

# NERC

NORTH AMERICAN ELECTRIC  
RELIABILITY CORPORATION

## Methods to Model and Calculate Capacity Contributions of Variable Generation for Resource Adequacy Planning (IVGTF1-2)

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to ensure  
the reliability of the  
bulk power system

# Scope & Objectives (continued)

- Specific actions, practices and requirements, including enhancements to existing or development of new reliability standards
  - Calculations and metrics, including definitions and their applications used to determine capacity contribution and reserve adequacy.
  - Contribution of variable generation to system capacity for high-risk hours, estimating resource contribution using historical data.
  - Probabilistic planning techniques and approaches needed to support study of bulk system designs to accommodate large amounts of variable generation.

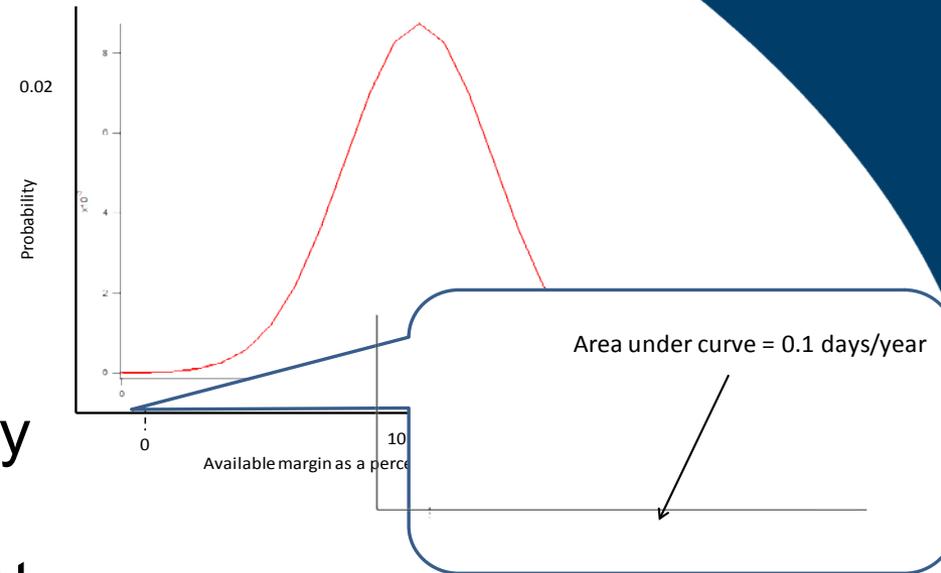
# Scope & Objectives

- Consistent and accurate methods are needed to calculate capacity values attributable to variable generation.
- Technical considerations for integrating variable resources into the bulk power system

- Introduction
- Traditional Resource Adequacy Planning
- Data Limitations
- Approximation Methods
- Ongoing Variable Generation Actions
- Conclusion and Recommendation
- Appendix: Results from Western and Eastern integration studies

- Draft report presented to NERC Planning Committee December, 2010
- Final report approved by NERC Planning Committee March 2011
- Task 1.2 initial coordination with NERC Resource Issues Subcommittee
- Presentation and comments from NERC's LOLEWG

- Loss of Load Expectation, LOLE
  - LOLE analysis is typically performed, calculations can be done hourly or daily on a system to determine the amount of capacity that needs to be installed to meet the desired reliability target. Common target is 0.1 days/year. Fundamental metric is LOLP; basis of LOLE.



# Traditional Resource Adequacy Planning

- **Loss of Load Hours, LOLH**

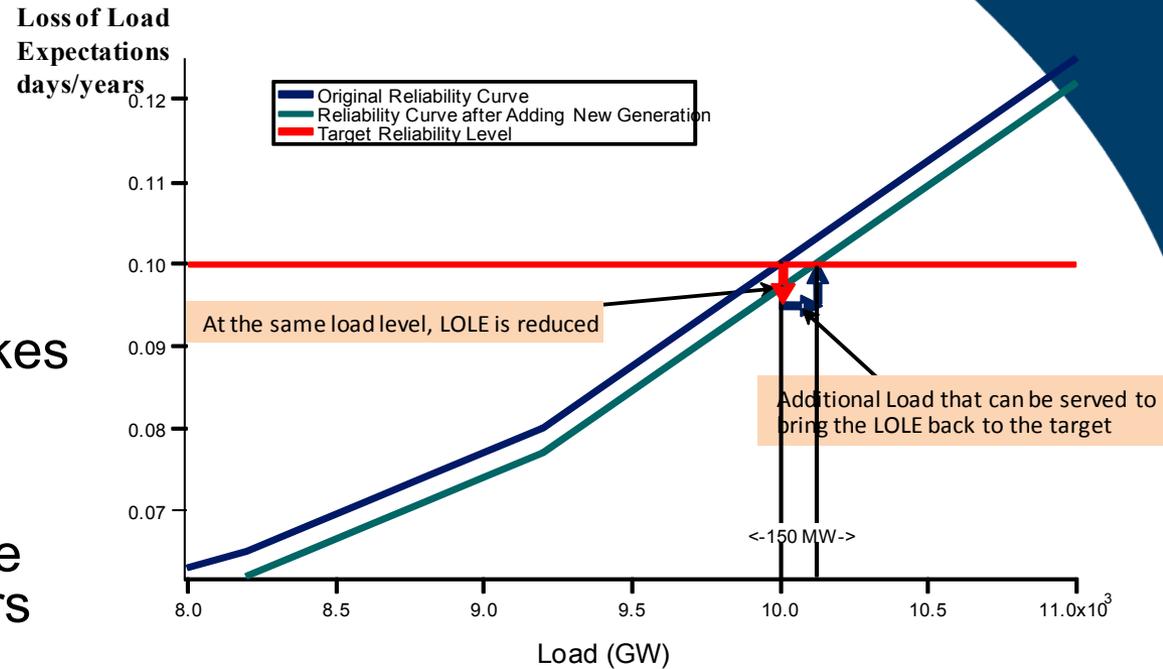
LOLH is concerned only with the number of hours of shortfall, and does not include any dimension for persistence of an outage event and therefore there is no quantification about how many days the outage is spread over.

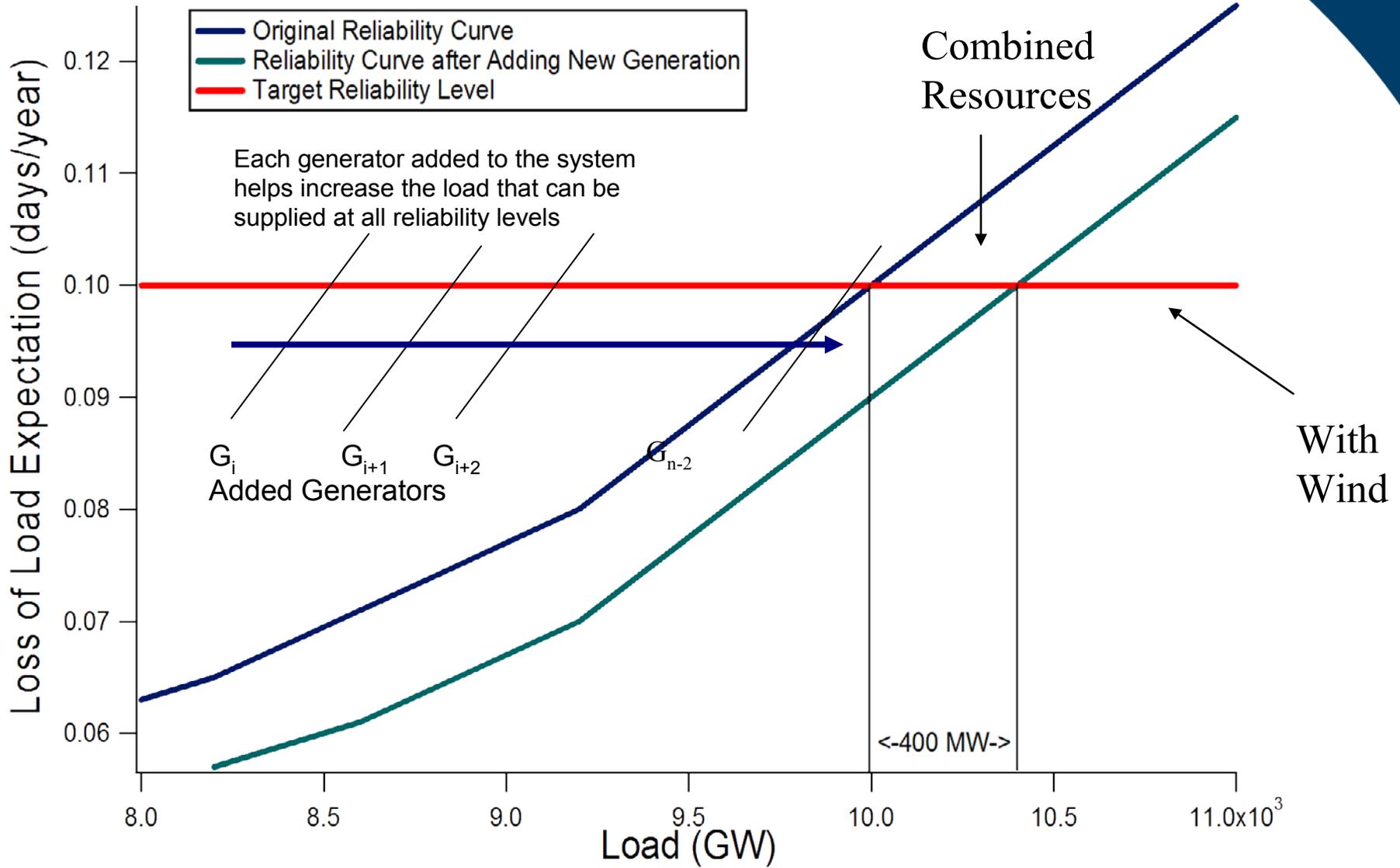
- **Expected unserved energy, EUE**

EUE measures cumulative probabilistic energy shortfall

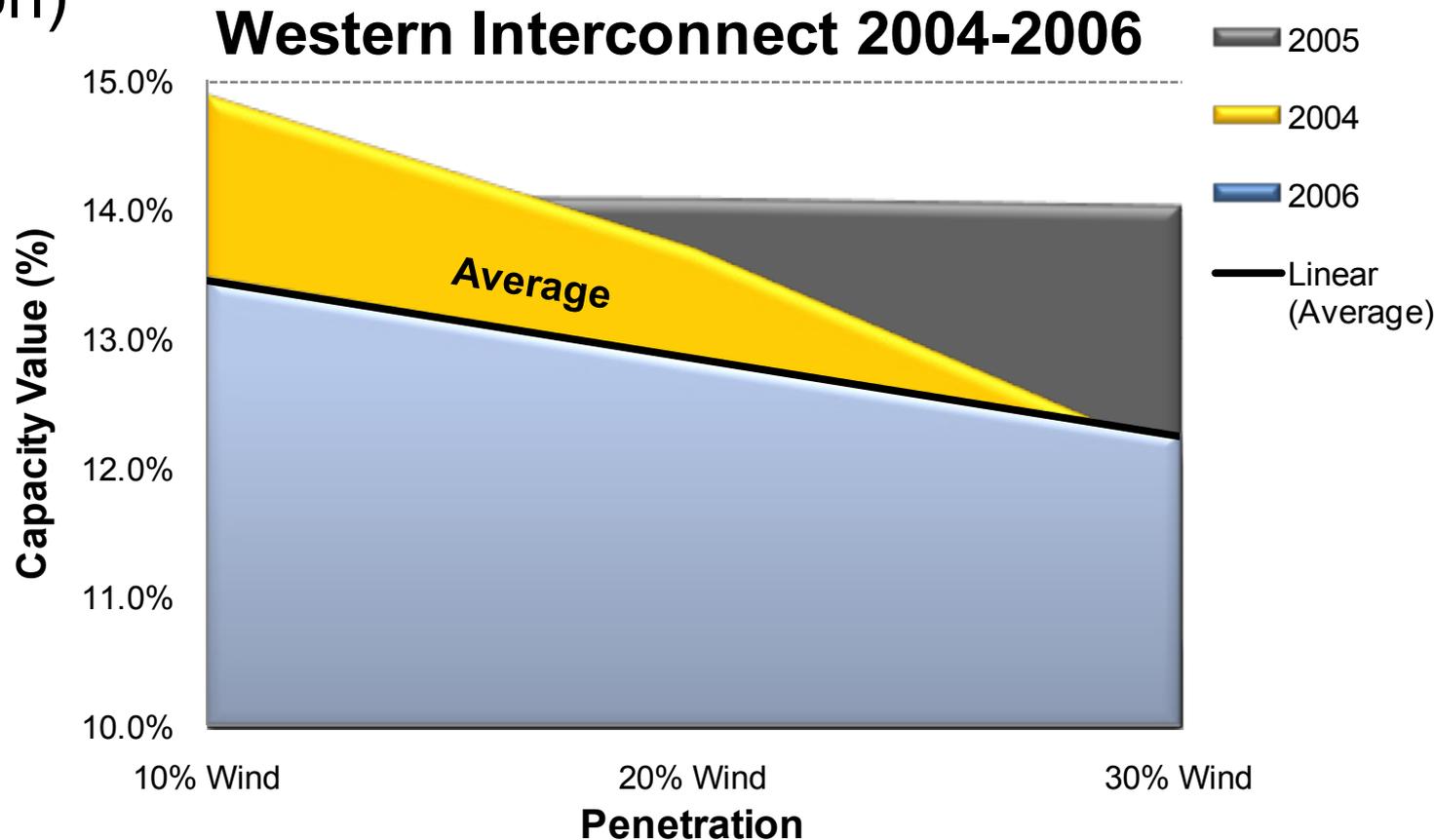
# Traditional Resource Adequacy Planning (continued)

- Effective Load Carrying Capability, ELCC
- ELCC essentially decomposes the contribution that an individual generator (or group of generators) makes to overall resource adequacy. A generator contributes to resource adequacy if it reduces the LOLP in some or all hours or days. Conventional generators' contribution to adequacy is typically a function of the unit's capacity and forced outage rate.





- Wind ELCC declines with penetration
- Inter-annual variation implies need for many years of data (as with conventional generation)



- Approximations are less than ideal and often do not take LOLP or risk into account

- Approximation to Reliability Analysis:

$$R' = \text{Exp}\{-(P-L)/m\}$$

Where:

P = annual peak load,

L = load for the hour in question,

R = the risk approximation (LOLP), measured in relative terms (peak hour risk = 1)

- Time Period Methods

- Define the relevant time period to use
- Calculate the mean output of the variable generation over that period; or alternatively calculate a percentile or exceedence level of the variable generation over the period

- Data
  - Thermal Generation does exist
    - Long-term forced outage rates
    - GADS
  - Wind and Solar does not have sufficient long term data
- Need for data from variable generation
  - Collected by NERC's GADS
  - Currently does not satisfy requirements for capacity valuation of variable generation

# Conclusions and Recommendations

*Additional research to equate traditional reliability targets (such as 0.1day/year) to alternative metrics is recommended. As adequacy studies are performed, we also recommend comparisons of results based on these alternative metrics.*

*Alternative approaches and assumptions regarding the treatment of interconnected systems should be transparent to the analysis, and the development one or more common approaches for handling the impact of interconnected systems in the reliability assessments will be useful.*

*Planning Reserve Margin levels should be benchmarked with, or derived from, an LOLP or related approach to resource adequacy. This should be done periodically to ensure that any correlation between a 0.1days/year target (or other adopted target) and a given Planning Reserve Margin do not change as a result of an evolving resource mix.*

# Conclusions and Recommendations (continued)

*Simplified approaches should be benchmarked and calibrated to the rigorous ELCC calculations to ensure the validity of the approximation.*

*NERC should design and implement a way to collect high-quality variable generation data that would help inform calculations of capacity value. The development of such a database should consider defining relevant time periods for the variable generation data.*

# Conclusions and Recommendations (continued)

*NERC should request that government agencies like the DOE, working with NOAA/NCAR develop annual high-resolution, modeled wind power and solar power data on 10-minute time scales (or faster, as technology allows) and 2 km (or smaller) geographic grids. NERC should consider collecting 10-minute load data to support reliability and other analyses.*

*NERC should facilitate the dissemination of information on how LOLP-related reliability and adequacy calculations perform and what they measure.*

- Task Force on the Capacity Value of Wind Power, IEEE Power and Energy Society: Capacity Value of Wind Power
- In press, IEEE Transactions on Power Systems



# Question & Answer