



# Wind Power Integration Issues for Texas

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# ***Energy World is Changing***

***Supply*** (mature options)

***Globalization*** (new demand)

***National Security***

***Environment***

***Diverse Supplies Needed***

# ***Overview***

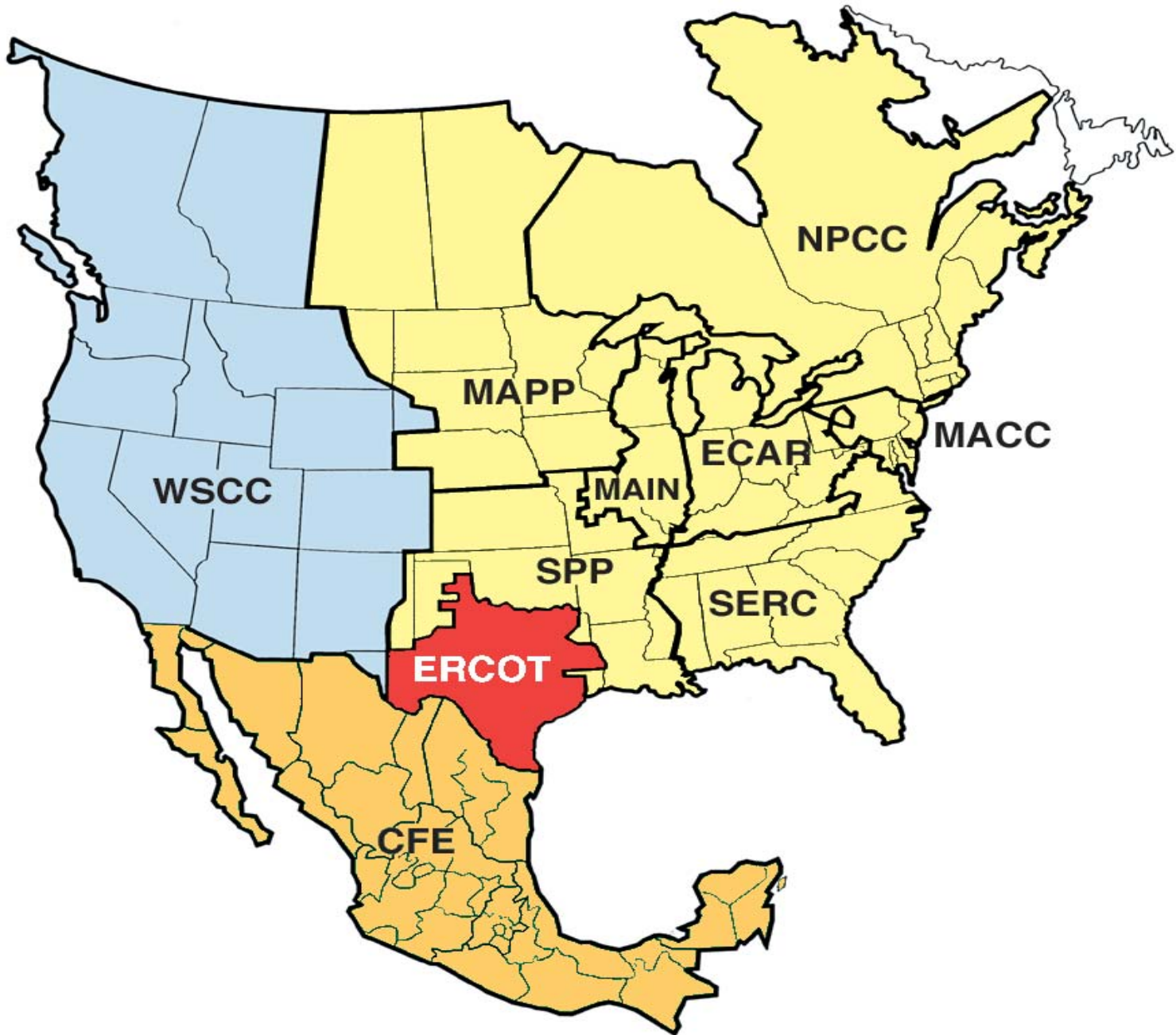
**Status of Texas Wind**

**Texas CREZ Process**

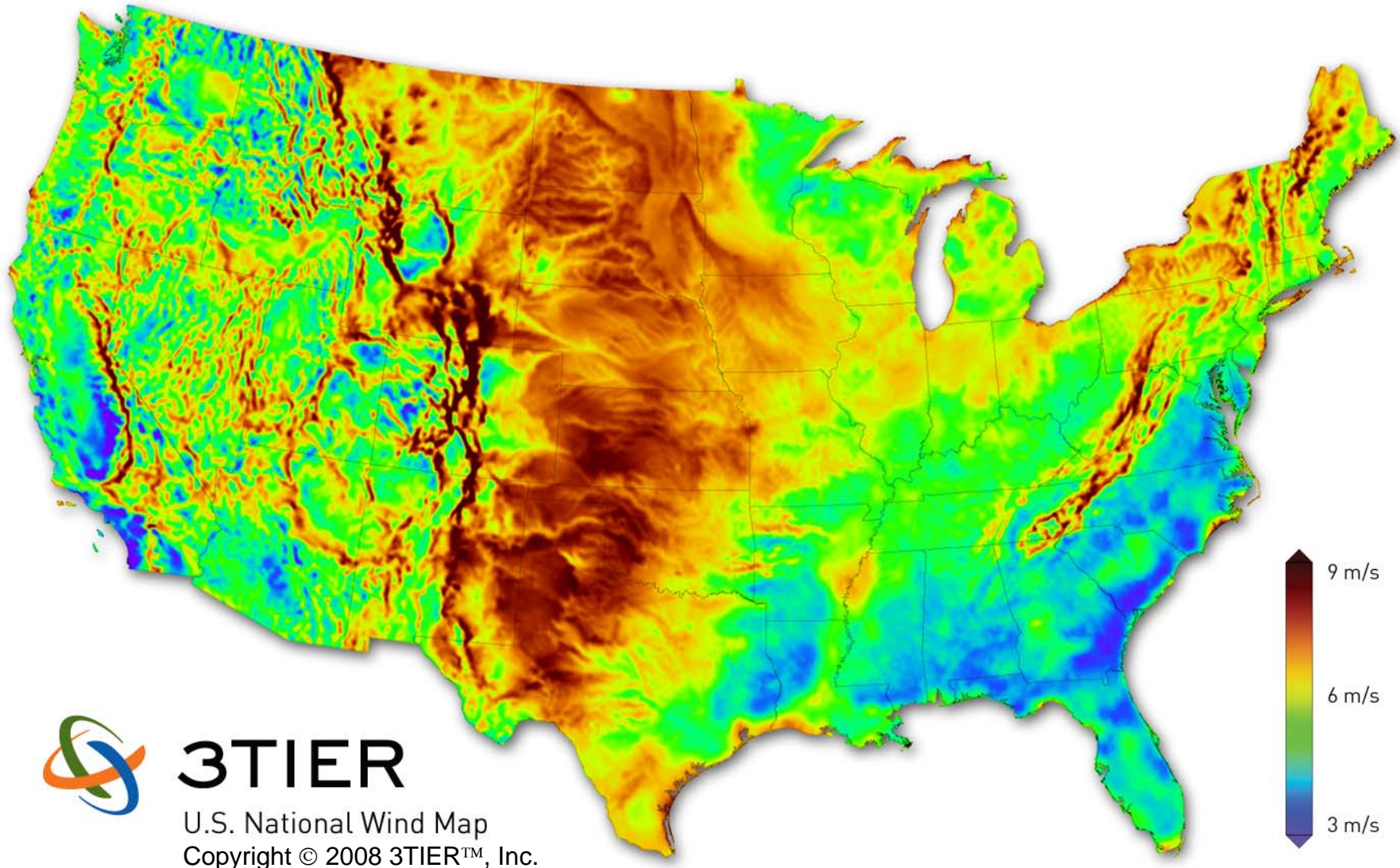
**Reliability: PR/Political Issue**

**GE A/S Study for ERCOT**

**ERCOT Reliability “Events”**



# *Average Wind Speed at 80 m*

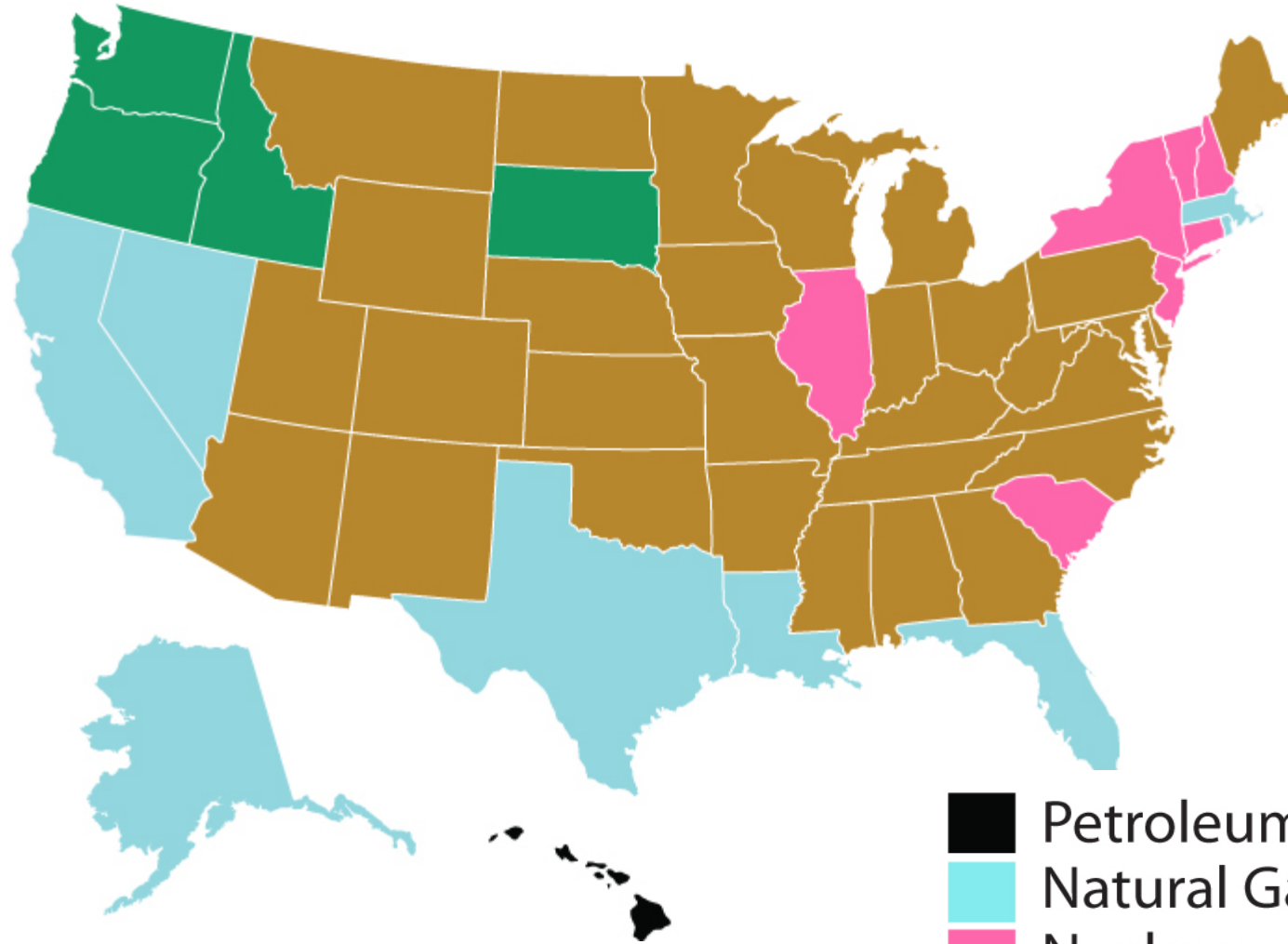


**3TIER**

U.S. National Wind Map  
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***Texas has great wind resources***

# Primary Electric Fuel Source by State



Average Retail  
Electric Prices  
(cents/kWh)

■	Petroleum	20.7
■	Natural Gas	11.7
■	Nuclear	11.6
■	Coal	7.2
■	Hydroelectric	6.1

Source: based on Energy Information Administration data

# ***Texas Wind Power: Current Status***



# ***Texas Wind Capacity***

## **1995 = 0**

***In Service -- May, 2008:***

# **5,960 MW**

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Source: ERCOT & SPP





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**5,960 MW**

***Additional Signed  
Interconnection Agreements***

**5,471 MW**

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Source: ERCOT & SPP





# ***Texas Wind Capacity***

## ***1995 = 0***

***In Service -- May, 2008:***

***5,960 MW***

***Additional Signed  
Interconnection Agreements***

***5,471 MW***

***Additional Interest  
Interconnection Studies***

***57,896 MW***

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Source: ERCOT & SPP



# **CREZ**

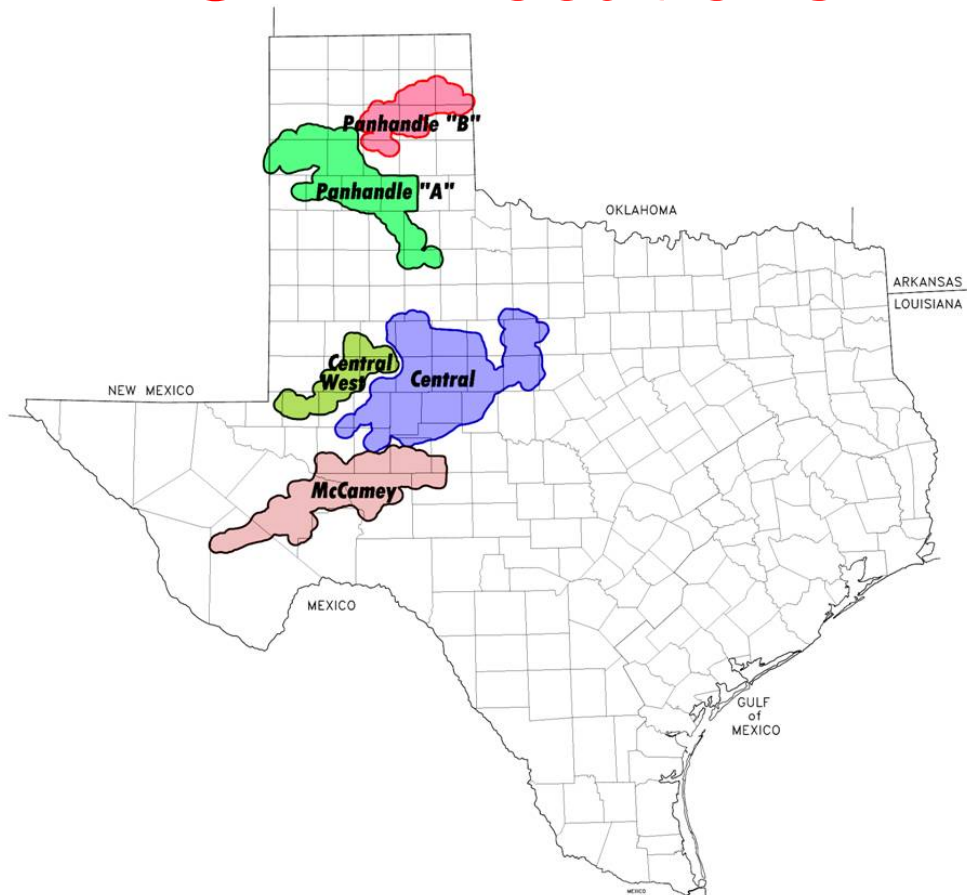
Competitive Renewable Energy  
Zones

**Proactive Transmission Policy**

# CREZ Final Order Pending

PUC final decision expected August 2008

## CREZ Locations



## CREZ Amount

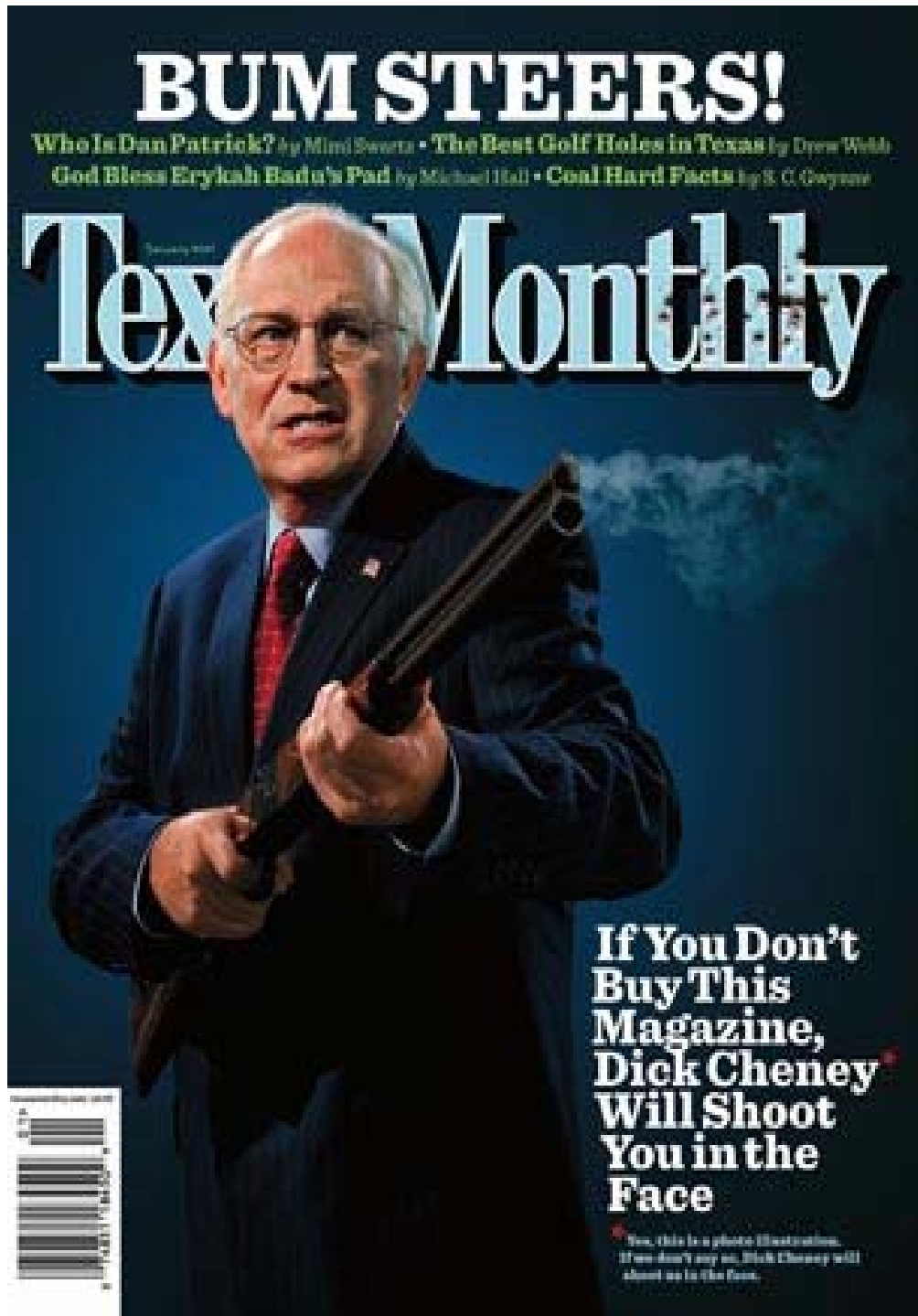
Capacity of New CREZ Wind by Scenario (MW)				
Wind Zone	Scen. 1	Scen. 2	Scen. 3	Scen. 4
Panhandle A	1,422	3,191	4,960	6,660
Panhandle B	1,067	2,393	3,720	0
McCamey	829	1,859	2,890	3,190
Central	1,358	3,047	4,735	5,615
Central West	474	1,063	1,651	2,051
Total*	12,053	18,456	24,859	24,419
* Assumes 6,903 MW of existing wind capacity				

Source: PUCT & ERCOT CREZ-RPG





# ***Reliability as a PR / Political Issue***



from **Coal Hard Facts**

“Coal and **gas** are relatively **cheap** but pollute...”

“**wind** and solar are gentle but **expensive**, and electrical expense is a leading cause of eviction of poor people in America”

# Wind Power: Texas' Leader in 2007

Of all ERCOT Interconnection Agreements in 2007:

**17 of 19 are wind** ( **89%** of total)

**3,064 MW is wind** ( **78%** of total)

GENERATION INTERCONNECTION REQUEST ACTIVITY IN 2007						
Fuel	Screening Studies Requested		Interconnection Studies Requested		Interconnection Agreements Signed	
	Number	MW	Number	MW	Number	MW
Coal	6	2,008	4	383	1	581
Natural Gas	40	23,613	17	5,292	1	255
Nuclear	2	6,400	3	9,100	0	0
Other	0	0	1	45	0	0
Wind	79	29,478	45	13,076	17	3,064
Total	127	61,499	70	27,896	19	3,900

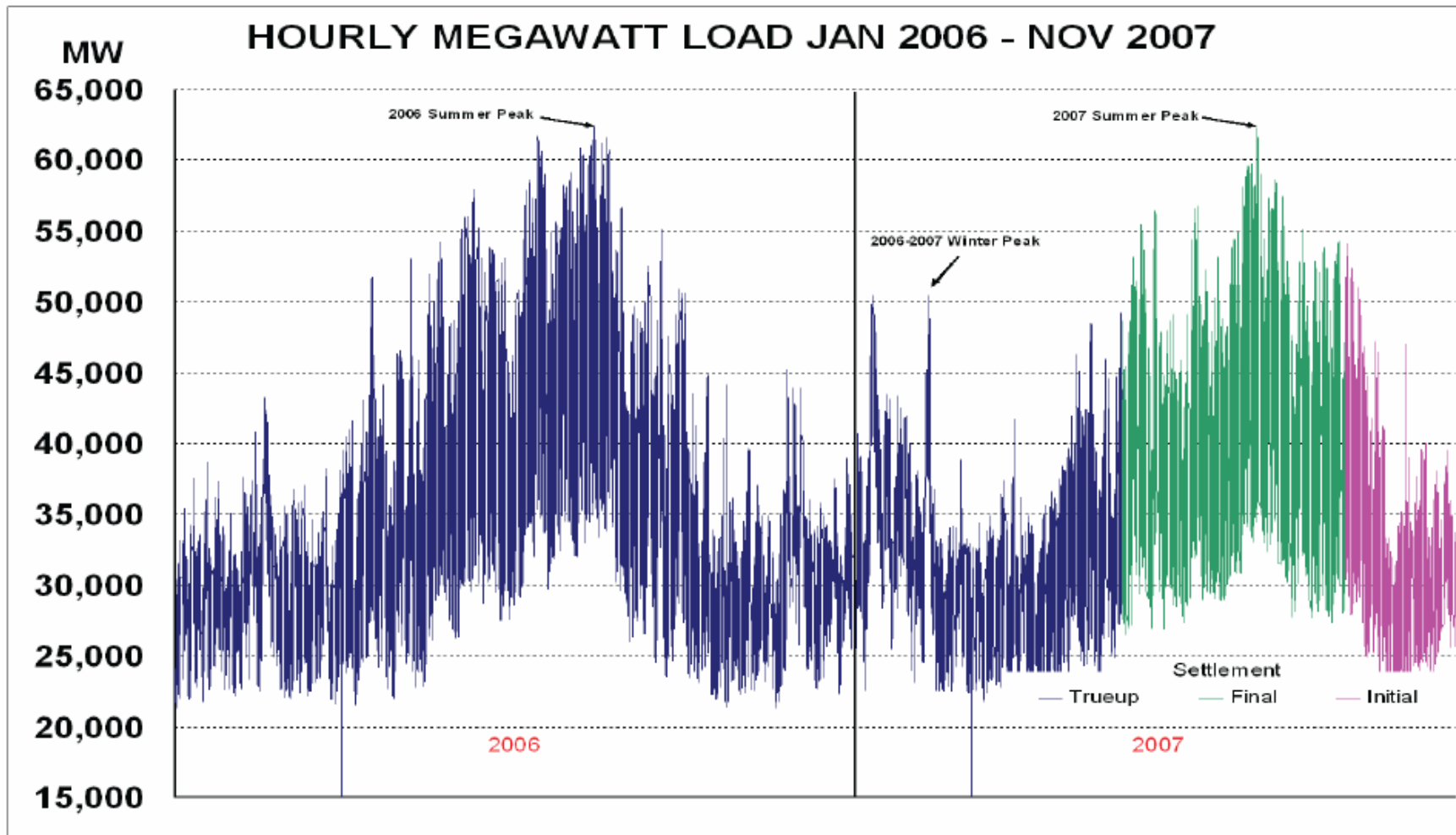
Projects may appear in more than one category.



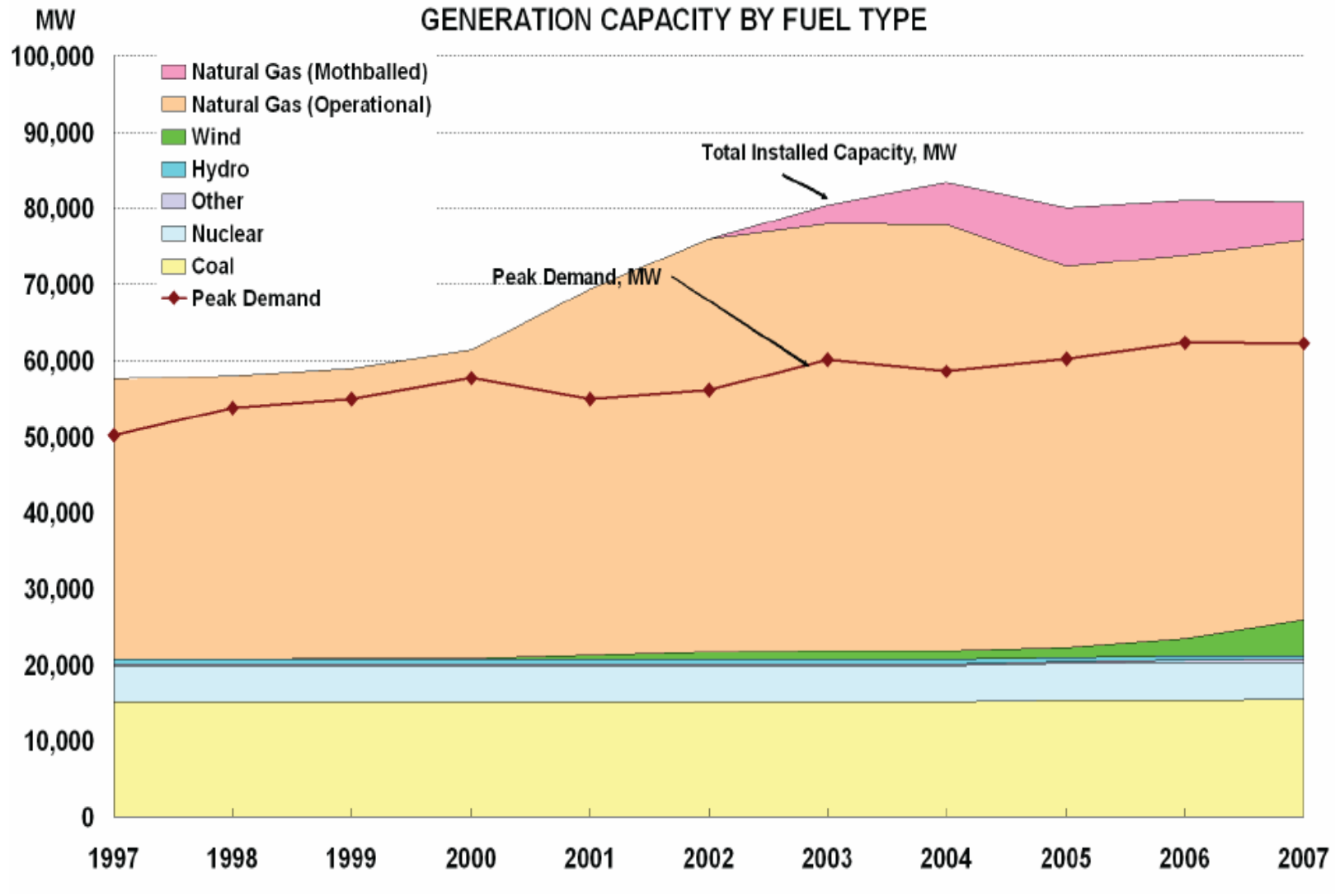
# *Reliability*

# Electric “System” handles Variations

(System is robust to handle consumption and production changes)

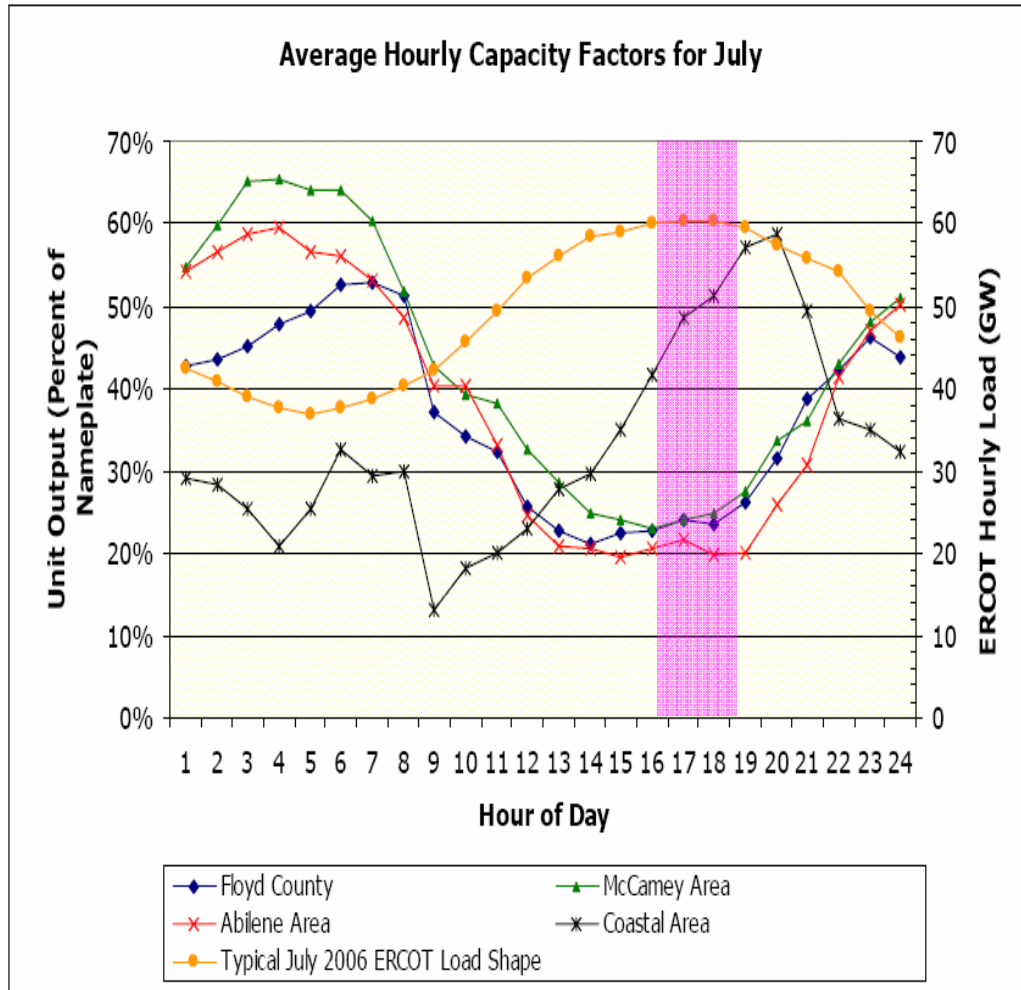


# Reliability: A System-wide Issue



Source: ERCOT Report on Existing and Potential Electric System Constraints and Needs, December 2007, p. 16.

# Wind Energy Production at Peak



## Average Production:

**West Texas: 22 %**

**Texas Coast: 50 %**

## Capacity Adequacy:

**ERCOT initial: 2.6 %**

**ERCOT (2007): 8.7 %**

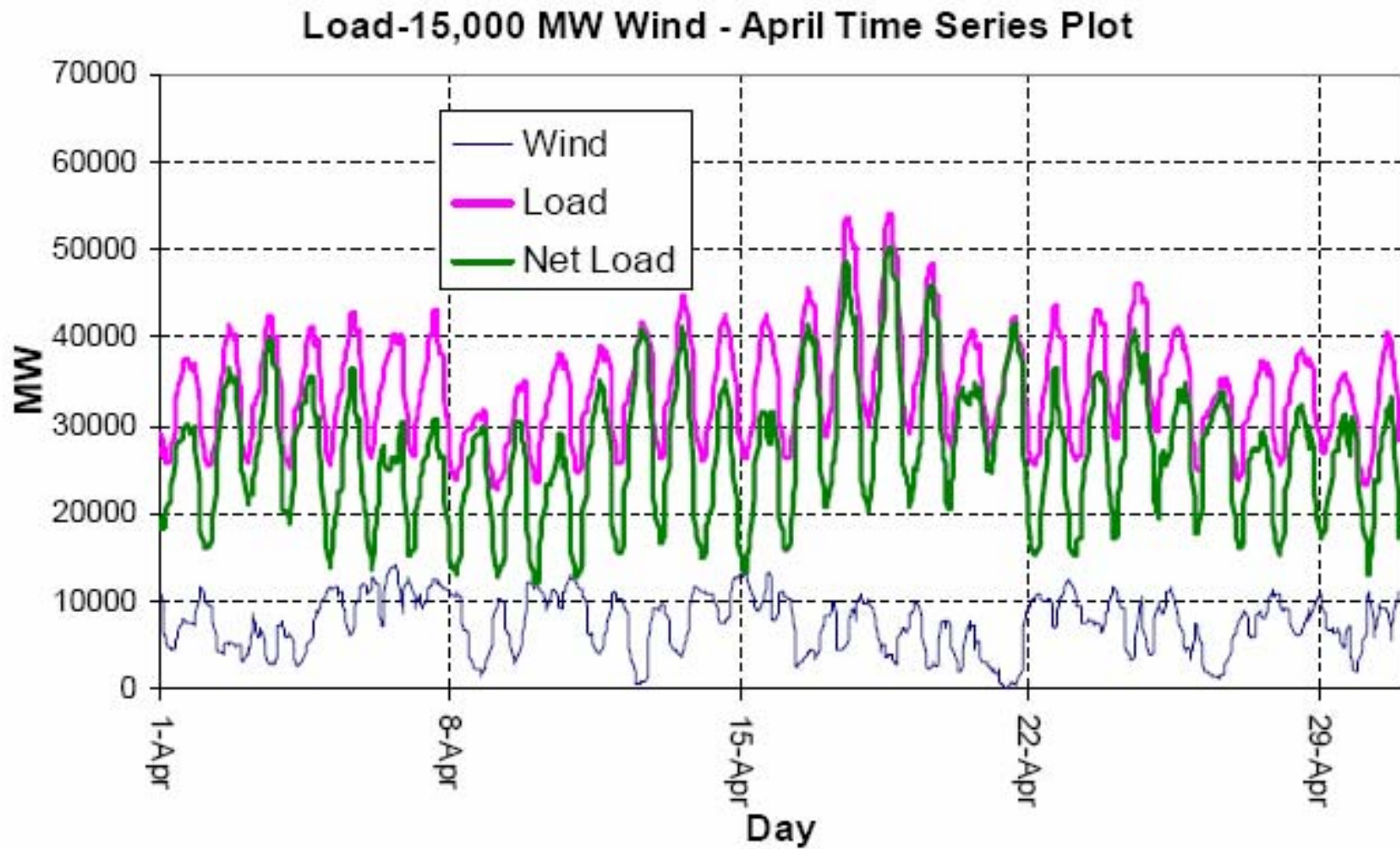
**In Future ? 15% ?**

Source: ERCOT 2006 CREZ Analysis, p. 15; ERCOT, Walter Reid



# ***GE Ancillary Services Study for ERCOT***

# Net Load (15,000 MW Scenario)



# Findings – Regulation

- Present ERCOT methodology effective if adjusted for increasing wind capacity
- Regulation requirements increase linearly for increases in wind generation (up to 20-23% in the 15,000 MW scenario)
  - Regulation requirements vary by season and time of day
- ERCOT needs to implement a state-of-the-art wind power production forecast
  - **Now implemented**



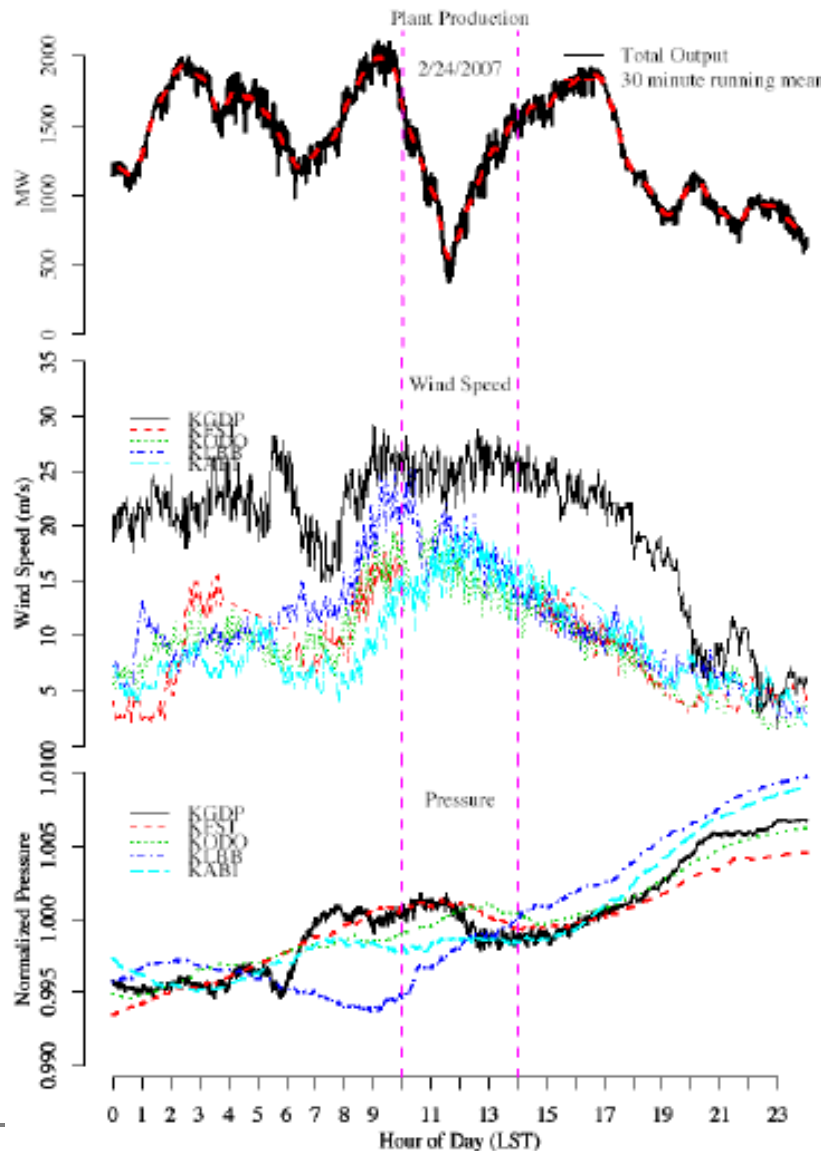
# ***ERCOT Reliability Events***

## February 26, 2008

- Began at about 6:30 PM
- Went to Emergency Electric Curtailment Plan (EECP) Step 2 due to low system frequency (59.907 Hz)
- Interrupted interruptible load (1,100 MW)
- Deployed added capacity
- Caused by:
  - Reduction in wind generation
  - Rapid increase in customer loads (2,550 MW in 41 minutes)
  - Reduced conventional generation available



# February 24, 2007



- Strong upper-level storm system passed over northern New Mexico and the panhandle of Texas substantially tightening the pressure gradients over west Texas, resulting in strong to severe winds along a straight line across much of the area
  - 8 AM - high wind speeds seen by most wind projects, maximum wind gust reported was 94 mph
  - 9 AM - aggregate output increased from just over 1100 MW to nearly 2000 MW (rated capacity)
  - 10 AM - sustained winds exceeded 25 m/s (55 mph) output at most wind farms, output declined as turbine-cutoff threshold reached
  - 11 AM - most intense pressure gradients and winds moved eastward, wind speeds relaxed, turbines resumed power production, resulting in a gradual increase in total output to pre-event levels
- Total drop in plant output was more than 1500 MW over a 90 minute period
- Most rapid declines occurred at the Horse Hollow interconnections
- Largest 30-minute drop of 450 MW (between 1104 and 1134 LST) represents about 22.5% of the plant rated capacity
- The event was unusual both in the magnitude of the 90-minute drop and the large geographic area affected

Source: GE Wind Study Phase II



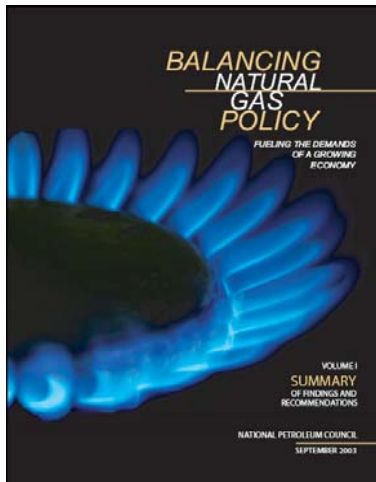
A photograph of a wind farm at sunset. The sky is a mix of blue and orange, with the sun low on the horizon. Several wind turbines are visible, their silhouettes against the bright light. The text is overlaid in a bold, yellow, italicized font.

***Wind Power:  
An important part of a  
Balanced Portfolio***

Source: Ken Donohoo, ERCOT; SPP



***10,000 MW of  
Wind Turbines***  
***\$20 Billion***



***1 Billion MWh of  
Natural Gas Fuel***  
***\$60 Billion***

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***(Natural Gas at \$8/mmbtu & 7,500 average heat rate)***



# Generalized Energy Cost Factors

<b>FUEL</b> <b>\$/million BTU</b>		<b>PLANT</b> <b>\$/kW</b>
<b>32</b>	<b>Gasoline (\$4)</b>	<b>250</b>
<b>22</b>	<b>Crude Oil (\$130)</b>	
<b>12</b>	<b>Natural Gas</b>	<b>750</b>
<b>2</b>	<b>Coal</b>	<b>3000</b>
<b>1</b>	<b>Nuclear</b>	<b>4000</b>
<b>0</b>	<b>WIND</b>	<b>2000</b>
<b>0</b>	<b>Solar</b>	<b>5000</b>