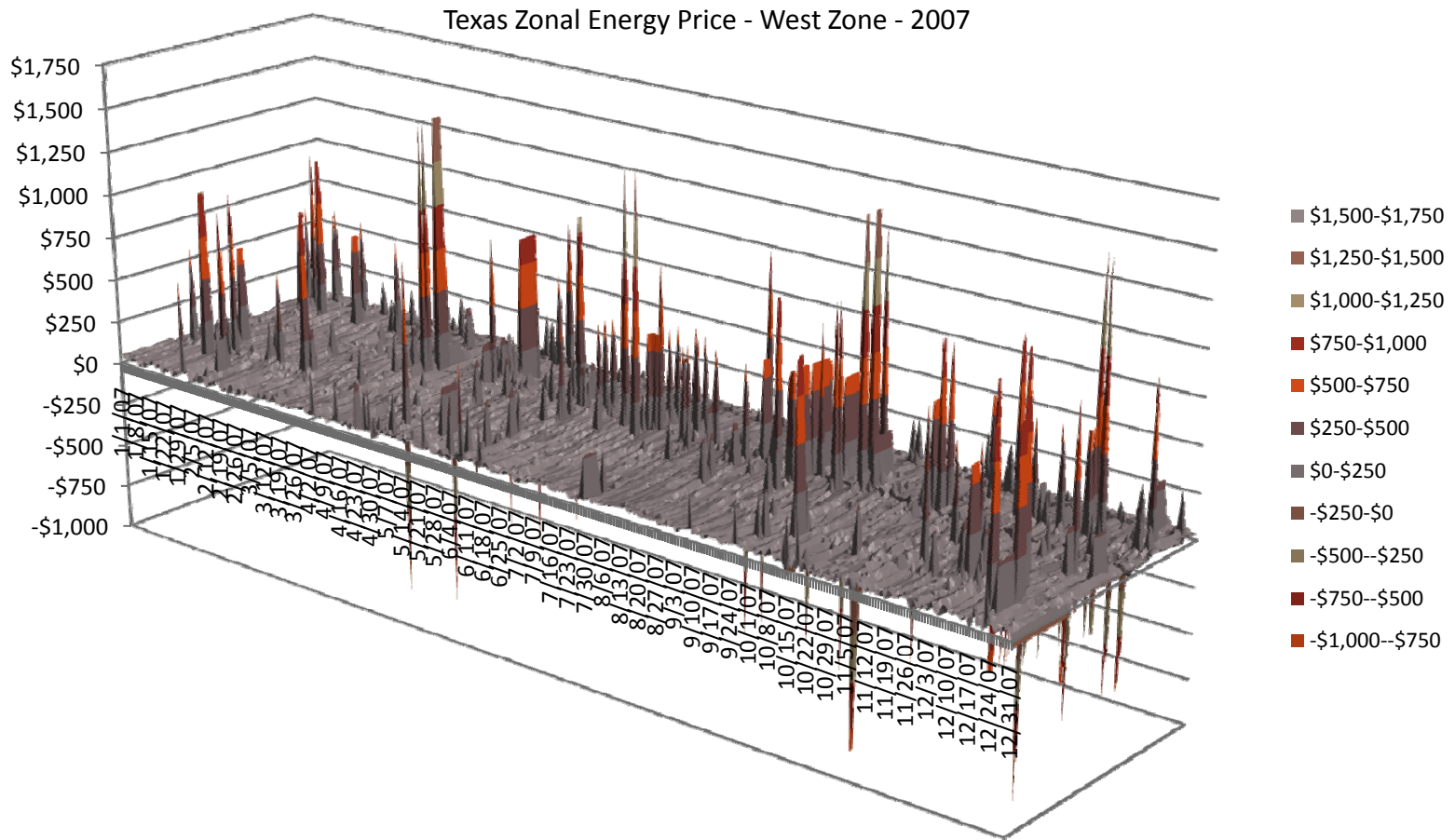


Energy & Ancillary Service Price Profiles



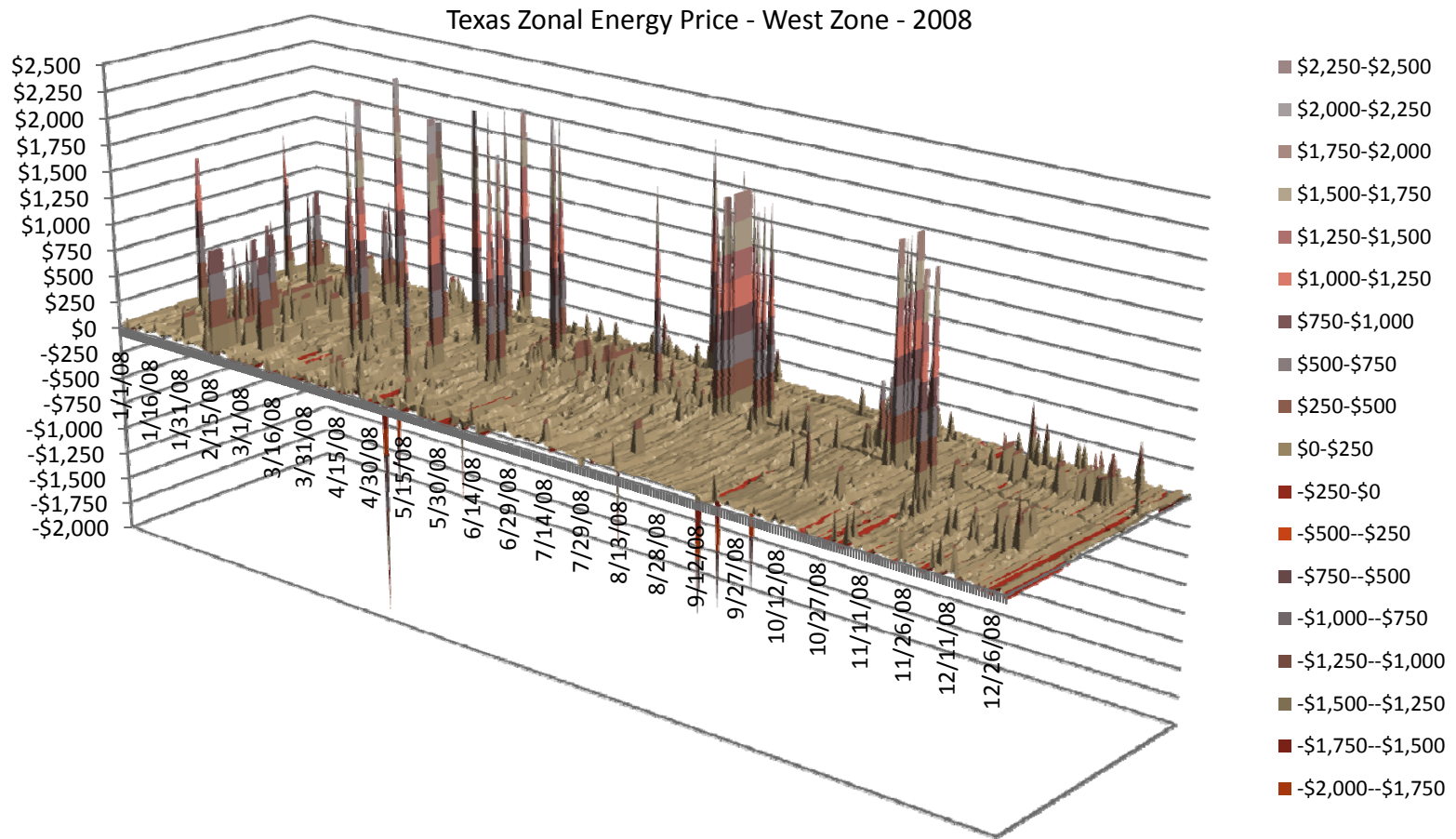


Texas Energy Prices – West Zone - 2007





Texas Energy Prices – West Zone - 2008





Growth of Wind in ERCOT

- **Existing wind generation nameplate capacity: 8,916 MW**
- **Expected to increase to 10,560 MW by 2013**
- **Only 8.7 percent of the wind generation nameplate capacity is included installed capacity, based on a study of the effective load-carrying capability (ELCC) of wind generation in the Region.**
- **Rapid wind ramps can present operational challenges, especially when combined with rapid load ramps**
 - ❖ **13 April 2008 – 1,610 MW up ramp in 30 minutes**
 - ❖ **01 April 2008 – 946 MW up ramp in 20 minutes**



Texas Policy Updates

- **Wind generation resources are expected to be more dispatchable**
- **For instance, WGRs are being expected to provide:**
 - ❖ **Better forecasting of their outputs**
 - ❖ **Governor response**
 - ❖ **Low voltage ride-through**
 - ❖ **Reactive power similar to that of thermal plants.**
- **In addition to traditional application of wind firming, EES could provide these additional ancillary services**

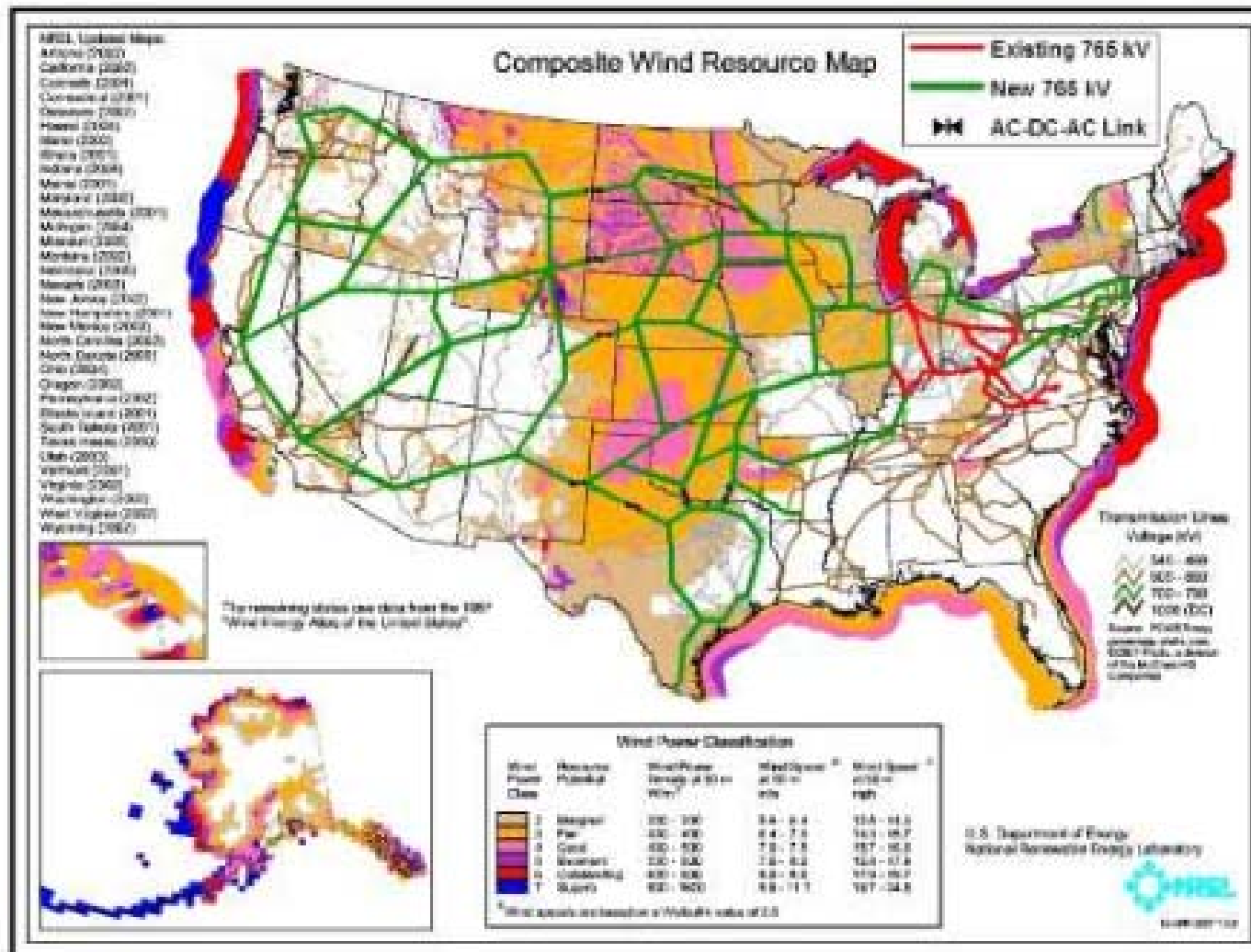


Texas Focus on Wind

- **PUCT's current focus is on wind – especially with respect to the transmission planned for the Competitive Renewable Energy Zones (CREZ).**
- **CREZ projects consist of \$4.9 B in new transmission to distribute 18,500 MW of wind energy to ERCOT markets by 2013.**
- **Currently 8,900 MW of Wind is bottled behind a 4,500 MW transmission limit.**



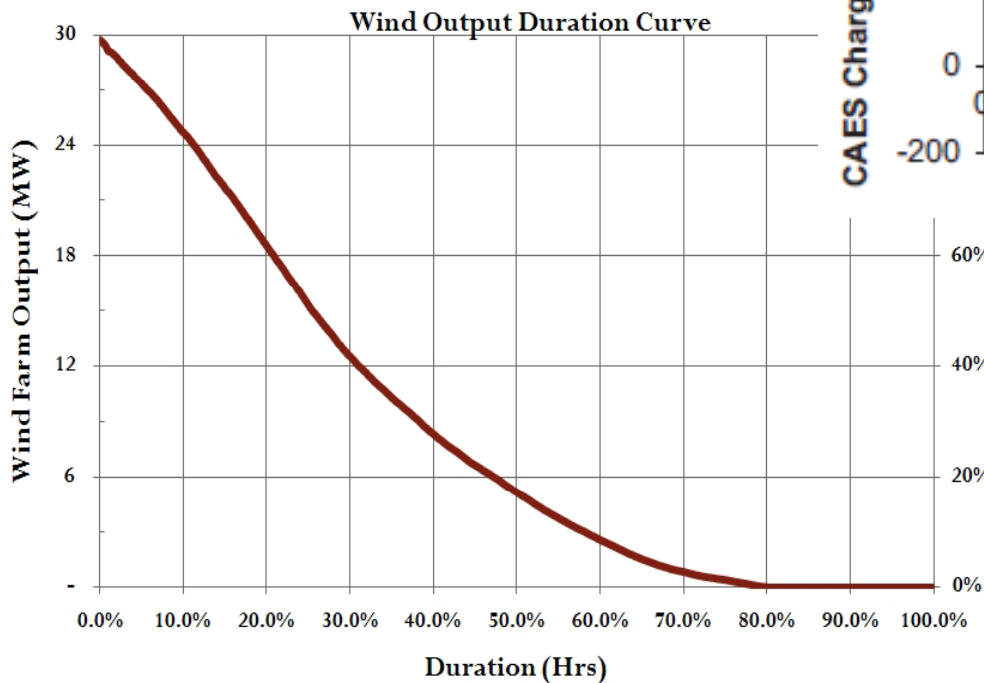
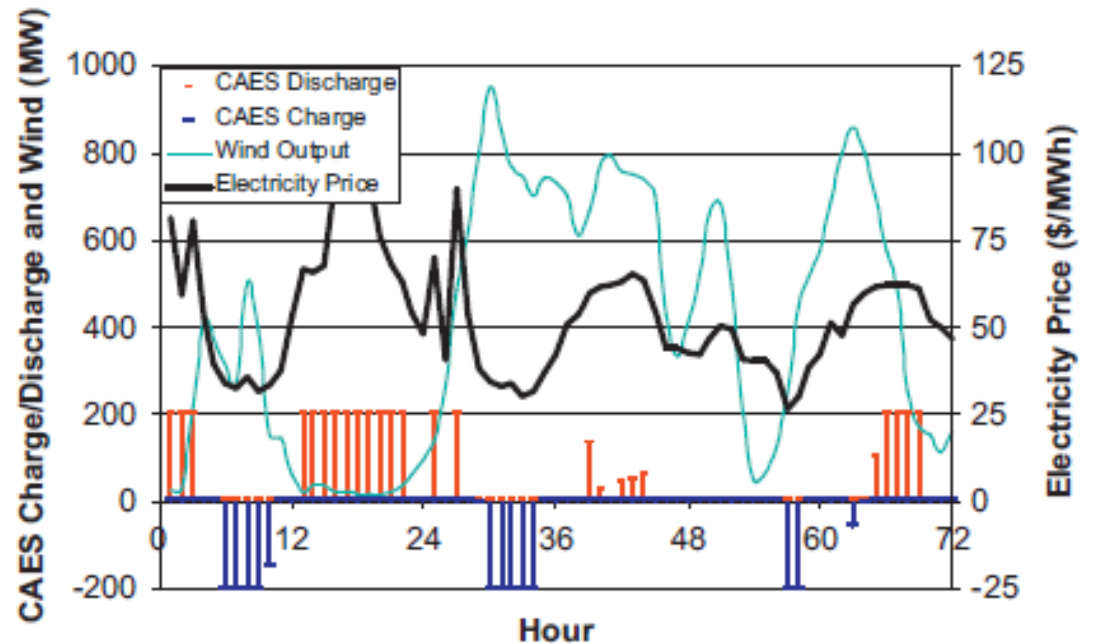
Proposed Transmission Upgrades for wind





Optimizing Transmission with EES

➤ Using CAES / Pumped Hydro for optimizing transmission capacity & energy arbitrage



Source: Dr. Paul Denholm, NREL 2009

➤ Using fast response EES for improving system stability & reliability



AEP Battery – A First for Storage in ERCOT

- **Two 2.4 MW NaS batteries are currently being installed at end of a 69kV radial line in ERCOT.**
- **The batteries will provide power to Presidio, Tx near the Mexican border during the day when the line is taken out of service for upgrading.**
- **Total battery installation cost is \$15,000,000.**
- **A PUCT decree designated this project as a transmission asset but the PUCT also deemed its approval as NOT setting a precedent for other energy storage projects.**



Duke Energy Storage Demonstration Project

- Duke has proposed a \$43.6 M project to deploy a 20 megawatt (MW) hybrid-energy storage system for Notrees Wind Farm at Goldsmith, TX
- This project is one of the recipients of the DOE Energy Storage Demonstration Grants of \$21.8 M.
- The project will demonstrate how energy storage and power storage technologies can help wind power systems address intermittency issues by optimizing the flow of energy.



Summary

- **ERCOT market presents significant opportunities for EES integration in grid.**
- **EES can participate in energy & ancillary services markets.**
- **The economic feasibility of EES will depend on factors including**
 - **Design parameters**
 - **Market Structure and location**
 - **Ability to capture multiple revenue streams**
 - **Financing**
 - **Environmental regulations**
- **For large scale integration of EES it is important that technology developers and market participants, as well as potential investors understand these factor while determining value proposition of EES for different applications in ERCOT.**



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QUESTIONS ???

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