



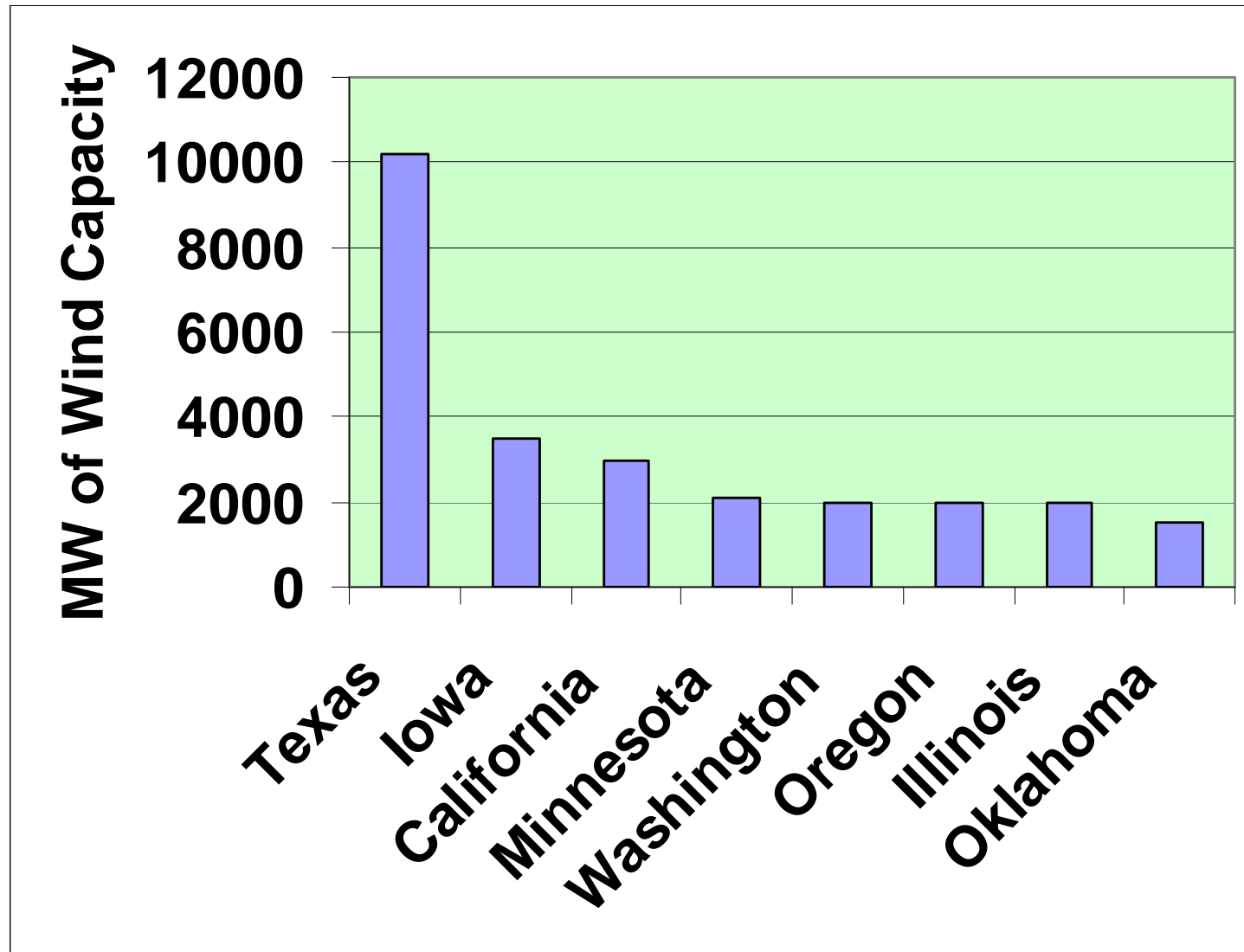
Wind Energy in Texas Lessons Learned

Mark Kapner, PE

Austin Energy

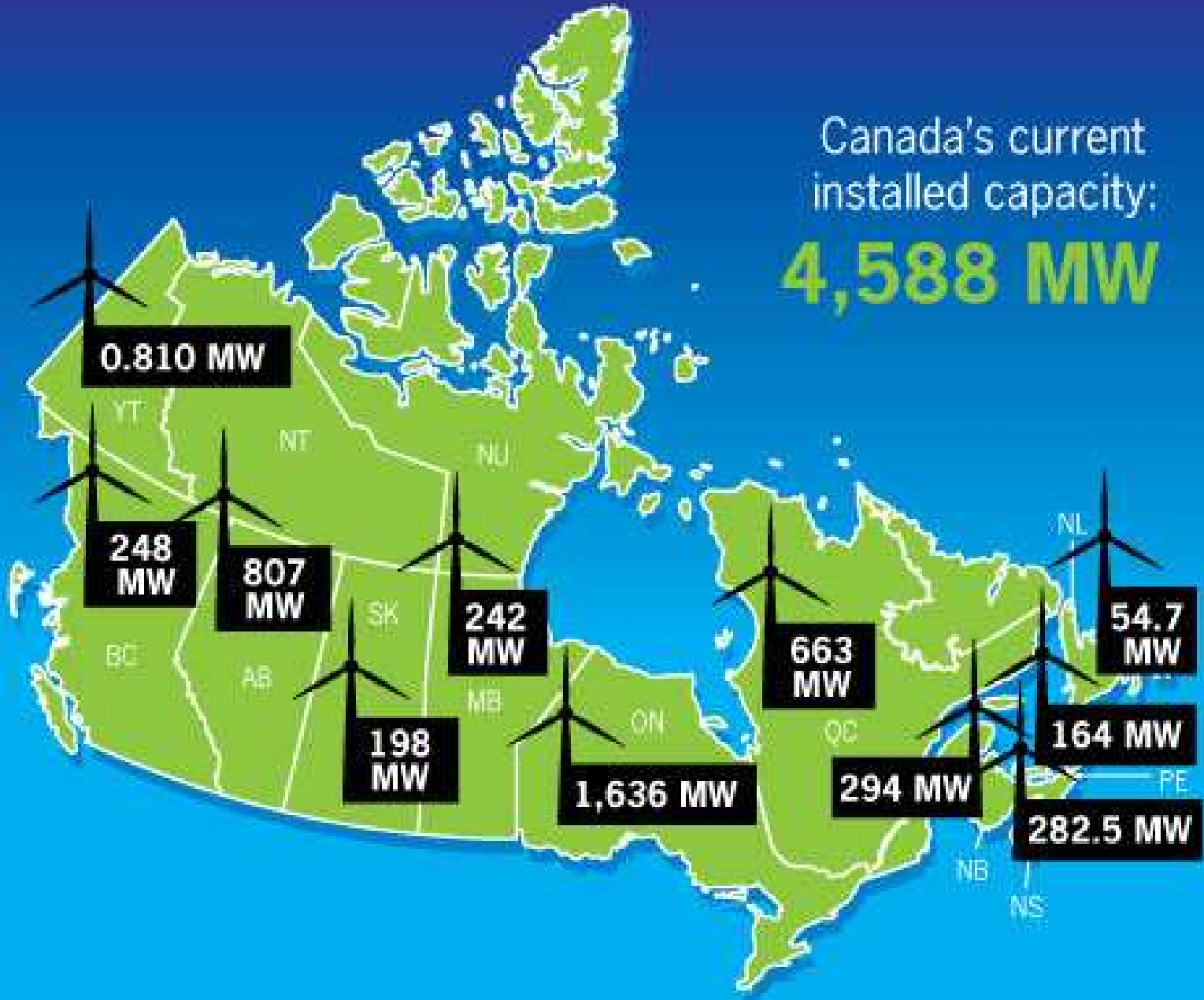
May 25, 2011

Installed Wind Capacity Top 10 States



Canada's current
installed capacity:

4,588 MW

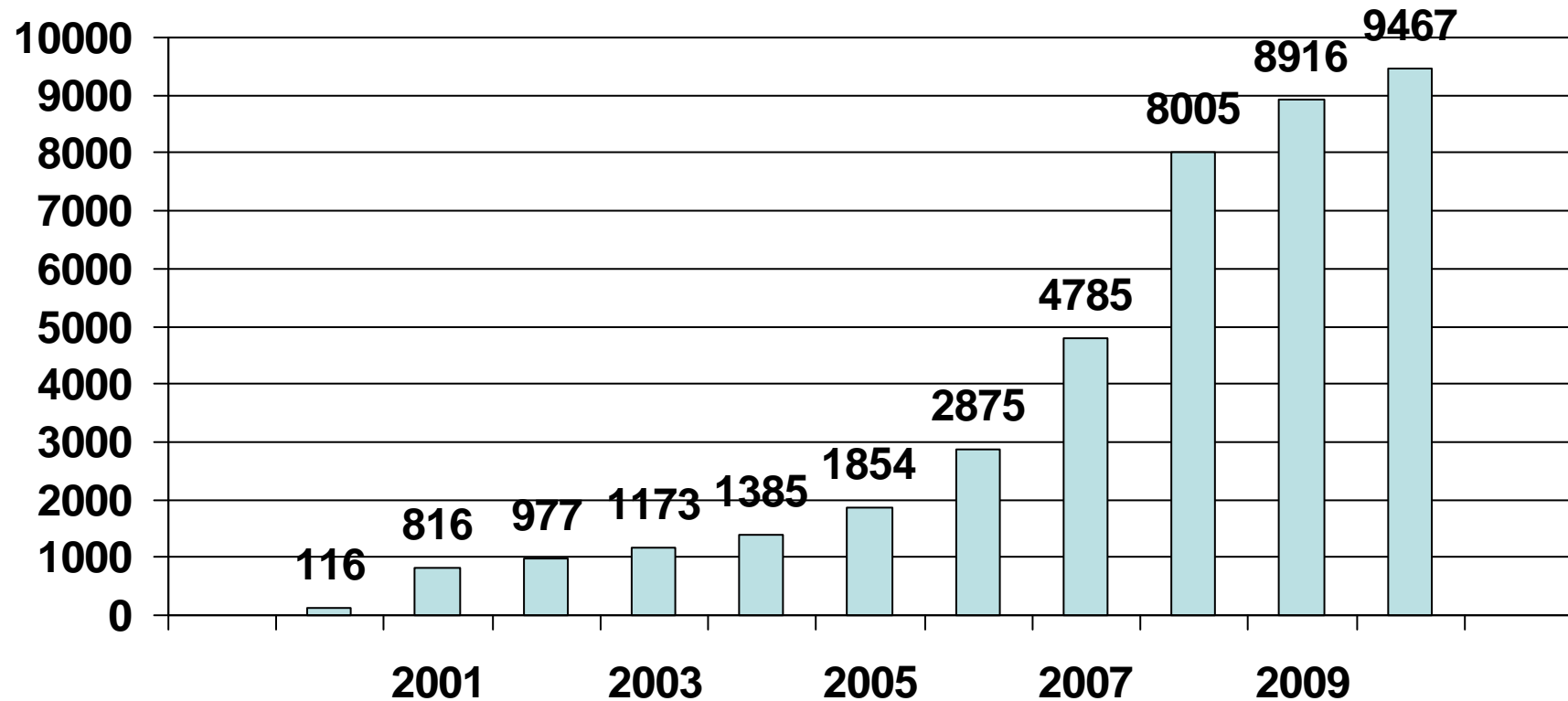




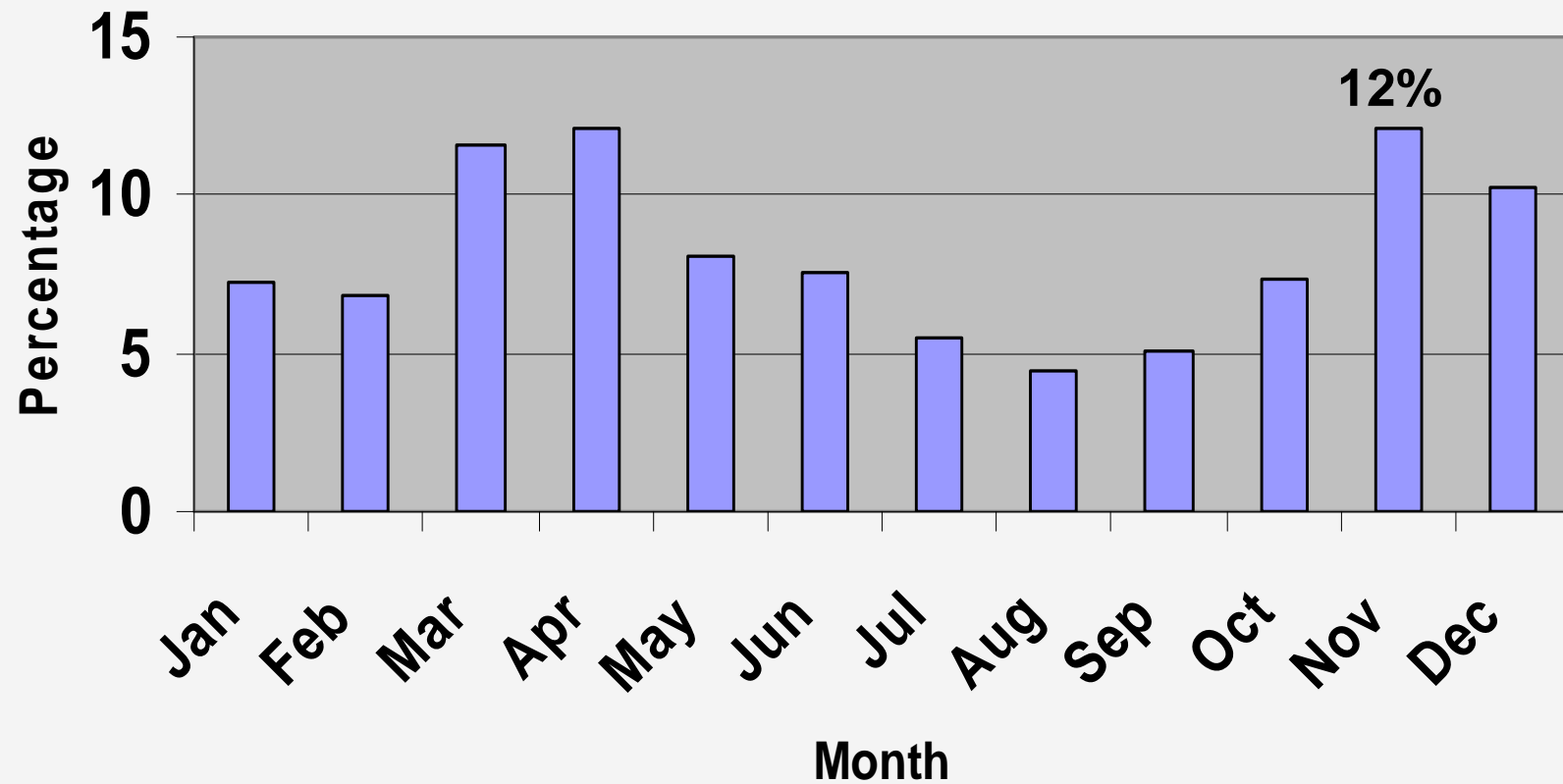
Wind Energy in Texas

- **Historic Growth & Current Generation Mix**
- **Factors that Contributed to Dramatic Expansion of Wind**
- **Impact of Wind on System Operations**
- **Adding Transmission to Accommodate More Wind – Policy Initiatives**

Growth of Texas Wind Generation (ERCOT Only)



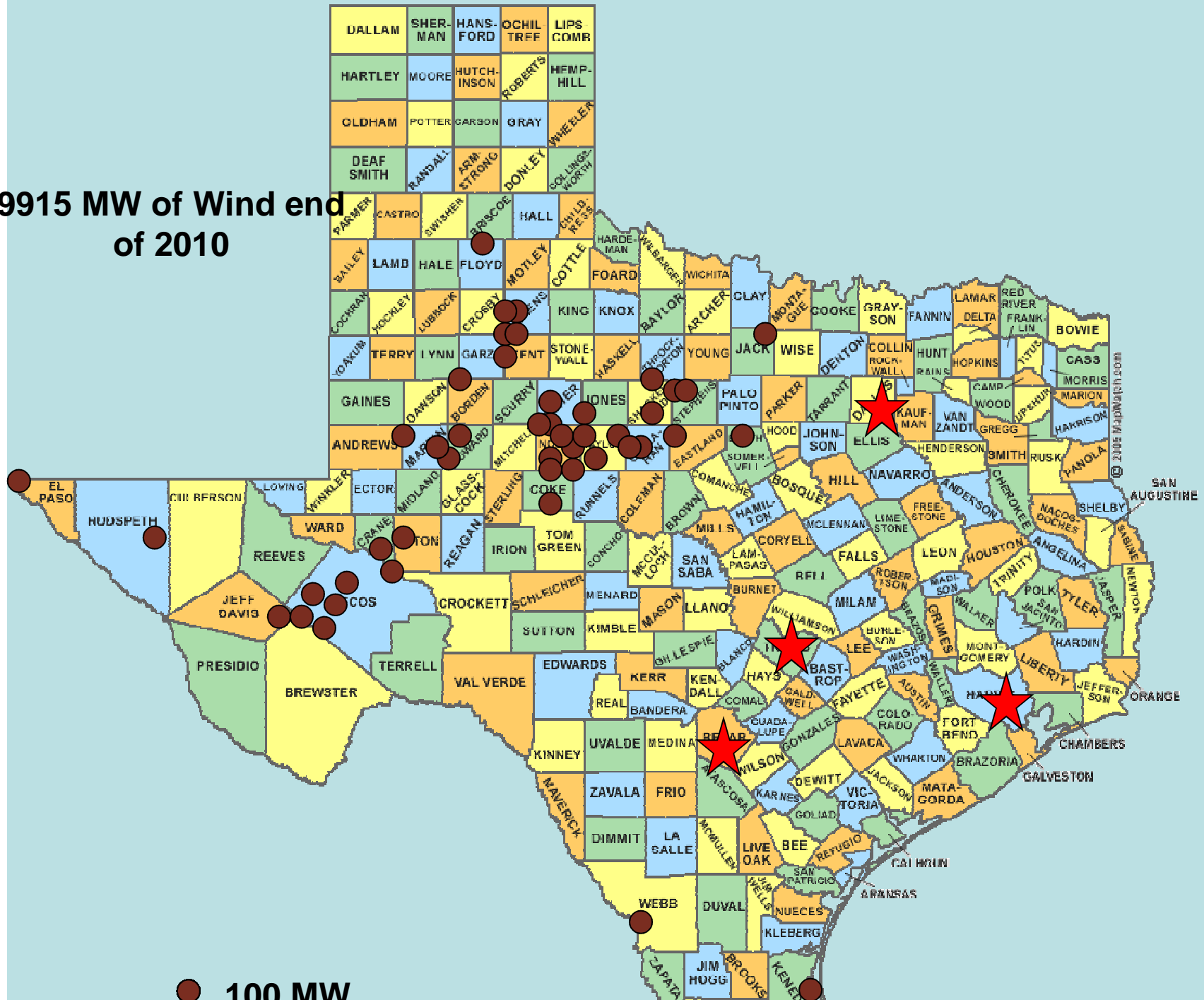
Monthly Energy from Wind as a Percentage of Total ERCOT Energy Production



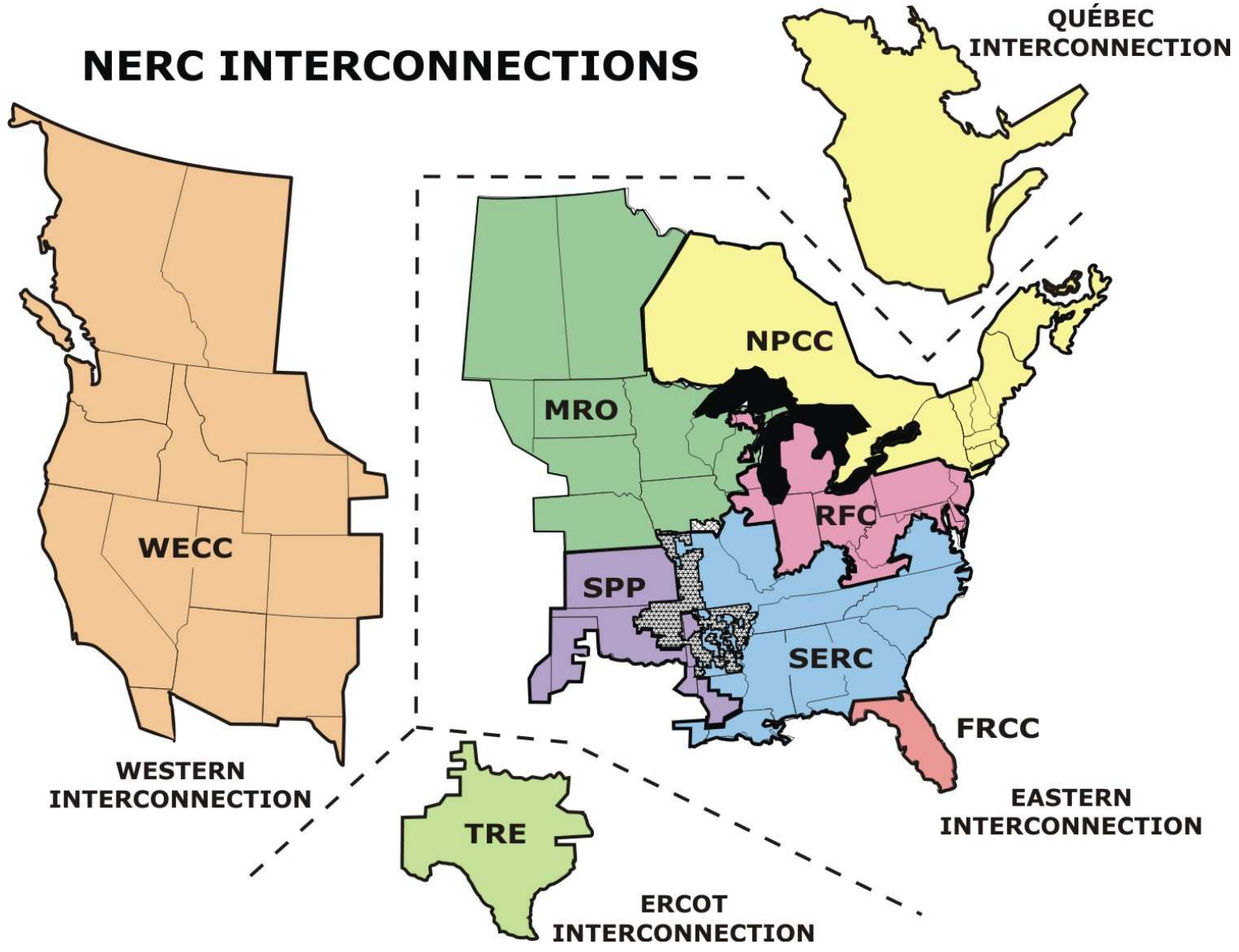
Wind Factoids

- **On December 11, 2010 at 7 AM ERCOT set a record for instantaneous wind generation of 7227 MW, which was 26% of the load at that time.**
- **6050 MW of additional wind capacity approved interconnection**
- **28,000 MW under study for interconnection**
- **Each 1000 MW of wind added reduced the MCPE in the balancing market by \$2.40 per MWH**

9915 MW of Wind end
of 2010

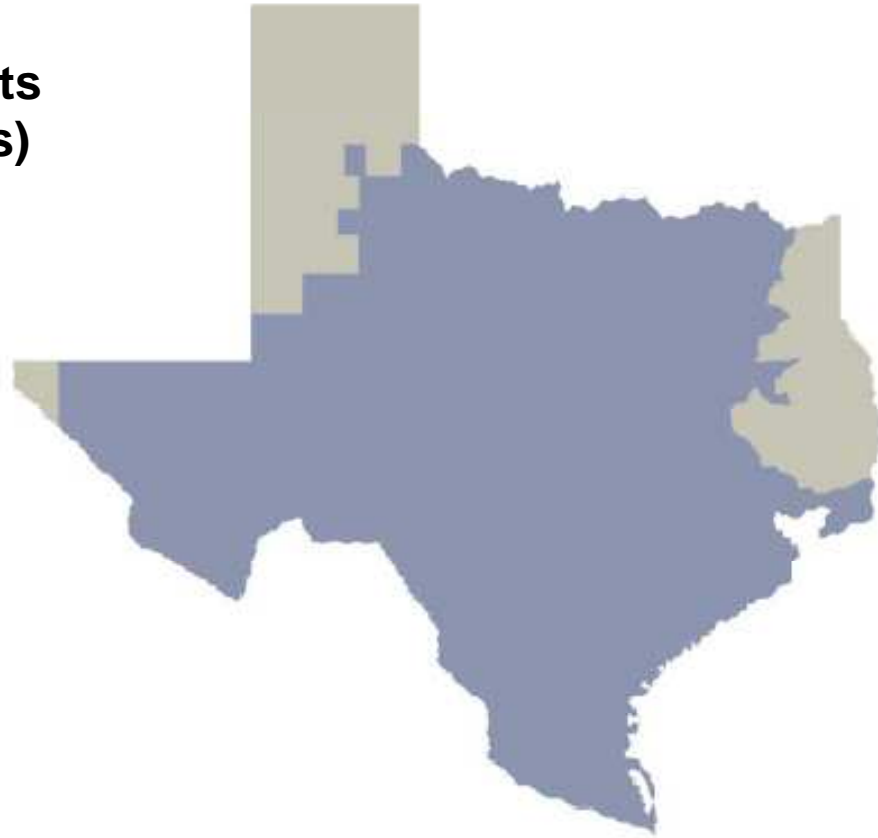


NERC INTERCONNECTIONS



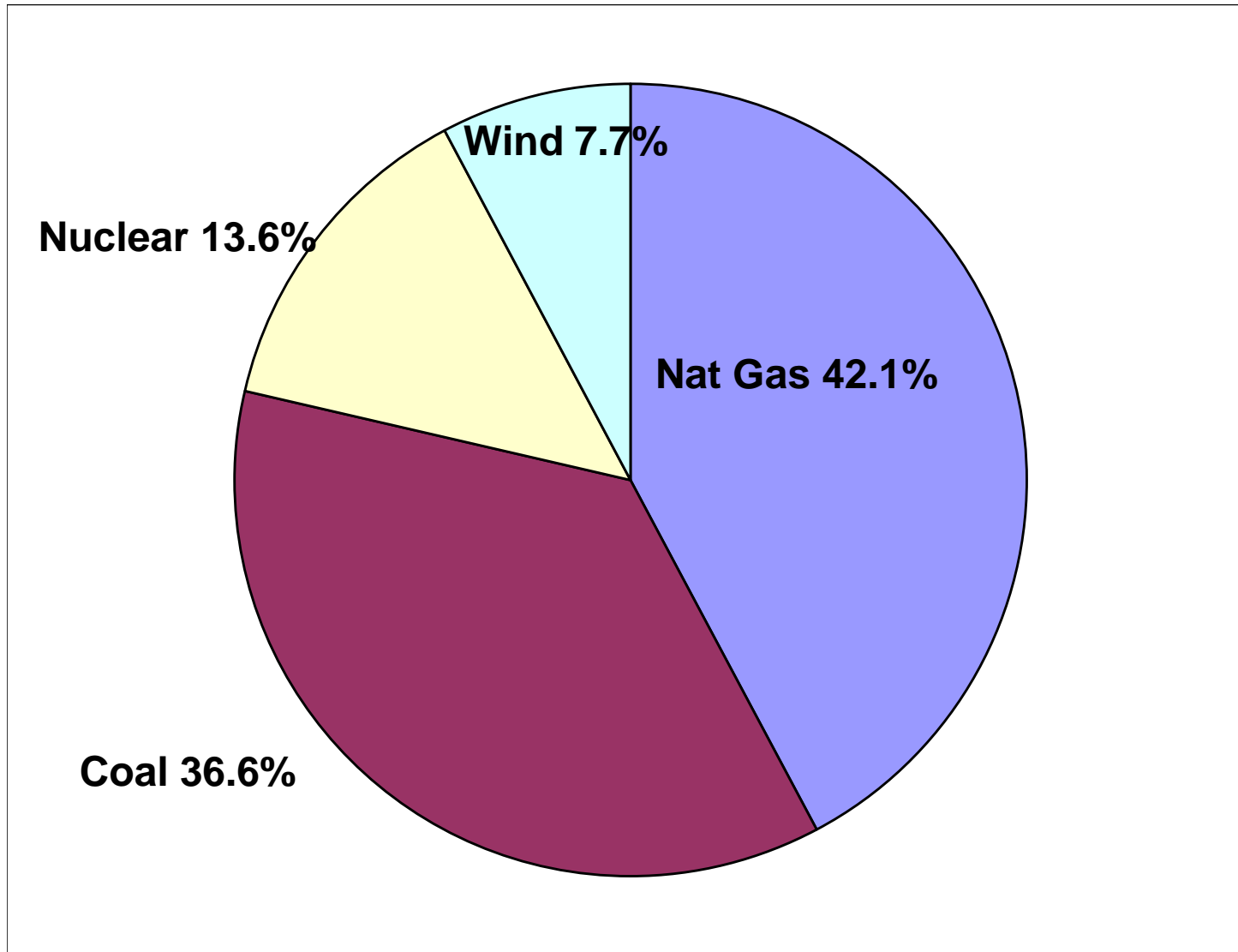
Peak Demand 65.8 GW
85% of Texas Load
319 Million MWHs
22 Million people
550 Generating Units
(incl 72 Wind Farms)

ERCOT



ERCOT Generation by Type

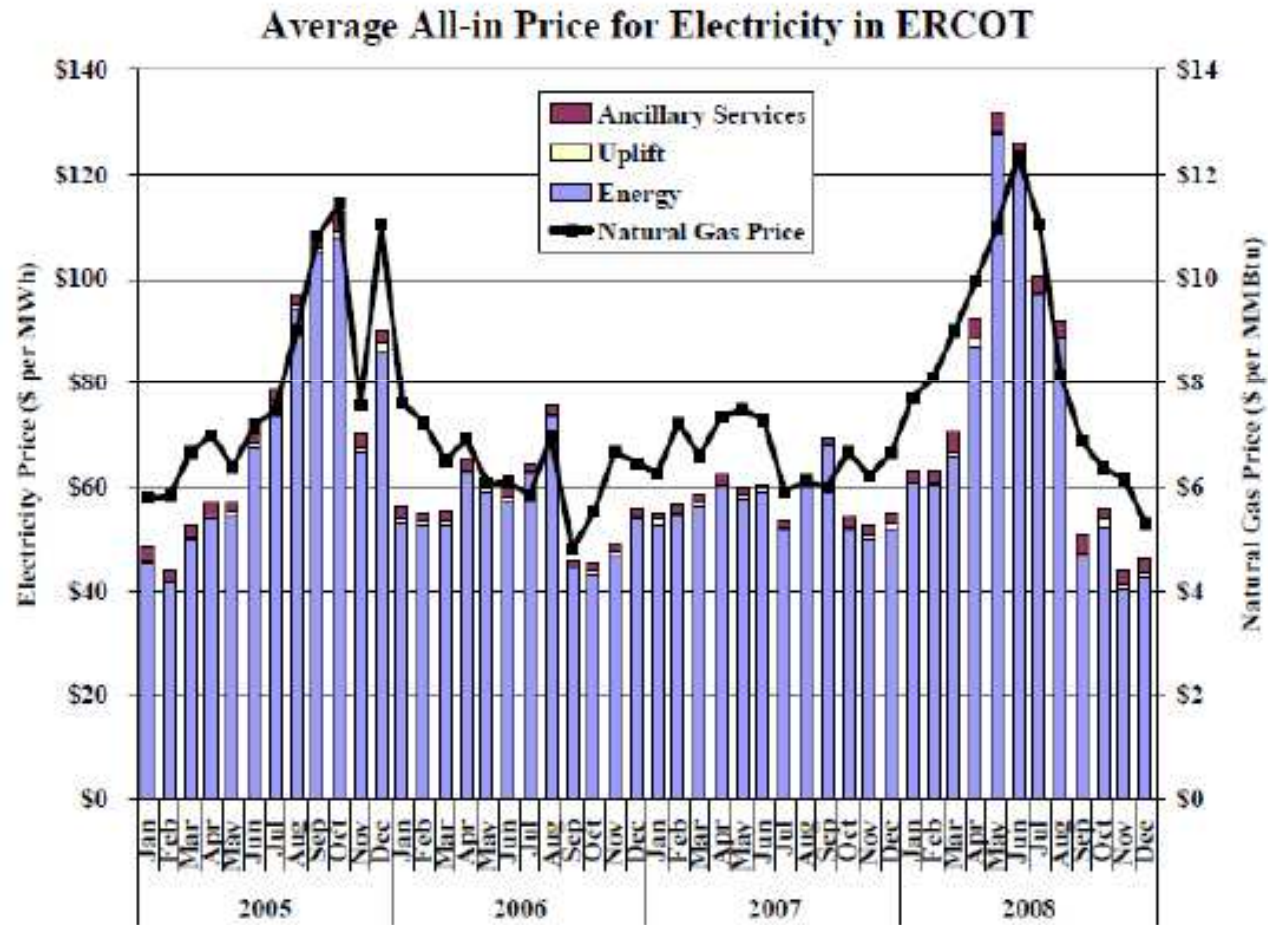
% of 320 Million MWHs



Why So Much Wind Development in Texas ?

- Abundant Resource in Areas with Sparse Population
- Natural Gas on the Margin Most Hours
- Transmission Interconnection “Open” Access
- Transmission Cost Allocation Policy
- Large Balancing Area
- Transparent Wholesale Power Market
- 5 minute Economic Dispatch
- Ease of Permitting
- Renewable Portfolio Standard

ERCOT Market Prices Track Natural Gas Prices



ERCOT Generation Interconnection Process

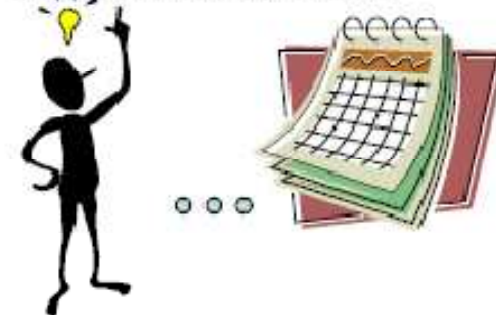
I. Interconnection Feasibility
Request submitted to
ERCOT



II. ERCOT performs steady
state analysis and provides
rough estimate of facility
additions



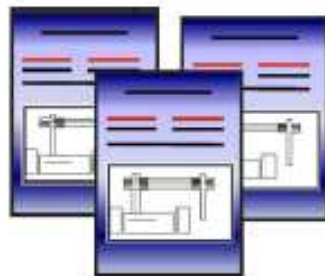
III. Generation owner
reviews information and
incorporates it into its
decision-making process



IV. Generation owner
requests a full
interconnection study



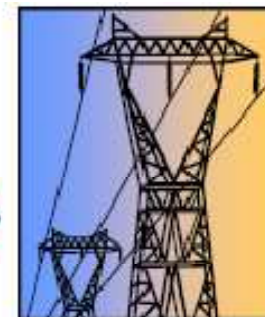
V. Transmission Owner
(TO) performs detailed
analysis and determines
final cost estimate.



VI. Generation
owner signs
interconnection
agreement with TO



VII. Transmission
Projects are
approved



ERCOT Market – Energy Auction

- **Security Constrained Economic Dispatch**
- **Day Ahead Market – Load Schedules and Supplier Bid Offerings submitted to ERCOT establishes unit commitment and MCPs**
- **Energy scheduled in Real Time Market – LMPs established on 5 minute interval**
- **Ancillary Services**
 - **Responsive Reserve – 10 minutes**
 - **Non-spin Reserve – 30 minutes**
 - **Frequency Regulation – 4 second**

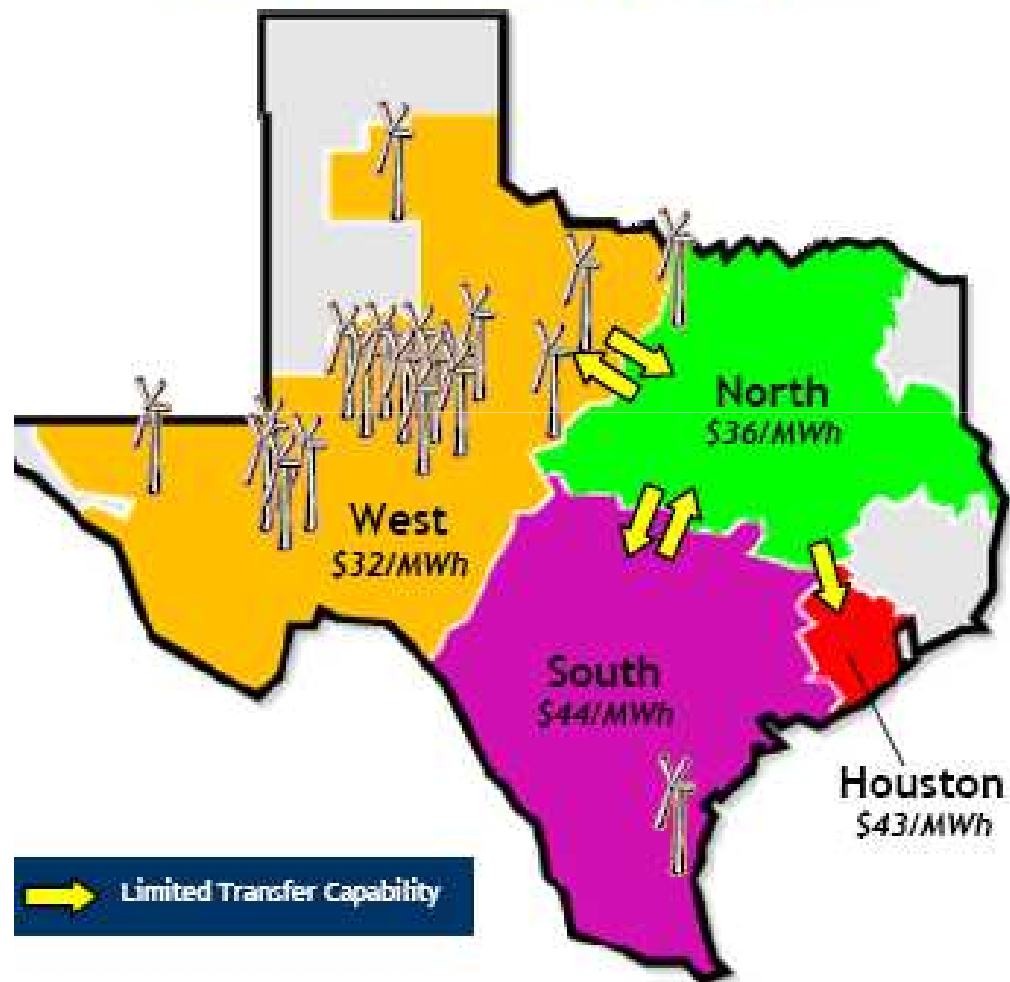
Wind Integration in ERCOT

- Wind Farm has option of using ERCOT forecast and can bid or accept the LMP
- Wind is always in the Unit Commitment
- More wind will increase the requirement for non-spin reserve capacity, won't change responsive reserve (2300 MW) or regulation requirement (600 MW)
- Wind Limited to Up-ramp rate of 10% per minute

Long Range Planning

- Transmission Adequacy is main barrier to further wind development
- Solving the “Chicken and Egg Conundrum” – the CREZ Process

ERCOT Market Zones and Average On-Peak Power Prices (January-August '09)



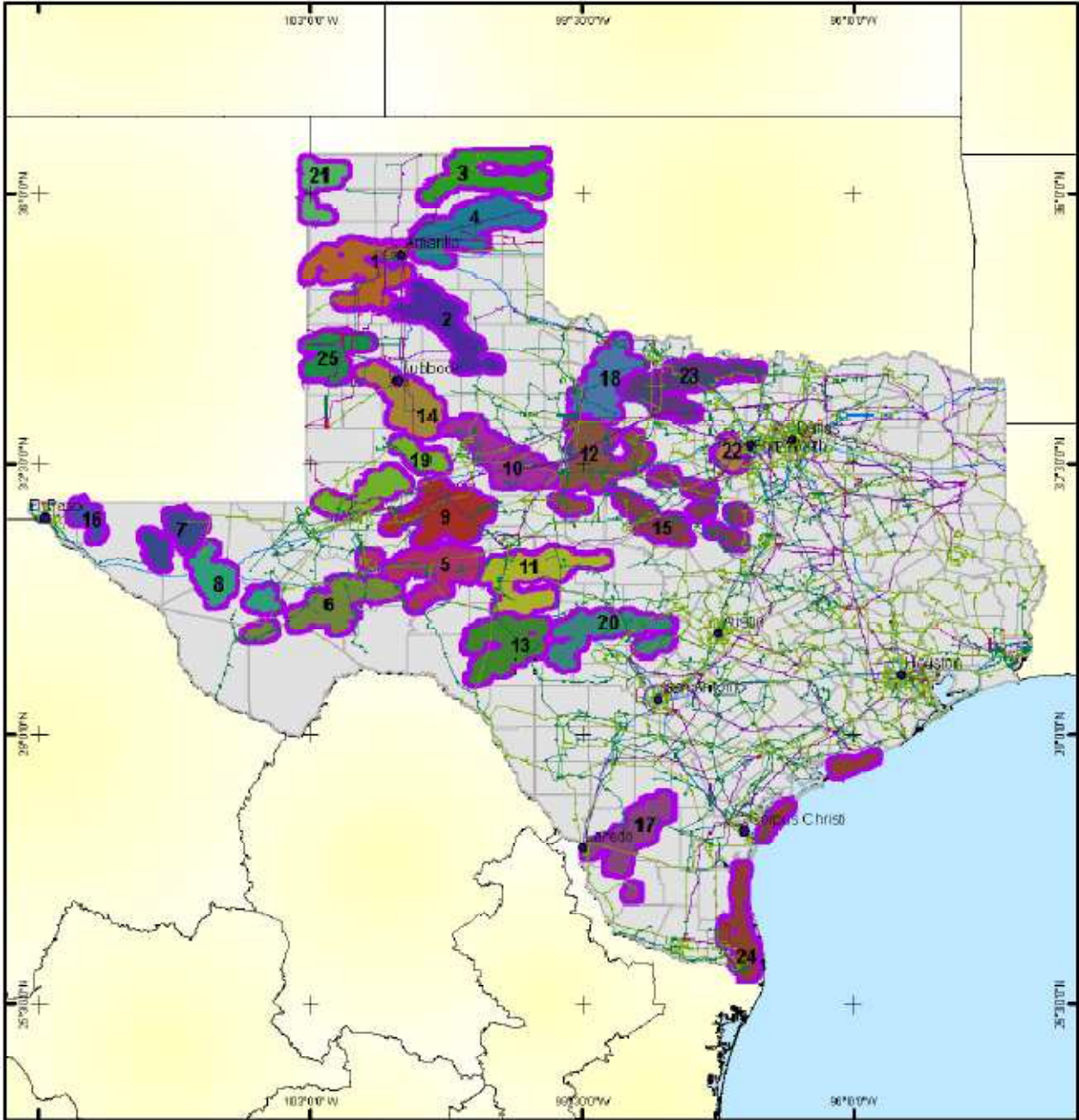
**4500 MW Transfer
Limit from West to
North Zone**

Legislative Solution: Senate Bill 20 (2005)

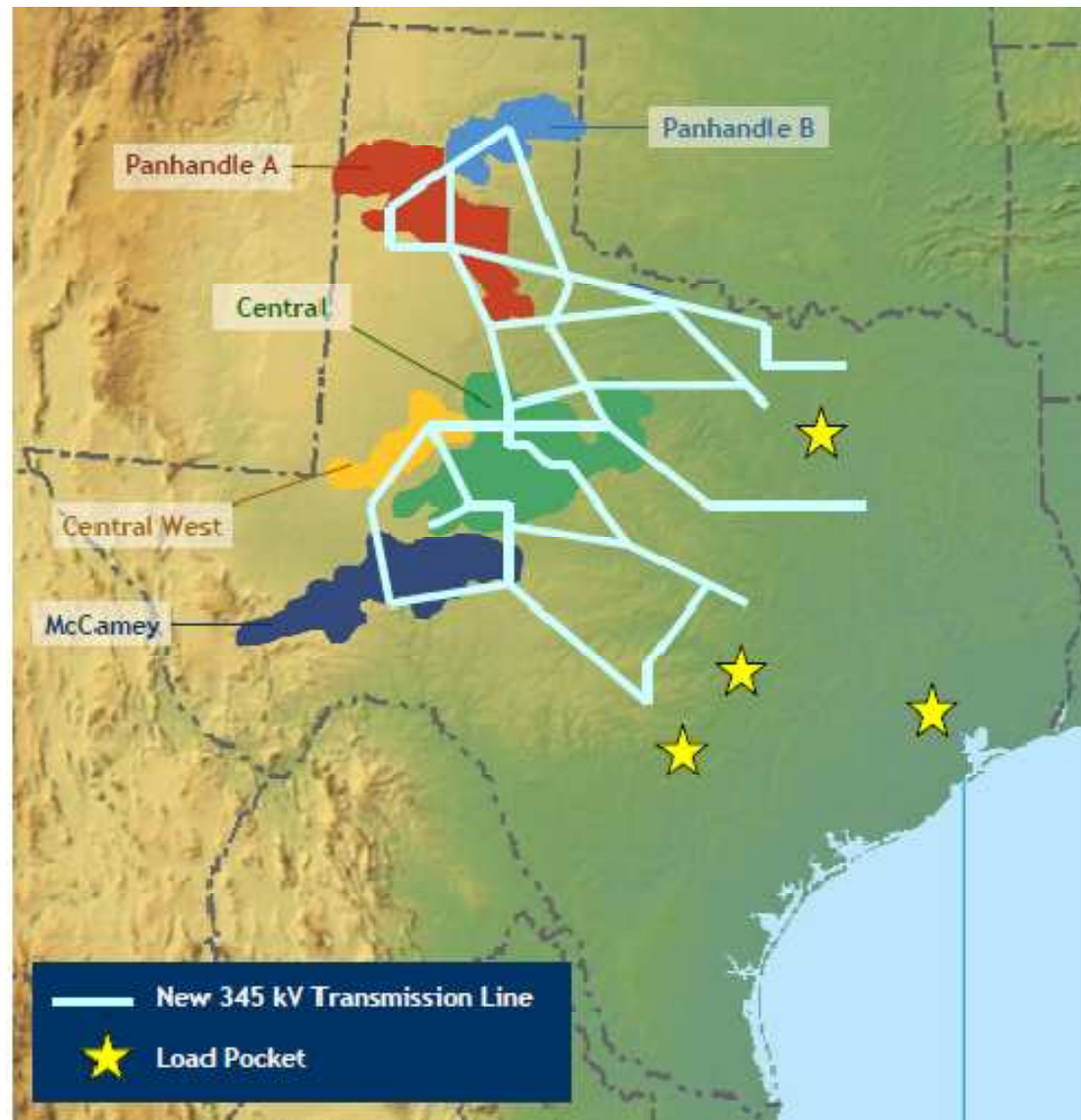
Mechanism for Expansion of Transmission to Meet the State's Goal:

- Designate Competitive Renewables Energy Zones (CREZ) with sufficient potential for renewables development.
- Develop plans for construction of cost-effective transmission from the CREZ.
- Consider the “level of financial commitment by generators” when establishing CREZ.
- ERCOT study filed at the PUC in December 2006.
 - Wind energy production potential.
 - Likely deliverability constraints.

**Potential CREZ
Examined by
the PUC:
The “Cloud”
Study**



CREZ Transmission Projects



Issues the PUC Must Consider in Designating the CREZ

- Suitability of land area and wind capability.
- Cost of transmission needed.
- Benefits of energy produced in each potential zone.
- Level of financial commitment by developers.
 - A significant change in transmission policy in the State.

Regulatory Proceedings to Build the CREZ

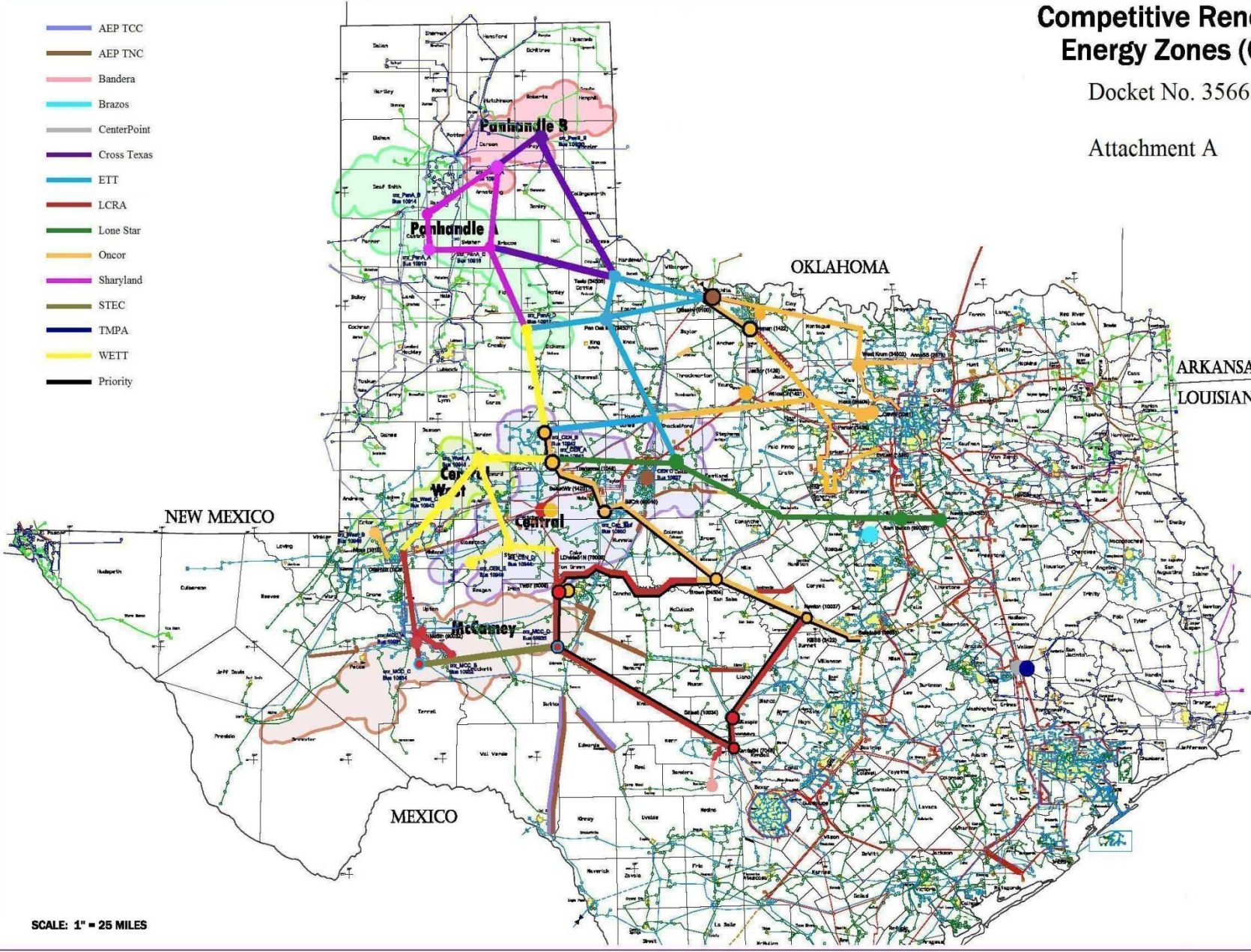
- Part One: Choose the Clouds.
- Part Two: Choose the size of the transmission build out.
 - Option 1: 12k MW of wind in CREZ
 - Option 2: 18k MW of wind in CREZ
 - Option 3: 24k MW of wind in CREZ
- Part Three: Who gets to build the transmission lines.
 - Traditional wires utilities.
 - New entrants.

Competitive Renewable Energy Zones (CREZ)

Docket No. 35665

Attachment A

- AEP TCC
- AEP TNC
- Bandera
- Brazos
- CenterPoint
- Cross Texas
- ETT
- LCRA
- Lone Star
- Oncor
- Sharyland
- STEC
- TMPA
- WETT
- Priority



CREZ Costs

- Total cost estimate: \$5 billion.
 - ERCOT 5-year plan: \$8.2 million.
- Transmission cost allocation:
 - Costs pooled across entire ERCOT region.
 - Austin Energy share—4 percent.

ERCOT CREZ Project

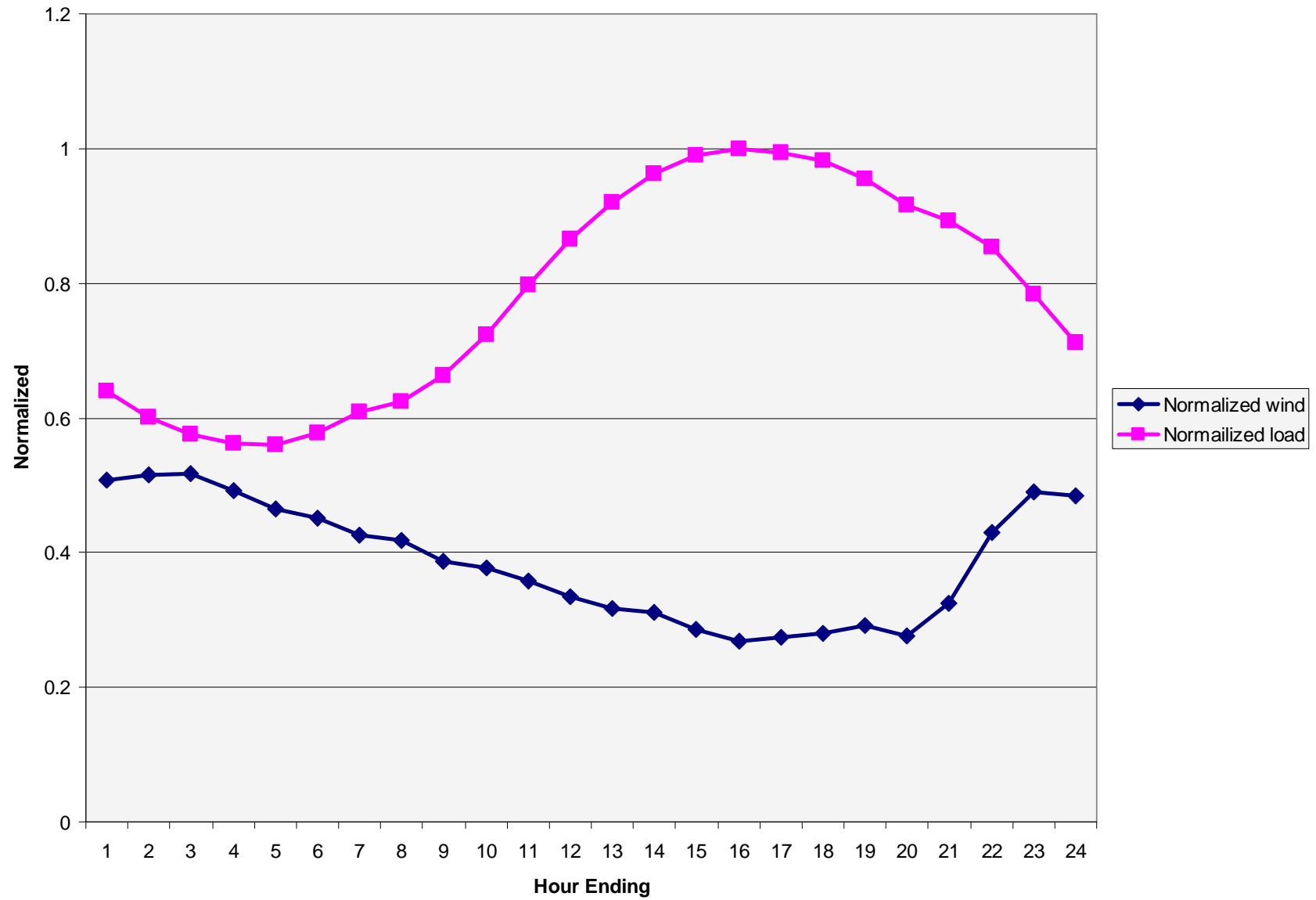
Unprecedented Transmission Up-grade Project for Support of Renewable Energy Integration in the U.S.

- National model for renewable energy integration
- Approx. 25% of the total investment of all reported U.S. transmission infrastructure projects to support renewable energy growth and integration
- Implications of CREZ project success will have national significance and will help to establish methodologies, procedures, technology developments and applications, and potentially standards regarding renewable energy penetration capabilities

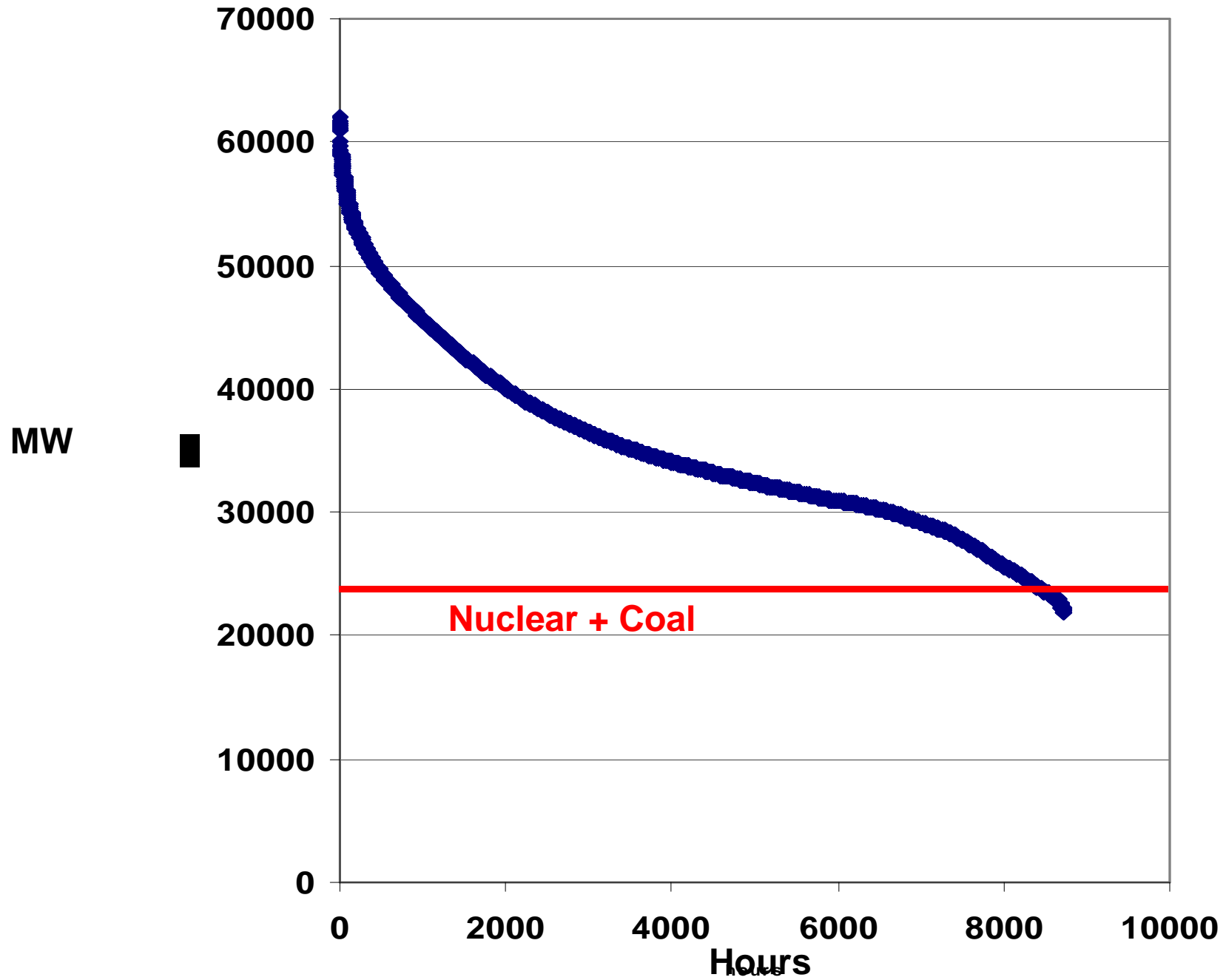
Wind Integration: Challenges

- Wind is highly variable—both up and down.
- Wind tends to ramp up as load is declining and vice versa – steep net load ramps
- Wind, being strong when loads are lowest, tends to force base-load generators to cycle
- Wind generators don't have inertia – put greater burden on conventional generators for frequency response to “events”
- Wind forecasting is inconsistent (but improving).

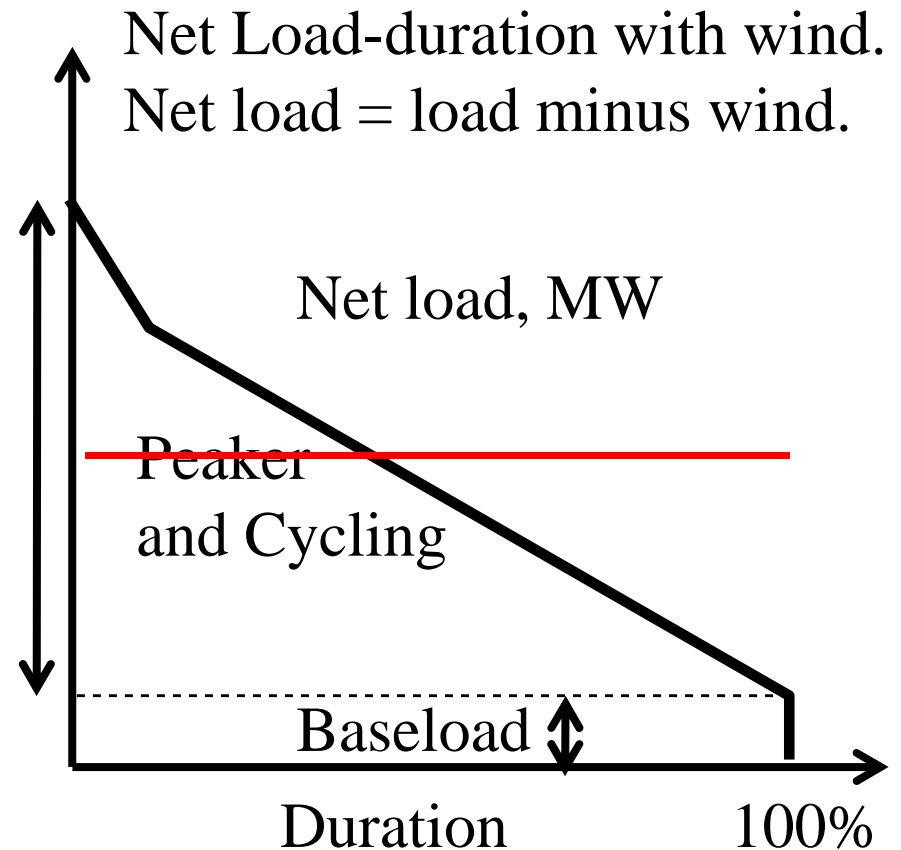
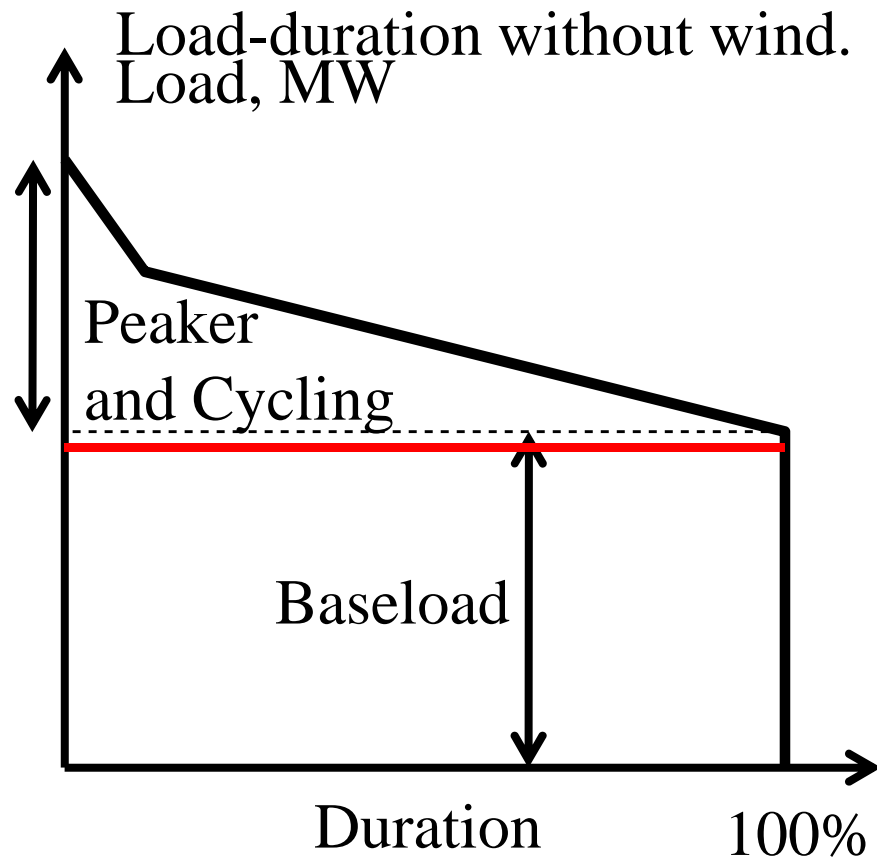
Wind and ERCOT Daily Load



ERCOT Load Duration Curve

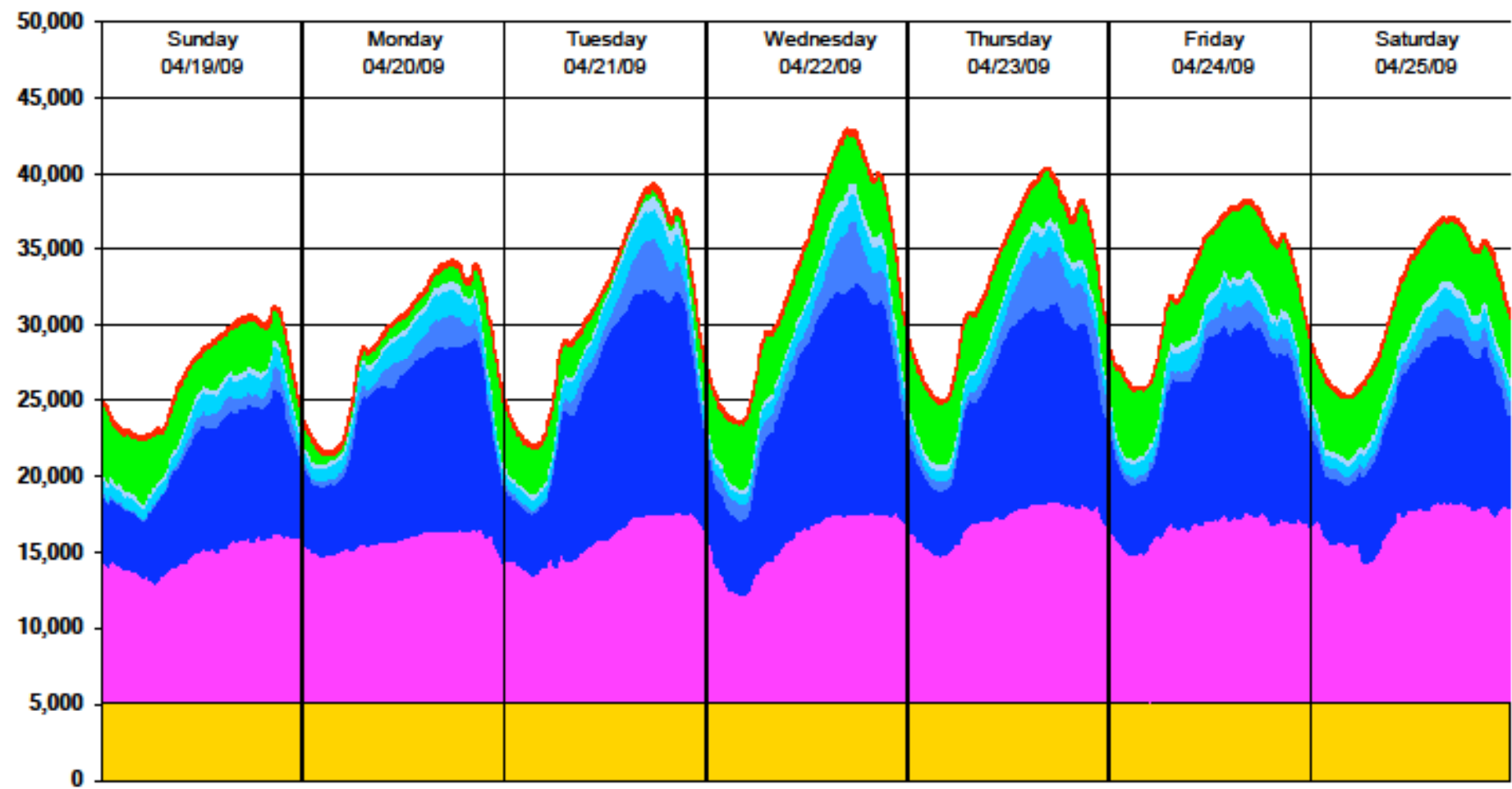


Typical wind and load correlation in North America.



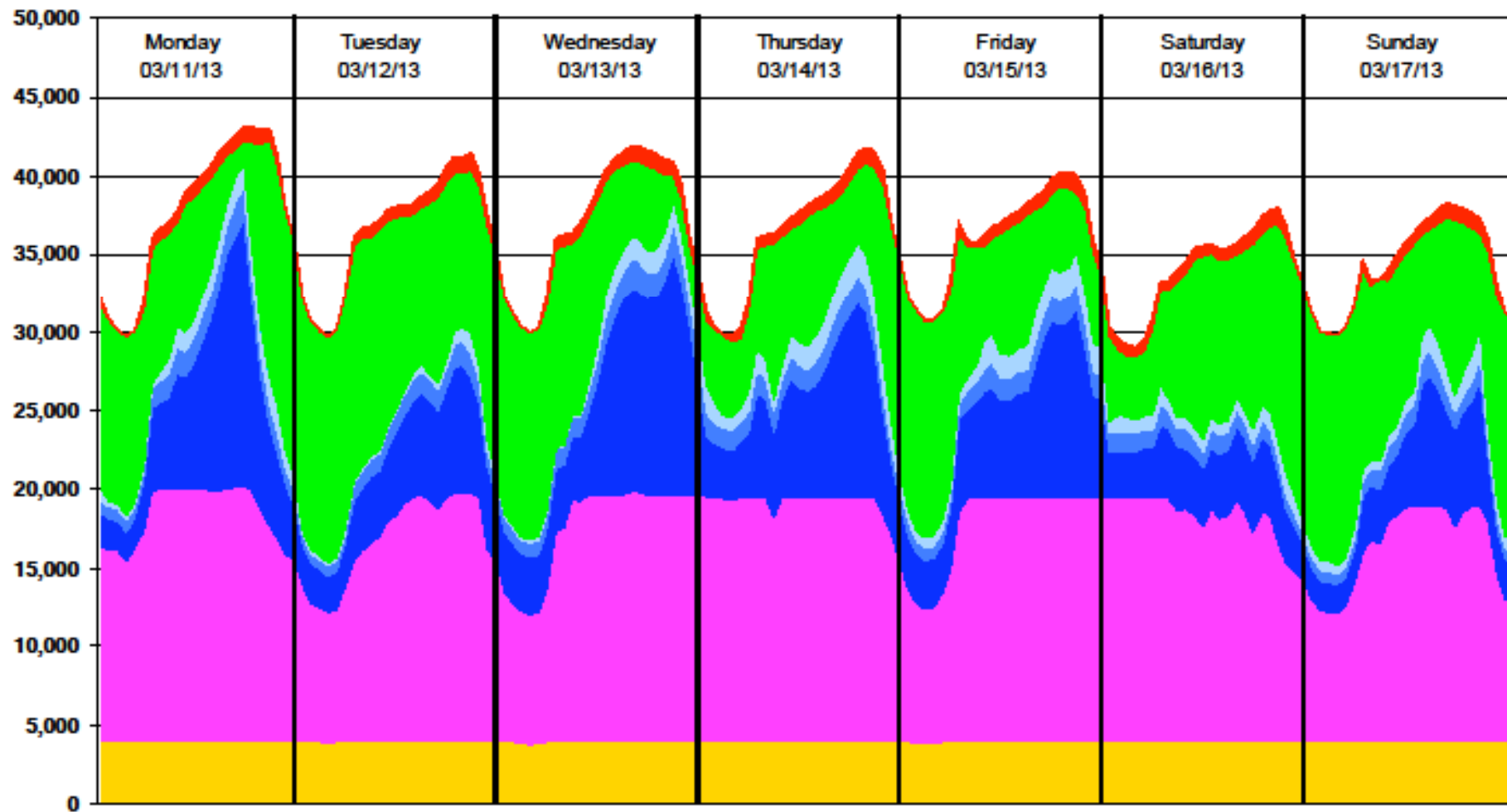
ERCOT Typical Spring Week Generation by Fuel Type (actual) April 19-25, 2009

■ Nuclear
 ■ Coal
 ■ CombCycle
 ■ GasSteam
 ■ PrivateGas
 ■ GasTurbine
 ■ Wind
 ■ Other



ERCOT 2013 High Wind Week Generation by Fuel Type (projected)

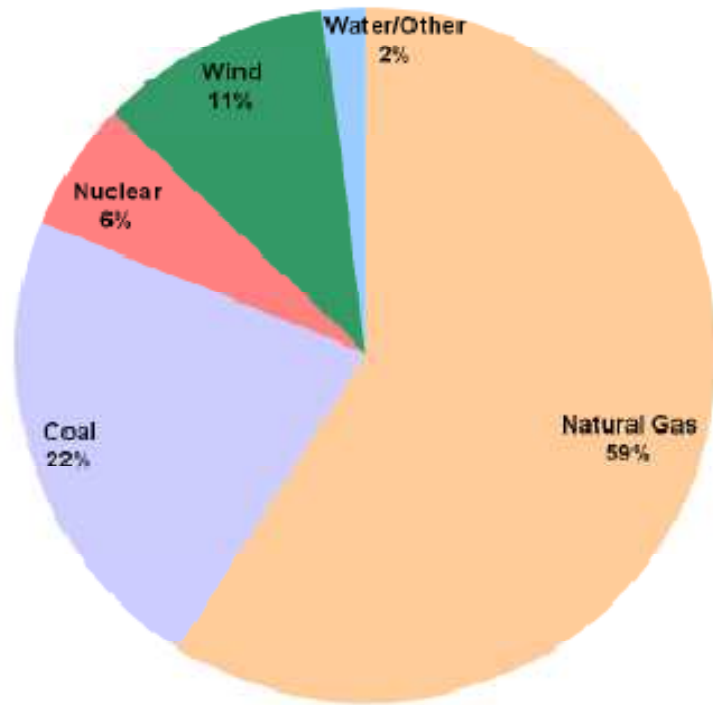
■ Nuke ■ Coal ■ Combined Cycle ■ Gas Steam ■ Private ■ Gas Turbine ■ Wind ■ Other



Thank You

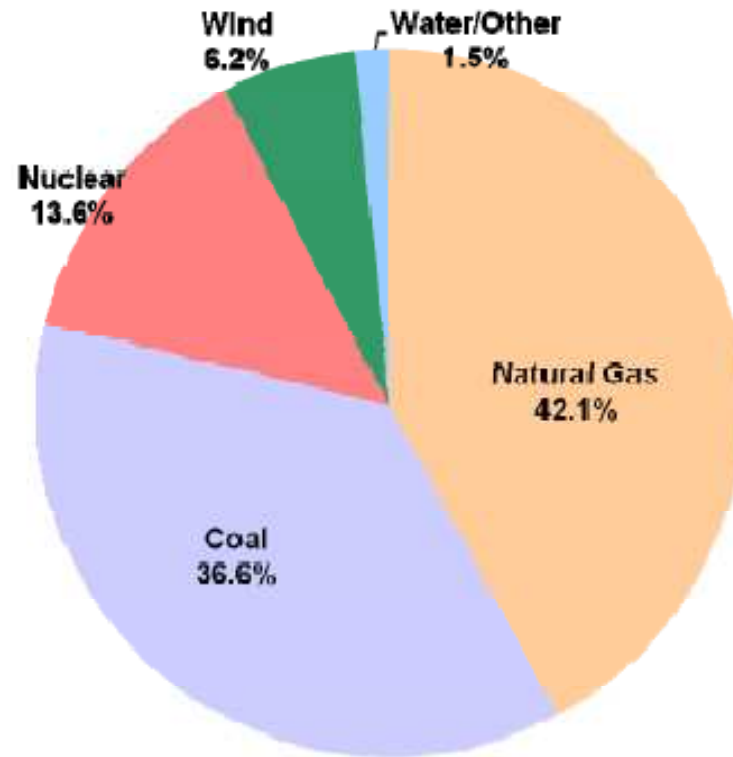
- Mark Kapner
- Mark.kapner@austinenergy.com
- 512 322-6123

ERCOT Capacity and Energy by Fuel Type



Installed Capacity by Fuel Type, 2010

87.7 GW total



Energy by Fuel Type, 2009

320 Million MWH