Flexible Transmission and Storage to Manage Wind

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PUBLIC UTILITY COMMISSION OF TEXAS

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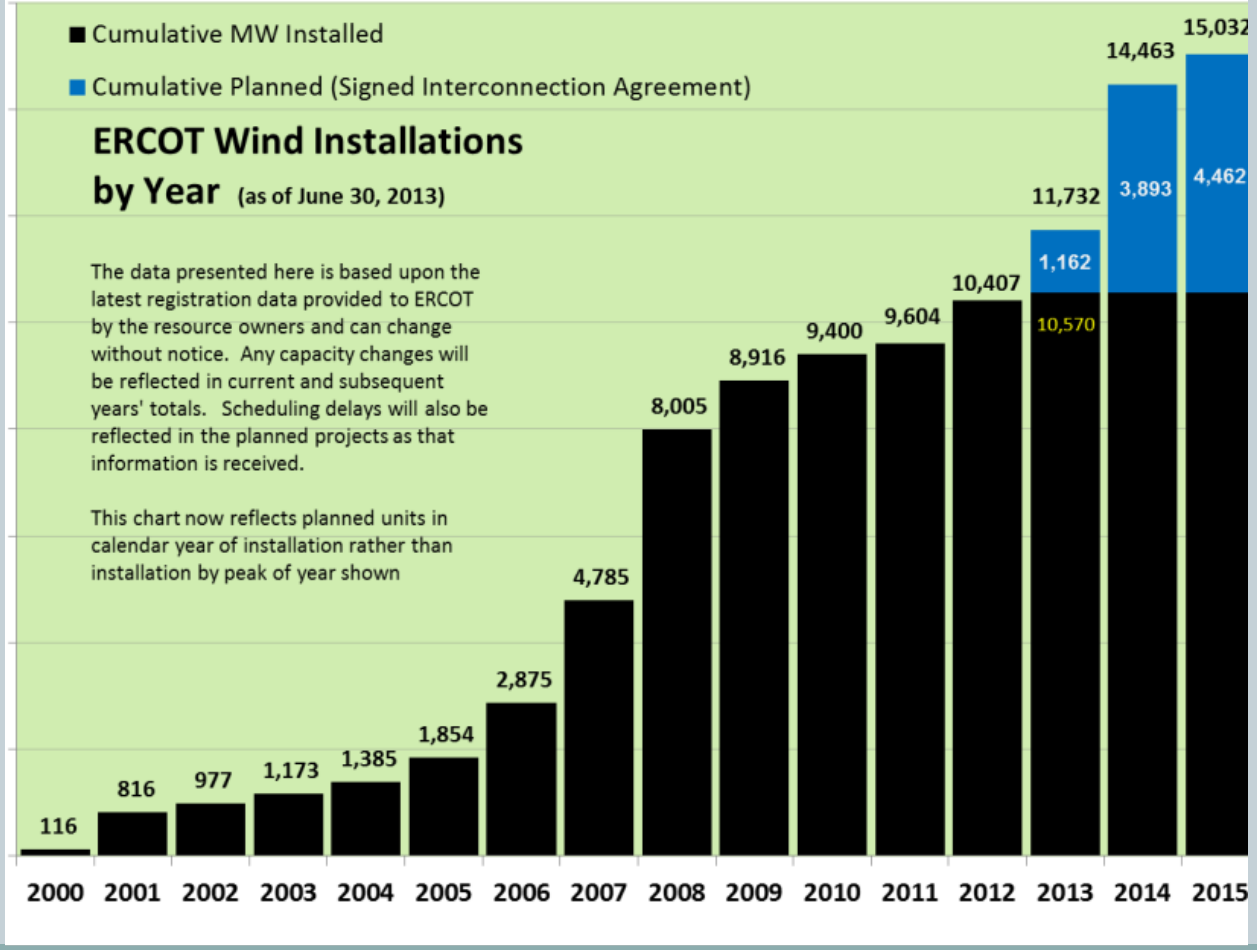
Introduction

- ERCOT –
  - Electricity Reliability Council of Texas – Operates grid and wholesale market.
  - ERCOT Region - $40B electric market that covers 75% of Texas land region and 85% of the state's load.
  - ERCOT is NOT synchronously interconnected to any other grid; only connected through 5 DC ties ranging from 36 MW to 600 MW capacity.
  - Loads pay for all transmission improvements based on a pro rata share of coincident peak load.
  - Peak load 68,379 MW on August 3, 2011.
  - Current installed capacity of wind: 10.6 GW.
  - Wind generation record of 9,481 MW on February 13, 2013, 28% of total load.

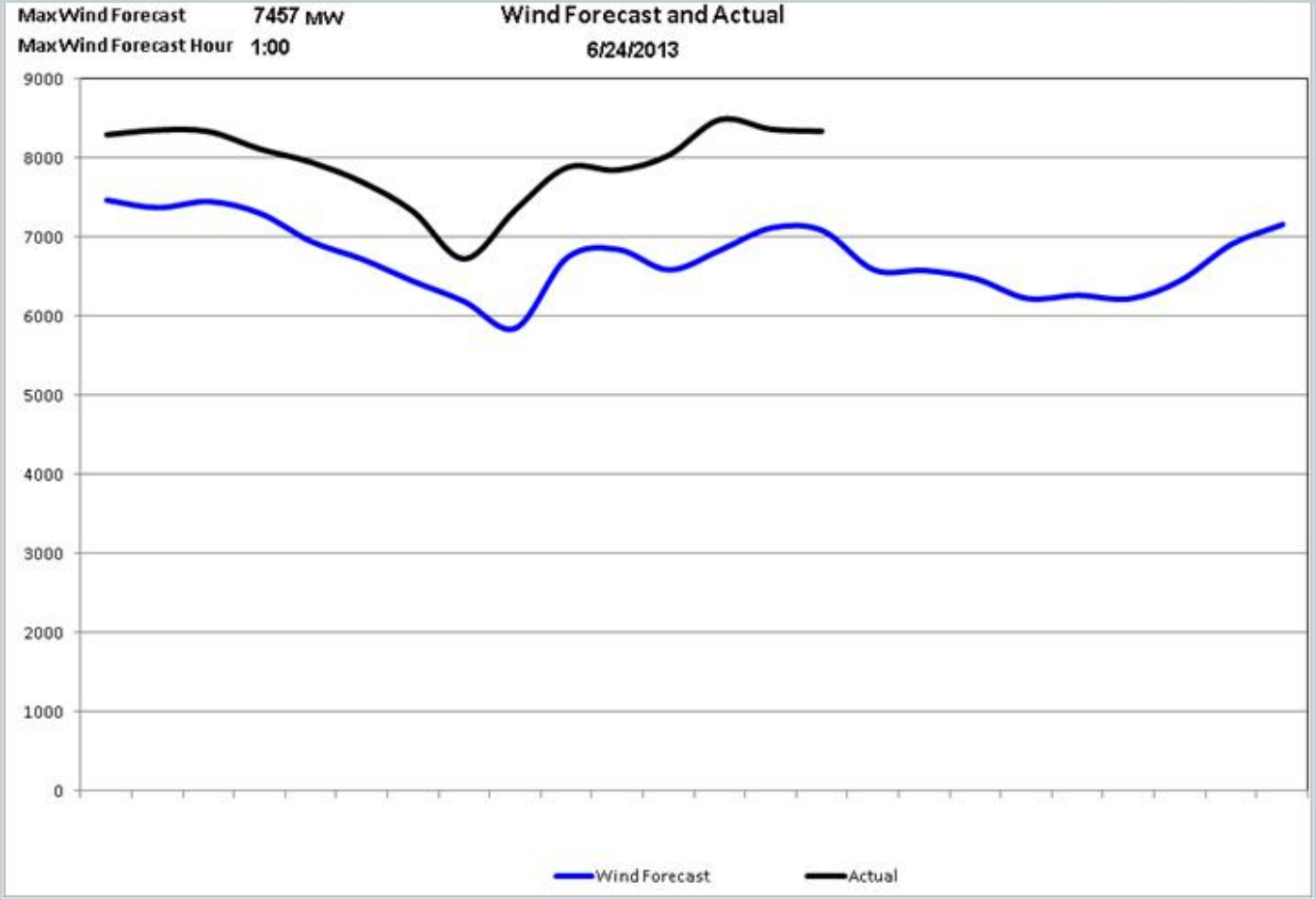
Introduction

- Today I will discuss wind and how we manage it in Texas.
  - Transmission upgrades.
  - New technologies used to operate the grid.
    - Macomber Map.
    - Nodal network.
  - Role of storage in balancing and improving grid stability.

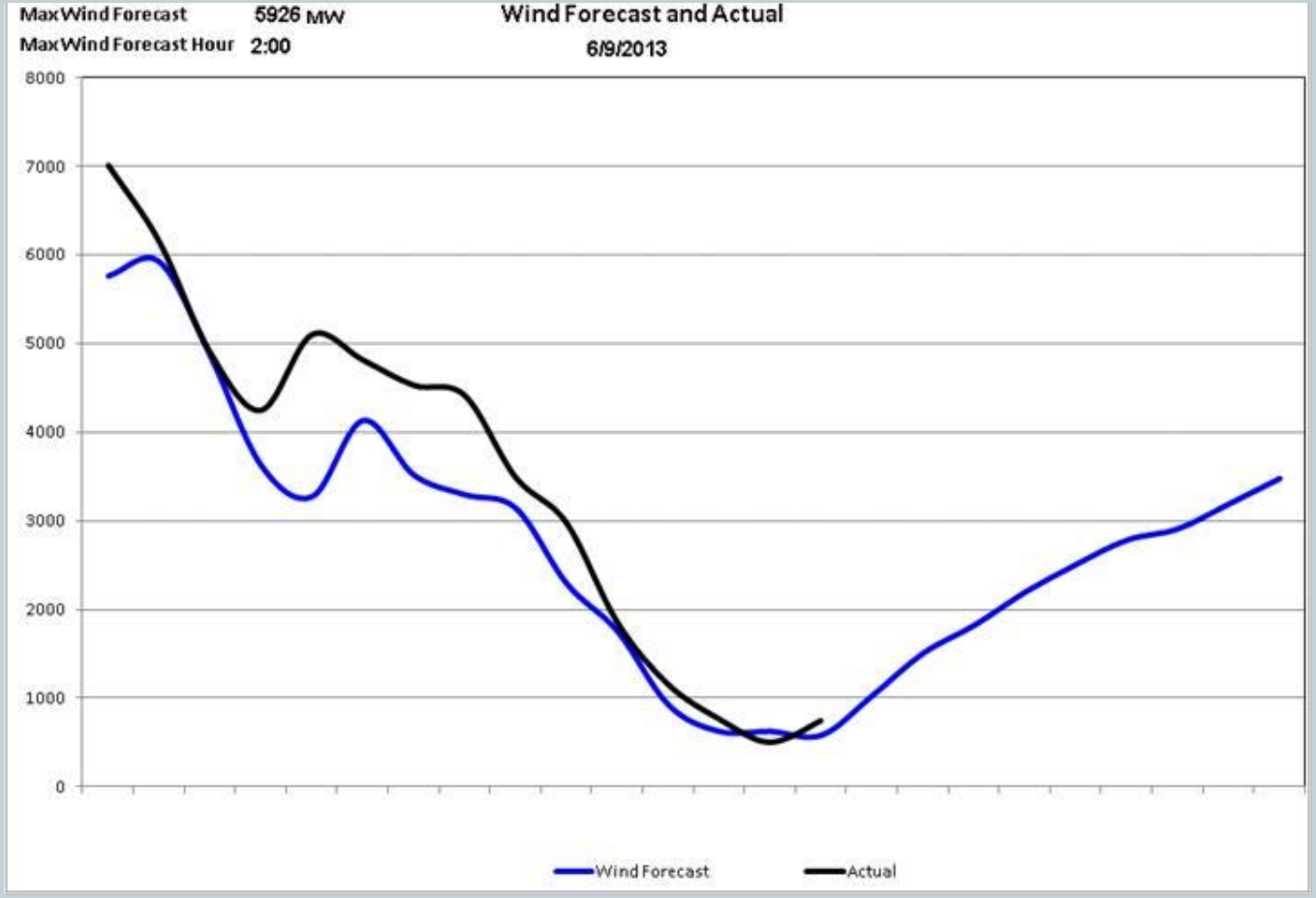
ERCOT Wind Generation



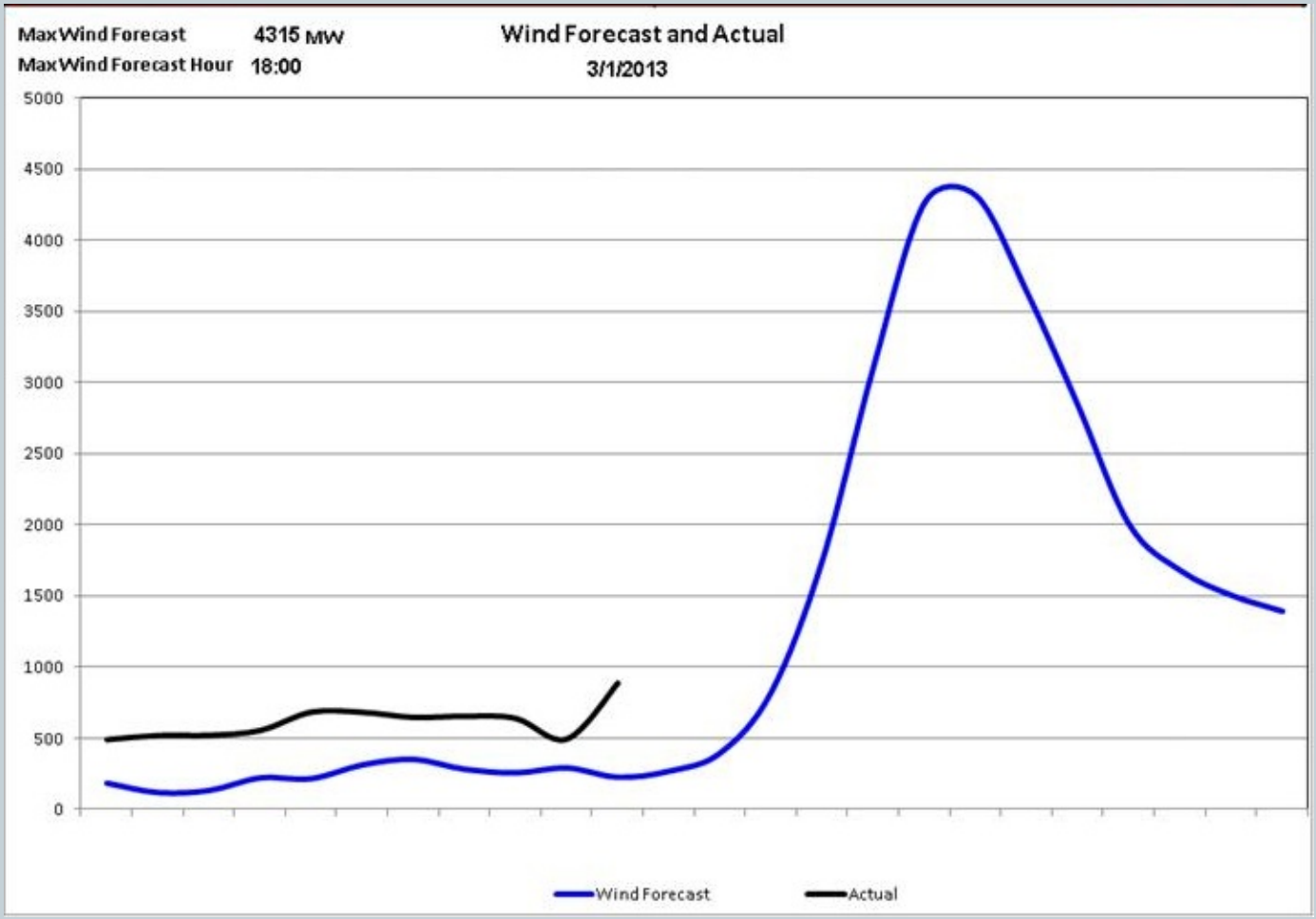
The Challenge of Wind: Sometimes it looks like this. Steady production.



And sometimes like this, a 6,500 MW reduction.

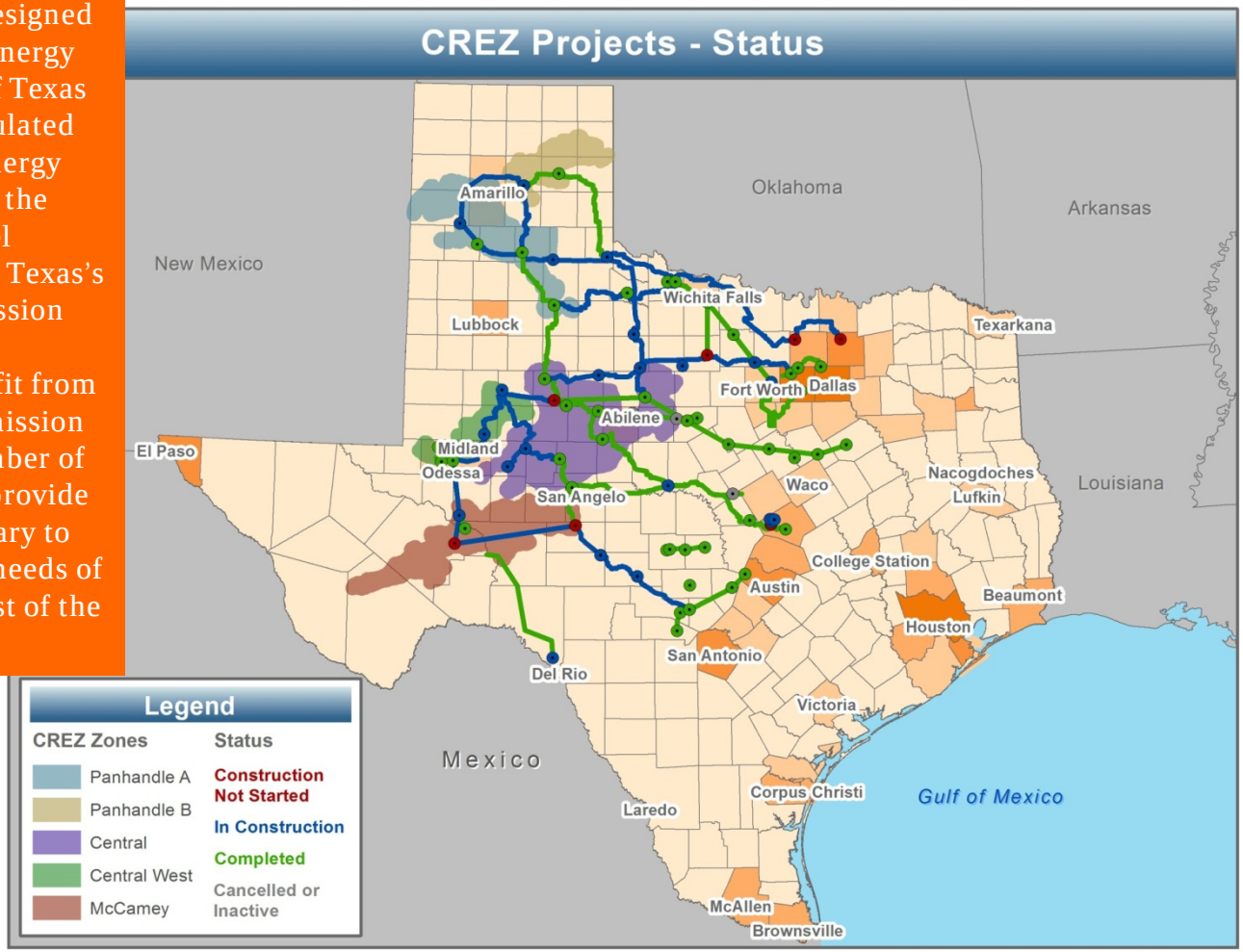


And sometimes a 4,500 MW increase in 4 hours, followed by a 3,500MW reduction in less than 6 hours.



Competitive Renewable Energy Zone (CREZ) and the ERCOT GRID

- CREZ is primarily designed to move renewable energy from remote parts of Texas to more heavily populated areas. More wind energy will further diversify the Texas generation fuel portfolio. Because of Texas's open access transmission network, non-wind generators will benefit from the increased transmission capacity, too. A number of CREZ projects also provide transmission necessary to meet the long-term needs of the growing area west of the I-35 corridor.



Status of CREZ Program

Originally anticipated in 2008:

- 2,963 miles of CREZ transmission lines.
- $4.98 B.
- 109 projects assigned to 7 transmission utilities.

Today:

- 2,643 miles of CREZ transmission lines completed out of 3,595 total as permitted and sited by PUCT.
- $5.95 B spent out of $6.82 B expected.
- 186 projects.
- Ultimately will have capacity to transmit 18,450 MW of wind power and other generation to metropolitan areas of the state.

ERCOT Regular Transmission Investment

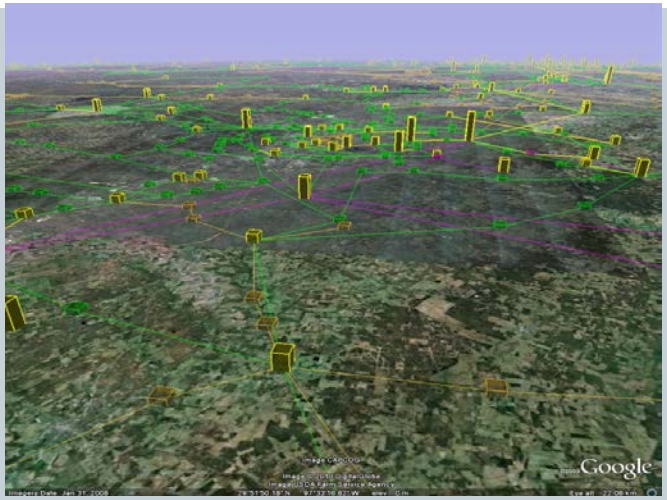
- In ERCOT we have continuously expanded and modernized the existing grid.
- Since 2006, over $5.1B have been invested in non-CREZ transmission projects.
  - 2006 – 2008: $1.61B.
  - 2009 – 2010: $2.14B.
  - 2011 – Present: $1.35B.

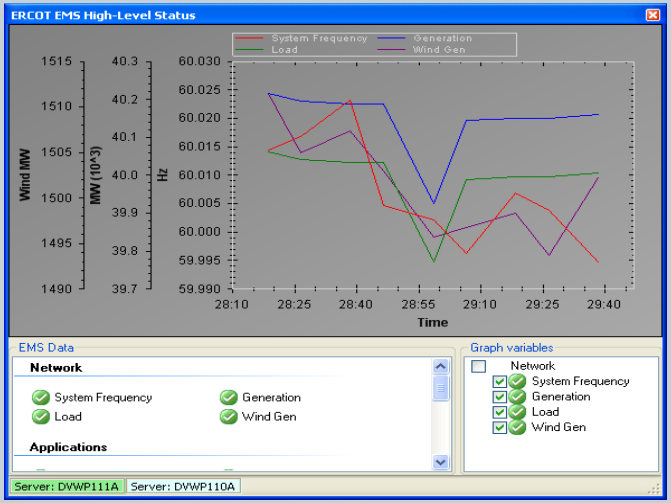
Transmission Utilization Technologies

- The Macomber Map.
  - Developed in house by ERCOT.
  - Utilized by both FERC and NERC.
  - Continuously used in grid operation by ERCOT operators.
  - Used as a simulator to train generator and transmission personnel (600 over a seven week period) each year in black start operations.
- The ERCOT Nodal grid.
  - Implemented in December 2010.
  - Produced immediate increases in grid utilization and corresponding reductions in congestion across the grid.

The Macomber Map

- **Visualization tool used by ERCOT operators for situational awareness.**
- **Allows operators to see all data for single element (e.g., a generator), across applications and systems.**
- **Used for many ERCOT applications:**
  - Control room
  - Network modeling group
  - Congestion Revenue Rights
  - Market Information System (contour map of LMPs and SPPs)
  - Training
  - Engineering
- **Developed in-house; named for one of the developers who passed away in 2008.**



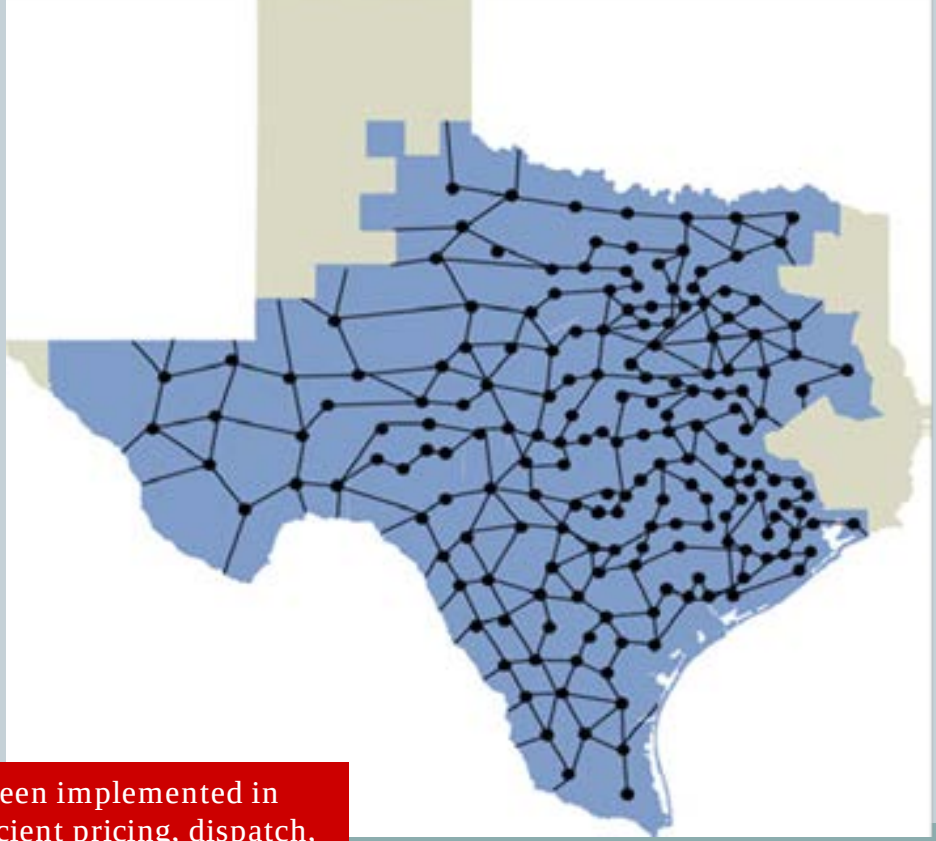


The Macomber Map, continued

- **Core functionality:**
  - Integrates numerous data sources in the control room -- network model, real-time and study energy data, market data -- across applications and systems.
  - “Google” approach to the transmission grid allows operators to locate elements by a series of keywords (e.g., name, county, voltage, owner).
  - Links all transmission elements to a point on the map, to prevent alarm and dust storms.
  - Pyramid approach allows operators to drill down quickly from high-level to detailed data rapidly: “forest and trees.”
  - Consistent positional awareness, regardless of detail level Linking equipment with ownership and operatorship information for rapid response.
  - When possible, linking problems with potential solutions.
  - Allows operators to aggregate data within regions (e.g., Hurricane Dolly).

ERCOT NODAL GRID

Real-Time Market (RTM) ERCOT controls the RTM by running a Security Constrained Economic Dispatch (SCED) at least every five minutes, using offers by individual resources and actual shift factors by each resource on each transmission element, while considering conditions on the transmission network. As the name implies, SCED determines the most economical dispatch of individual resources across the grid. The distinction between zonal and local congestion disappears as all congestion is managed using individual resources instead of portfolios.

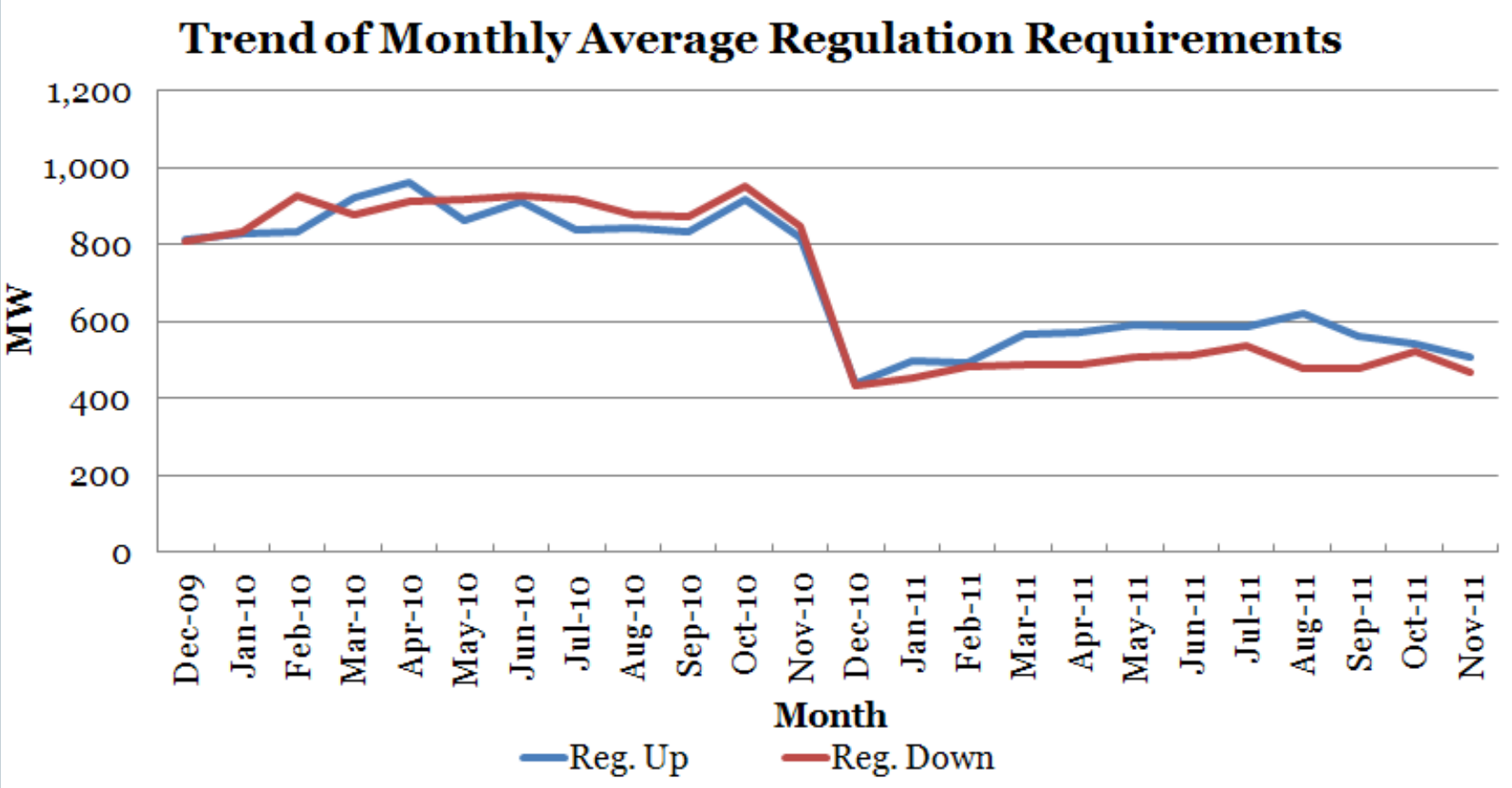


The nodal market design has been implemented in ERCOT, allowing for more efficient pricing, dispatch, and siting of generation.

Real-Time/SCED

- Overall – System operator has greater transparency to the system conditions which leads to greater efficiency.
- Improved Ancillary Service monitoring.
- Ability to deploy Non-spin Reserve Service to specific Resources.
- Transparency of Resource providing services.
- Resource specific management of congestion.
- Transition from 15 to 5 minute dispatch.
- Allow quicker response to system volatility.
- Load, wind, forced outages, etc…
- Quicker response time in managing congestion.
- Reduction in requirements for Regulation Reserve Service.

Real-Time/SCED



Procuring ~40% less Regulation in Nodal as was required in Zonal.

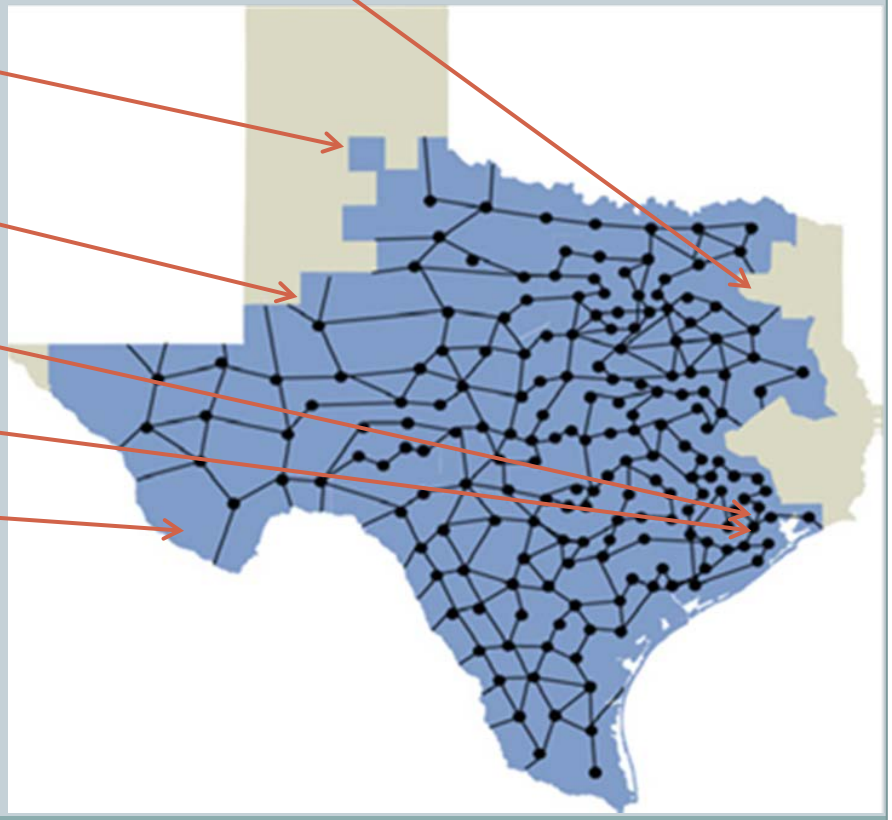
Increased Utilization of System: Example-the West-North Stability Limit

- **ERCOT has been able to more efficiently utilize the physical capability of the West-North Stability Limit.**
  - The grid was operated between 80% and 90% of its capacity at the end of 2011, as compared to ~64% on during 2010 Zonal operation.
  - The nodal market allowed significantly more electricity to flow by decongesting the choke points.
  - This allows more wind energy to be dispatched and thus provided an increase in grid utilization.

Energy storage options

Total Planned: 1,017 MW, Operational: 42 MW.

- 317 MW Apex CAES storage plant approximately $350M - $400M.
- 270 MW Chamisa CAES at Tulia.
- 36MW Notrees battery storage
  Duke energy approximately $44M.
- 40MW Deepwater ES battery storage.
- 2MW Project Redstone AES.
- 4MW Presidio battery.
- Two other confidential projects of 290 MW.



ERCOT Energy Storage Projects

- Currently Operational Energy Storage Facilities:
  - Project Redstone (AES), a 2 MW facility in operation since 2010 (behind the meter).
  - NoTrees (Extreme Power and Duke Energy), a 36 MW facility in operation since December 2012 (in Winkler County).
    - Participant in ERCOT's Fast-Responding Regulation Service (FRRS) Pilot.
    - A form of Regulation Service requiring resources to respond within 60 cycles of an instruction or triggering event.
    - When providing FRRS, pulls or discharges energy to help maintain ERCOT system frequency.
  - Presidio battery storage 4 MW (Electric Transmission Texas.

- Planned Energy Storage Facilities:
  - Deepwater Energy Storage (AES).
    - 40 MW.
    - Battery.
    - July 2013.
    - Included in the Dec. 2012 CDR.
  - APEX CAES 317 MW located in Tennessee Colony, Texas.
  - Chamisa CAES 270 MW located in Tulia, Texas.

- Two other confidential projects:
  - Total of 290 MW.
  - 2014 and 2015.

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