

The Wind Farm to Market Highway: National Perspective on Transmission



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(EPRI Renewables Programs: 1976 – 1998)

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Wind Power 2010 Nebraska Wind Conference

November 10, 2010

Kearney, Nebraska

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Outline



-
- ❖ Historical Background
 - ❖ Why Transmission: Benefits of Expanded Connectivity
 - ❖ Transmission Expansion Issues
 - ❖ Major Transmission Planning Activities
 - ❖ Personal Perspective on Transmission



Historical Background



- ❖ Traditional rationale for transmission expansion:
 - Connect generation to load
 - Maintain system reliability (help from neighbors)
 - Economic energy exchanges with neighbors
- ❖ Scope of transmission function expanded by FERC in the 1990s
 - All generators allowed to connect (including IPPs)
 - Emergence of regional wholesale markets
 - Led to congestion – need for more transmission capacity
- ❖ Transmission planning approach expanded to a more regional view in much of the nation
 - But access to remote renewable resources is only now becoming a significant consideration

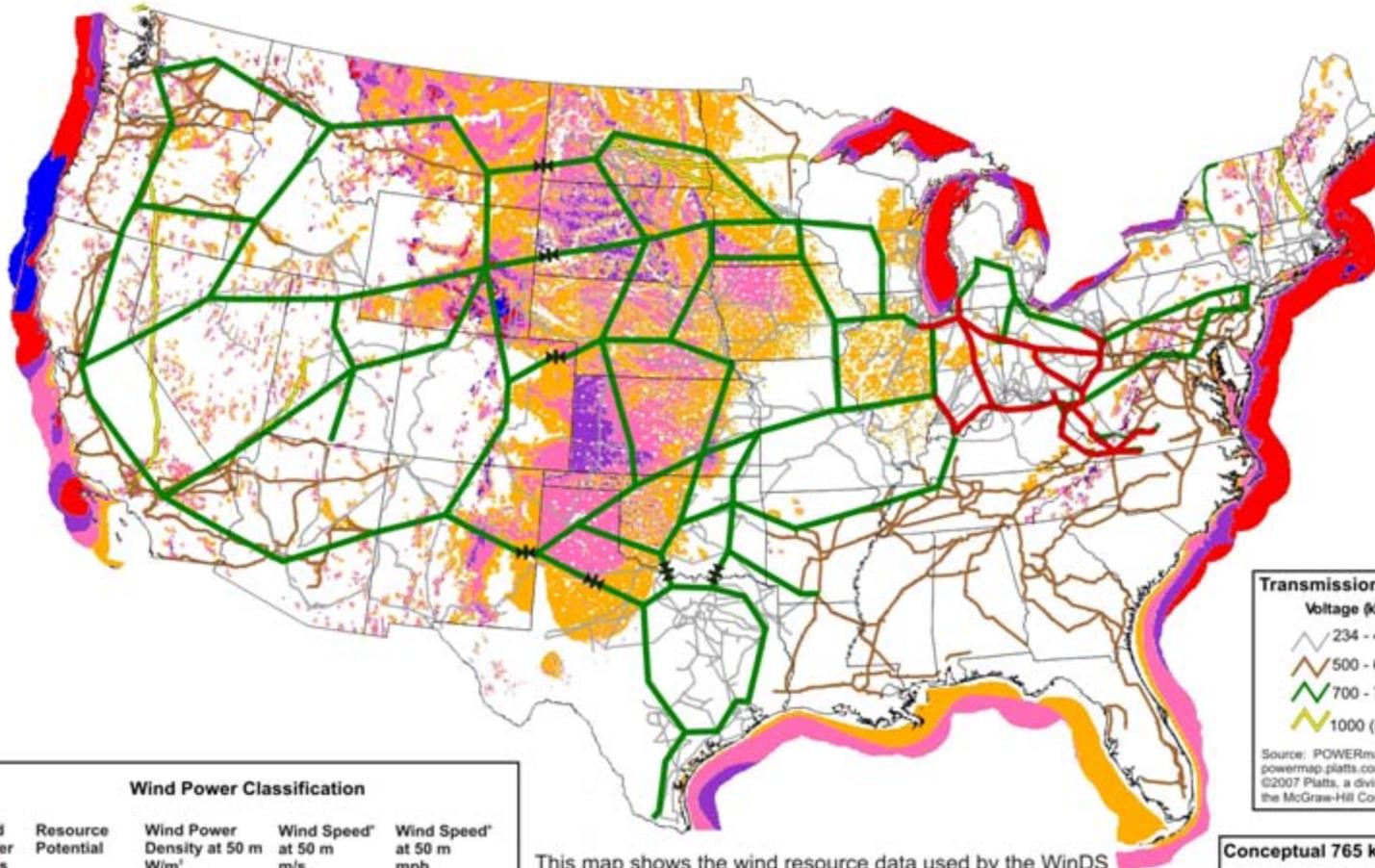


Transmission Expansion Benefits



- ❖ Access to lower cost energy now blocked by congestion
- ❖ Enhanced system reliability
- ❖ Sharing of reliability responsibilities, thus reducing operating costs
- ❖ Enhanced access to diversity in loads and generation
- ❖ Access to remote renewable resources

Conceptual transmission plan to accommodate 400 GW of wind energy (AEP 2007)



Transmission Lines

Voltage (kV)

- 234 - 499
- 500 - 699
- 700 - 799
- 1000 (DC)

Source: POWERmap, powermap.platts.com, ©2007 Platts, a division of the McGraw-Hill Companies

Wind Power Classification

Wind Power Class	Resource Potential	Wind Power Density at 50 m W/m ²	Wind Speed* at 50 m m/s	Wind Speed* at 50 m mph
	3 Fair	300 - 400	6.4 - 7.0	14.3 - 15.7
	4 Good	400 - 500	7.0 - 7.5	15.7 - 16.8
	5 Excellent	500 - 600	7.5 - 8.0	16.8 - 17.9
	6 Outstanding	600 - 800	8.0 - 8.8	17.9 - 19.7
	7 Superb	800 - 1600	8.8 - 11.1	19.7 - 24.8

* Wind speeds are based on a Weibull k value of 2.0

This map shows the wind resource data used by the WinDS model for the 20% Wind Scenario. It is a combination of high resolution and low resolution datasets produced by NREL and other organizations. The data was screened to eliminate areas unlikely to be developed onshore due to land use or environmental issues. In many states, the wind resource on this map is visually enhanced to better show the distribution on ridge crests and other features.

Conceptual 765 kV Network

- Existing 765 kV
- New 765 kV
- AC-DC-AC Link

Source: American Electric Power (AEP)

Conceptual transmission plan to accommodate 400 GW of wind energy (AEP 2007)



- 2003 Eastern US Blackout
- AEP 765 kV overlay (in red)
- AEP system continued full operation!
- Huge financial benefit to the region



SPP Regulating Reserves (2006 pattern, hourly maximums)

Wind Penetration	Load Only(MW)	Wind & Load (MW)	Increment (MW)
10% (7.5 GW)	528	1152	852*
20% (15.1 GW)	528	1800	1542
40% (30.2 GW)	528	2357	3034

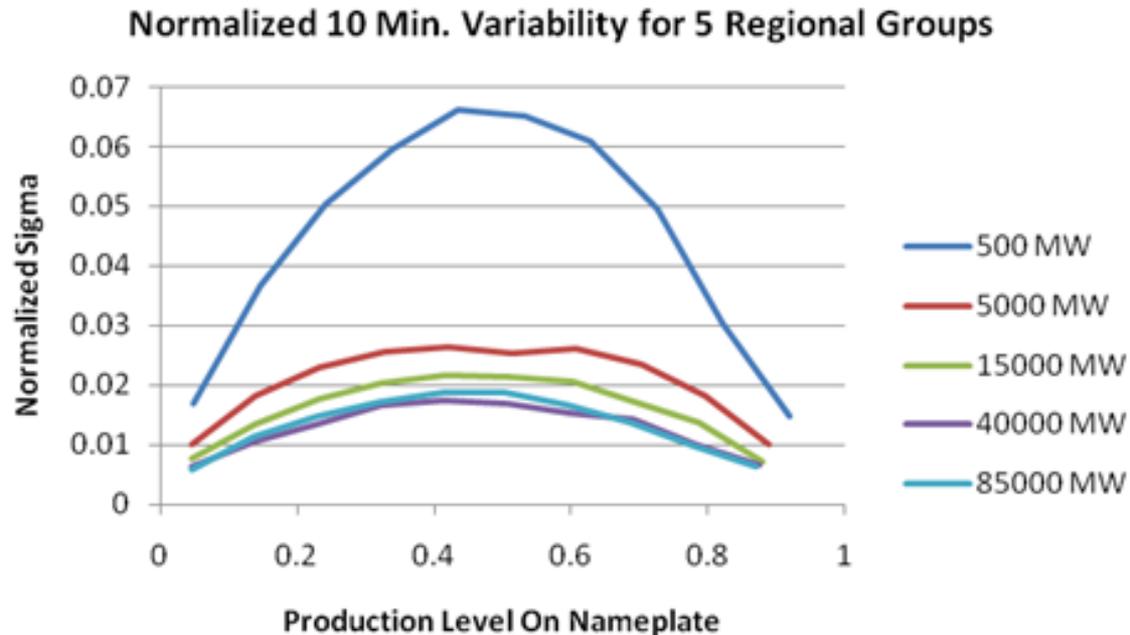
*Incremental reserves for NPA separately and Rest of SPP separately would be 177 MW and 821 MW, respectively, totaling to 998 MW

Combined operation reduces reserves by 146 MW

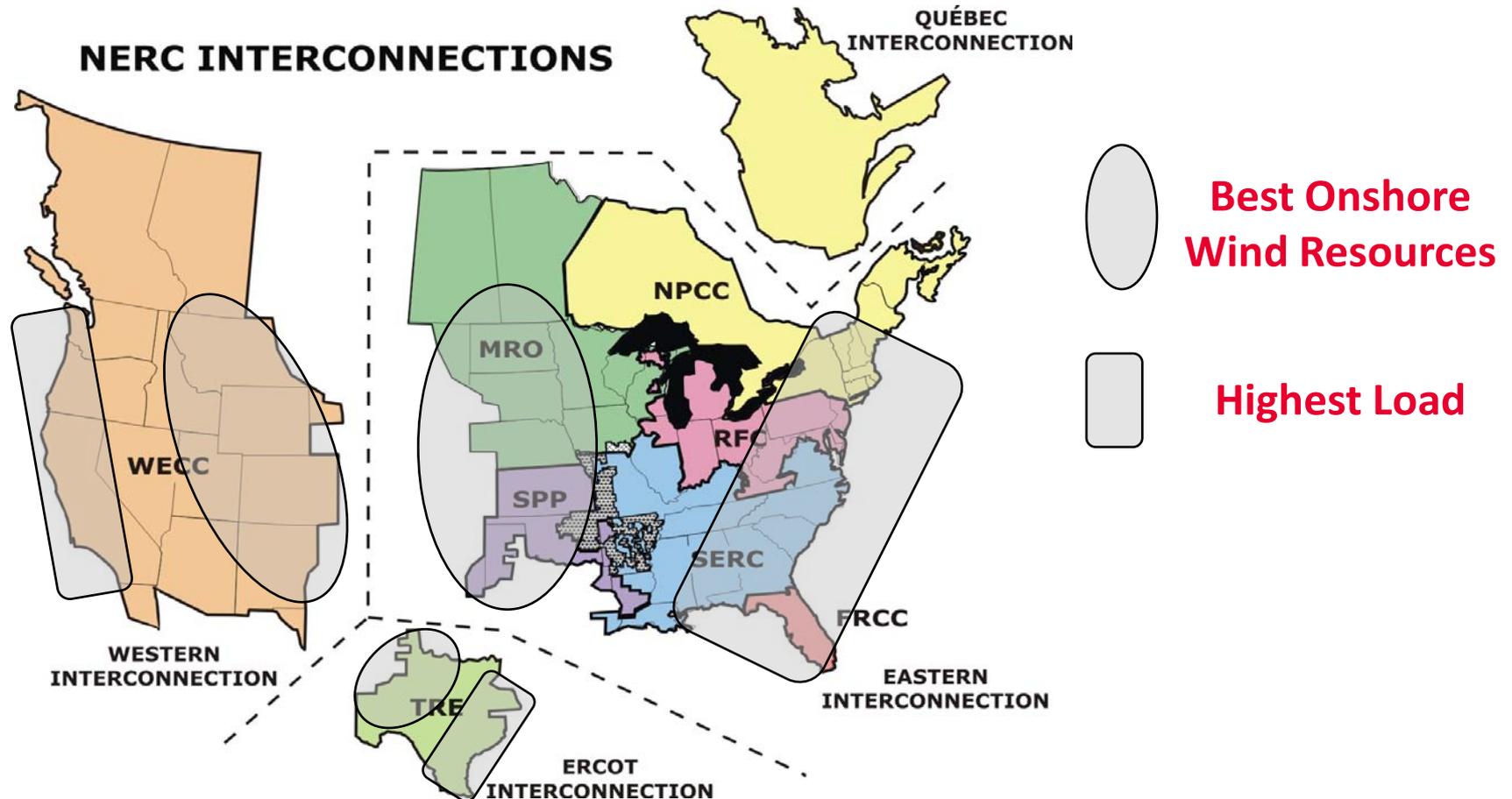
Diversity Benefits

Both variability and uncertainty of aggregate wind decrease percentage-wise with more wind, more geographic area

Transmission is key to exploiting this phenomena



Lots of wind, Lots of load, Lots of distance





Transmission Expansion Issues



- ❖ Identification of full range of benefits and impacts – along with beneficiaries and affected parties
- ❖ Costs – along with allocation and recovery
- ❖ Transmission additions can result in winners and losers
 - Some potential losers try to protect market power
 - How can they be fairly compensated?
- ❖ Opposition from those along the rights of way; visual, aesthetic, proximity, etc.
- ❖ Traditionally, justification based primarily on electrical reliability and congestion relief



Identifying Benefits and Impacts



- ❖ Traditional justification criteria are too narrow: reliability and congestion relief
 - Additional criteria of importance to society:
 - Environmental sustainability
 - Economic development
 - Energy security
 - Greenhouse gas emissions reduction
 - Consideration of alternatives; e.g., local generation, demand response

- ❖ Western Grid Group developing guidelines for consideration of all of these in transmission planning efforts



Transmission Costs



- ❖ Transmission costs generally account for under 10% of utility bills
- ❖ Seemingly endless discussion of how to allocate these costs
 - Is this driven in part by those with market power?
- ❖ SPP has a sensible approach to allocation based on voltage: Higher voltage lines provide broader benefits so costs spread broadly



Fair Treatment for Those Opposed



- ❖ Those protecting market power: their generating units may run less and command lower power prices
 - Use some units for reserves, ramping, assured capacity, other ancillary services, and pay for these services
 - Provide compensation for other assets that are truly stranded
- ❖ Landowners and communities along rights of way:
 - Provide a revenue stream: royalties, tax payments, etc.



Key Transmission Activities Underway



- ❖ Initiation of interconnection-wide transmission-planning infrastructure in the nation: Eastern, Western, Texas
 - Funded by DOE Office of Electricity (~\$60 million)
 - Fostering proactive, regional cooperative planning
- ❖ Competitive Renewable Energy Zones (CREZ) transmission planning and construction process in Texas
 - Began by identifying best wind locations in Texas
 - Process far along; construction has begun
- ❖ Western transmission planning based on a CREZ approach; now part of the DOE initiative
- ❖ California Renewable Energy Transmission Initiative (RETI)
 - Driven by California 33%-by-2020 RES



Personal Perspective on Transmission



- ❖ Wind growth has been a key driver behind the recent attention to proactive, coordinated transmission expansion
 - Access to energetic, remote wind resources
 - Growing recognition of benefits of large-area operational coordination
- ❖ Wind growth is now hampered by transmission limitations
 - Curtailment and grid-access issues
- ❖ The wind community needs to stay closely involved with current regional transmission planning processes



Personal Perspective on Transmission



- ❖ Cost Allocation and Recovery
 - Relatively small portion of delivered electricity costs
 - Can't we simply allocate much of these cost to rates?
- ❖ Transmission benefits and impacts
 - Consider broad range of societal concerns (Western Grid Group concept)
- ❖ Winners and Losers
 - Aim to make the losers whole
- ❖ Landowners and affected communities
 - Provide a revenue stream
- ❖ Give serious consideration to undergrounding
 - Ten years of permitting process is worth a lot!