



# The 20% Wind Energy Vision: Transmission and System Integration

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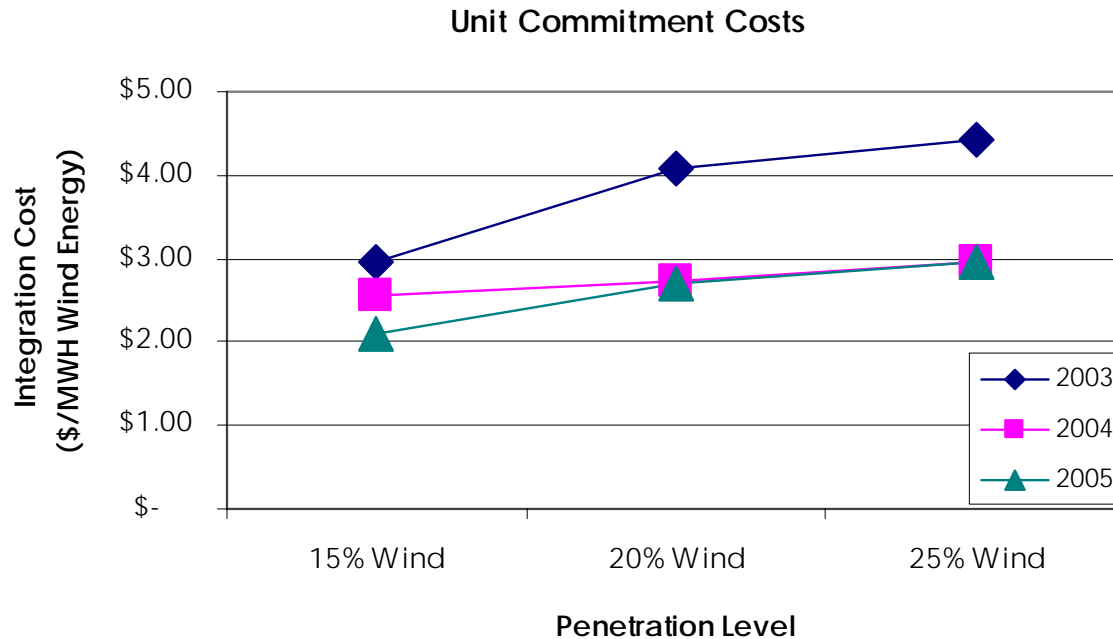
Presented at USDOE

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UWIG

# 20% Wind Energy Can Be Managed



Unit commitment costs for three penetration levels and pattern years.  
Cost of incremental operating reserves is embedded.



# Some Additional Reserves May Need to be Committed

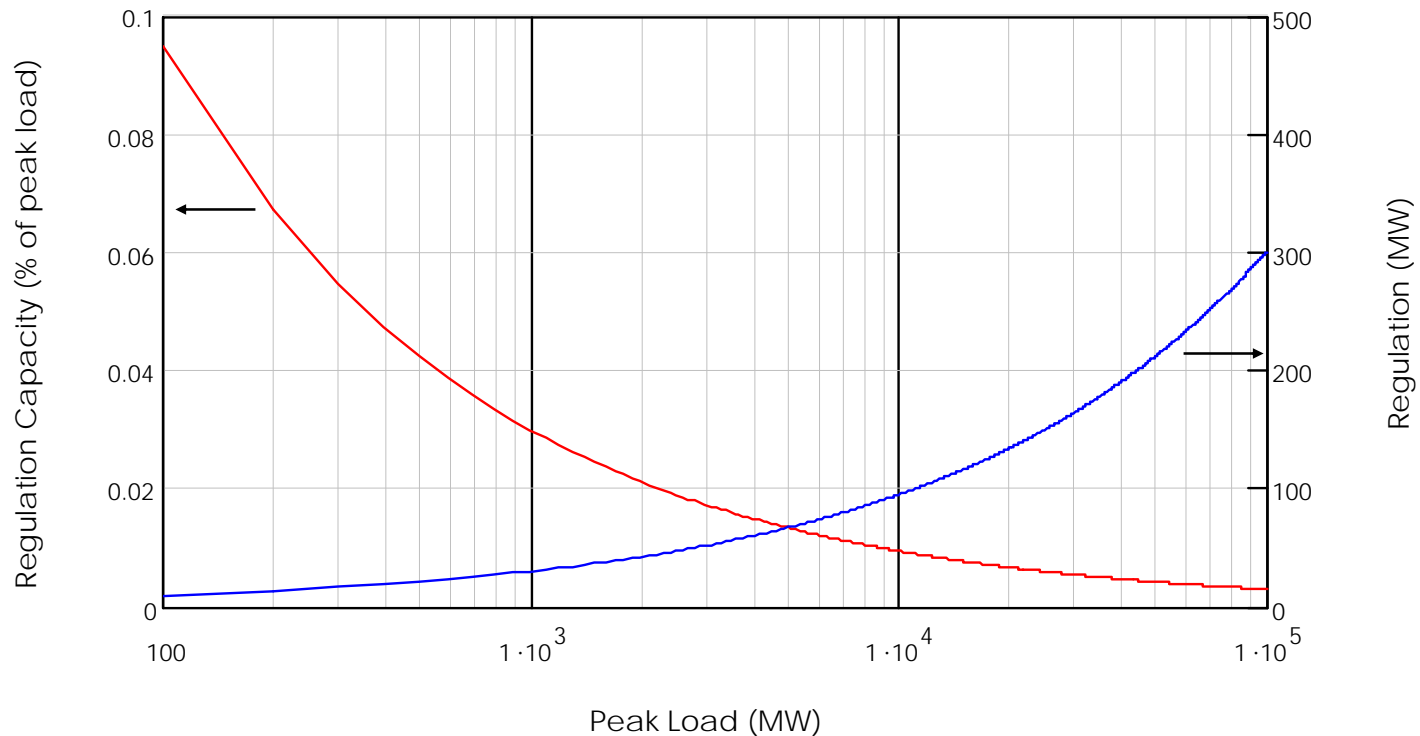
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Reserve Category	Base		15% Wind		20% Wind		25% Wind	
	MW	%	MW	%	MW	%	MW	%
Regulating	137	0.65%	149	0.71%	153	0.73%	157	0.75%
Spinning	330	1.57%	330	1.57%	330	1.57%	330	1.57%
Non-Spin	330	1.57%	330	1.57%	330	1.57%	330	1.57%
Load Following	100	0.48%	110	0.52%	114	0.54%	124	0.59%
Operating Reserve Margin	152	0.73%	310	1.48%	408	1.94%	538	2.56%
Total Operating Reserves	<b>1049</b>	<b>5.00%</b>	<b>1229</b>	<b>5.86%</b>	<b>1335</b>	<b>6.36%</b>	<b>1479</b>	<b>7.05%</b>

Estimated Operating Reserve Requirement for  
MN BAs – 2020 Load

Source:  
MN DOC  
**DOE Plng Mtg, Feb '08 -- 3**

# Large Balancing Areas Reduce Reserve Requirements



Approximate regulating requirements for a BA  
as a function of peak demand.

# A Comparison of Regulating Reserves

<i>Balancing Authority</i>	<i>Peak Load</i>	<i>Regulating Requirement (from chart)</i>	<i>Regulating Requirement (% of peak)</i>
Great River Energy	3443 MW	56 MW	1.617%
Minnesota Power	2564 MW	48 MW	1.874%
Northern States Power	12091 MW	104 MW	0.863%
Otter Tail Power	2886 MW	51 MW	1.766%
Sum of Regulating Capacity		<b>259 MW</b>	
Combined	20984 MW	<b>137 MW</b>	<b>0.655%</b>

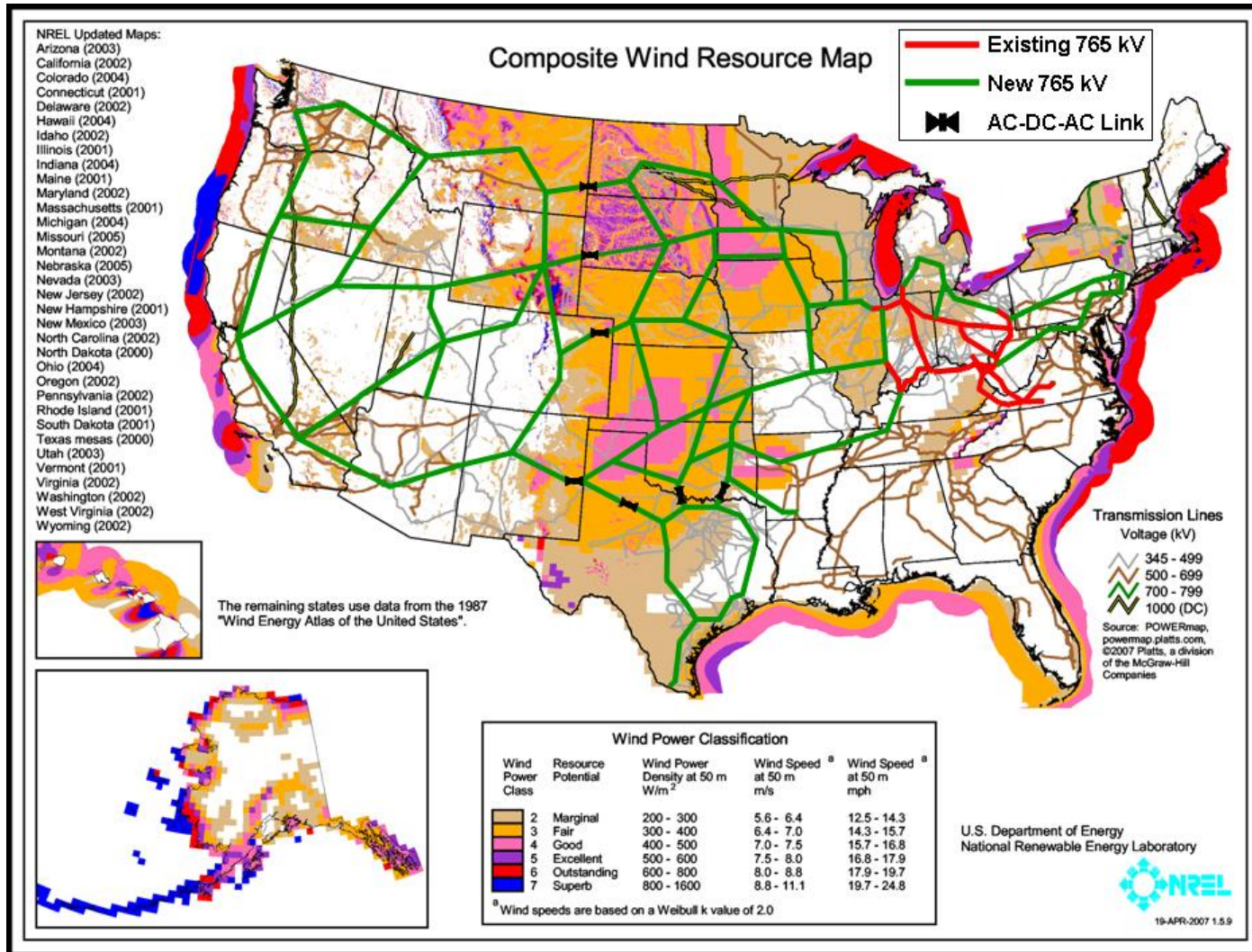
Estimated Regulating Requirements for MN BAs - 2020

# Transmission Issues

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- ◆ Existing transmission system infrastructure is inadequate to achieve the vision
  - Insufficient capacity
  - Aging and congested
  - Reliability and operational flexibility concerns
- ◆ Current situation leads to inadequate generation competition
- ◆ Conceptual 765 kV EHV overlay examined by AEP
- ◆ Investment of \$60 billion over next 20 years for 19,000 mi of line to deliver additional 200-400 GW
- ◆ Equivalent to approximately \$20B on present worth basis
- ◆ Current transmission investment \$7 billion/yr and growing

# Conceptual EHV Transmission Overlay



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- ◆ Perform detailed wind integration studies
  - ◆ Deploy more flexible generation and load technologies
  - ◆ Improve wind plant output forecasting tools
  - ◆ Improve grid codes and wind plant models
  - ◆ Aggregate wind plant output over large regions
  - ◆ Improve balancing area consolidation and ACE sharing
  - ◆ Ongoing forums to share operating experience

# Transmission Planning Recommendations

- ◆ Develop adequate transmission capacity
- ◆ Comprehensive regional planning processes
- ◆ Federal leadership in developing transmission in the national interest
- ◆ More certainty of transmission cost recovery
  - State policy on recovery for RPS (CA, TX)
  - State policy on current cost recovery
  - FERC protection from stranded cost
- ◆ Reassessment of transmission financing approach
  - Participant funding is a non-starter
  - Economies of scale and limited right-of-ways
  - Load pays in the end

## Market Operation and Transmission Policy Recommendations

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- ◆ Develop well-functioning hour-ahead and day-ahead energy and price responsive load markets and expand access to those markets
- ◆ Adopt market rules and tariff provisions that are more appropriate to weather-driven resources
- ◆ Make better use of physically (in contrast with contractually) available transmission capacity
- ◆ Eliminate pancaked rates

## and the conclusion is...

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- ◆ There are no fundamental technical barriers to the integration of 20% wind energy into the nation's electrical system, but...
- ◆ There needs to be a continuing evolution of transmission planning and system operation policy and market development for this to be achieved.