Exhibit ___ (GWE-15)

Minnesota Wind Integration Study

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Overview

- Study Background
- Key Issues
- Objectives & Scope
- Methods & Key Results
- Summary

Background

- In May of 2005 the MN Legislature adopted a requirement for a Wind Integration Study of the of the impacts on reliability and costs associated with increasing wind capacity to 20% of MN retail electric energy sales by 2020.
- Law authorizes and directs the Reliability Administrator to manage the study.
- PUC directed all MN utilities to participate in the study; to use the results to estimate impacts on rates; and to incorporate the findings in resource plans and renewable energy objective reports.
- Reliability Administrator assembled a broad stakeholder group (MN Utilities, MISO, MAPP, Chamber of Commerce, Environmental Orgs, AWEA, UWIG, NREL, ORNL, etc) to develop the study scope based upon an extensive literature search, insights from recent studies, and stakeholder input.

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Background

- Study was competitively bid to qualified consultants; Reliability Administrator selected EnerNex/WindLogics to perform the study.
- MISO has been a key study participant supplying power system data and models, contributing technical expertise, and, in collaboration with the study contractor, has run much of the power system modeling.
- A Technical Review Committee of regional and national experts on wind generation and power systems analysis was assembled to guide and review the study.
- An aggressive schedule for the study began in December 2005; study was completed in November 2006.

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Key Issues

- Reliable power system operation requires precise balance between load and generation.
- Capacity value of power plants depends on their contribution to system reliability.
- Output of wind plants cannot be controlled and scheduled with a high degree of accuracy.
- Wind generation is becoming large enough to have measurable impact on system operating cost.
- Recent development of regional energy markets and current development of regional ancillary services markets.

Objectives

- Evaluate impacts on reliability and costs associated with increasing wind capacity to 15%, 20%, and 25% of Minnesota retail electric energy sales by 2020;
- Identify and develop options to manage the impacts of the wind resources;
- Build upon prior wind integration studies and related technical work;
- Coordinate with recent and current regional power system study work;
- Produce meaningful, broadly supported results through a technically rigorous, inclusive study process.

Study Context

- All utilities with Minnesota retail electric sales are participating in this study, totaling approximately 62,000 GWh in 2004
- Eight Balancing Authorities are represented
- Over 85% of the retail sales are in the four largest Balancing Authorities:
  - Xcel Energy (NSP)
  - Great River Energy
  - Minnesota Power
  - Otter Tail Power

Study Context

- Projected to 2020, 20% of retail sales requires approximately 4,500 MW of total wind generation
- Study area within the NERC reliability region Midwest Reliability Organization (MRO) and the Mid-Continent Area Power Pool (MAPP) Generation Reserve Sharing Pool
- Nearly 95% of the retail sales are within the Midwest Independent System Operator (MISO)

Study Scope

- Characterize the Wind Resource & Technology
  - detailed modeling of temporal and spatial variations
- Evaluate Wind Integration Reliability Impacts
  - regional reliability analysis
- Evaluate Wind Integration Operating Impacts
  - regulation, load following, unit commitment

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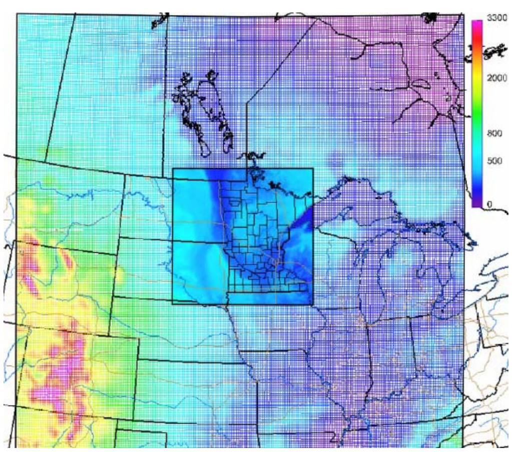
Characterize the Wind Power Resource



- WindLogics utilized a sophisticated, science-based atmospheric model (run for 3 full years, normalized to 40 year database, validated with actual historical data)
- Nested grid with innermost values extracted every 5 minutes

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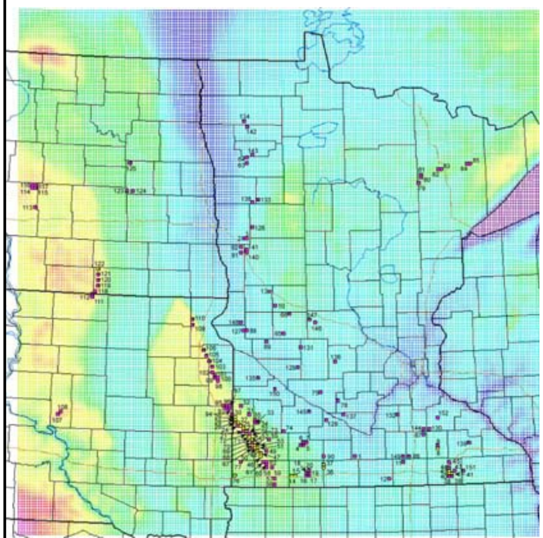
Characterize the Wind Power Resource



- 152 proxy tower (wind plant) locations
- Modeled results include wind speed, air density, power density, energy production
- Temporal and geographic variations are characterized
- Benefits shown for geographic diversity & for a sophisticated method of forecasting wind power production

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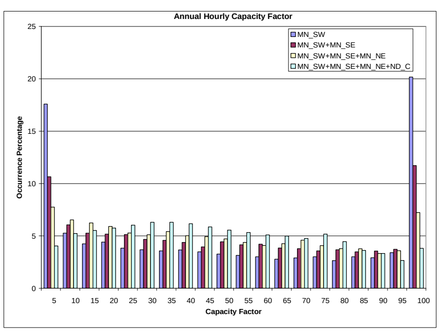
Benefits of Geographic Diversity

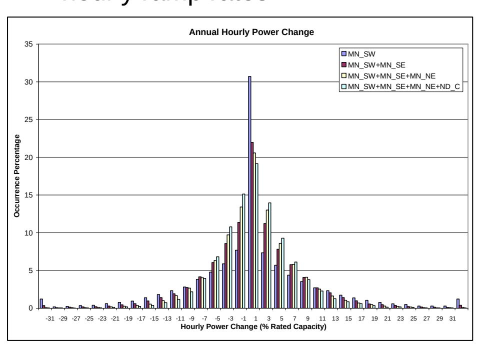


Annual histogram of hourly capacity factor

Progressive increase in geographic dispersion of wind generation substantially

- Reduces time when little or no power is produced;
- Increases production in 20-80% capacity factor range;
- Reduces frequency of large hourly ramp rates.

Both graphs show four levels of geographic dispersion starting with just SW MN and building up to include the full study area



Annual frequency distribution of hourly power change

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Models & Assumptions

- Wind Scenarios
  - 15%, 20%, & 25% of MN retail electric energy sales in 2020 (~3500, 4600, & 5700 MW of wind generation)
  - Three years modeled (2003, 2004, & 2005)
- MISO Market & Reliability Authority
  - West Regional Study Group model
    (included regional transmission & non-wind generation expansion plans; wind generation was connected at the EHV level)
  - Consolidated Balancing Authority functions
- Reliability analysis
  - Loss of Load Probability (GE MARS and NEA Marelli)
- Operating Impacts
  - Synchronized load & wind generation data
  - Hourly security-constrained economic dispatch (PROMOD)

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Evaluate Reliability Impacts

- Wind generators capacity contribution is based on its influence on overall system reliability
- Effective Load Carrying Capability (ELCC), a common reliability measure, is evaluated to determine wind generation reliability impacts
- The system's hourly loads and generation are modeled with and without the wind generators while maintaining a fixed reliability level (one day in ten years)
- Results show the ELCC values of approximately 20%, 12%, and 5% of nameplate for the three years studied
- Significant inter-annual variability, more years of data would increase confidence

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Evaluate Operating Cost Impacts

- Determine how the costs to serve load are affected by accommodating the wind generation while maintaining the reliability and the security of the power system
- Impacts result from the variability and predictability of wind generation for the time frames:
  - Regulation
  - Load Following
  - Scheduling / Unit Commitment
- Evaluate impacts in the MISO market context

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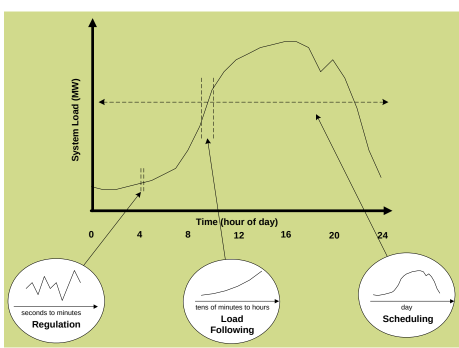
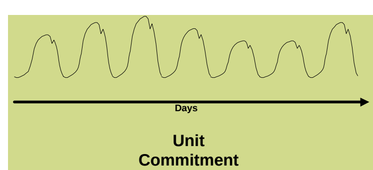
Power System Operation Impacts

Time Scales of Interest:



- **Regulation** -- seconds to a few minutes -- similar to variations in customer demand
- **Load-following** -- tens of minutes to a few hours -- usage follows predictable patterns



- **Scheduling and commitment of generating units** -- one to several days

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Power System Operation Impacts

- **Regulation**: *Can wind plants affect or increase the area control error (ACE)?*
- **Load following**: *What happens if wind plant output decreases in the morning when the load is increasing?*
- **Scheduling**: *How can committed units be scheduled for the day if wind plant output is not predicted? What happens if the wind forecast is inaccurate?*
- **Committing generating units**: *Over several days, how should wind plant production be factored into planning what generation units need to be available?*
- **Market Operations:** *How does large amounts of wind generation affect regional energy markets? Does congestion result?*

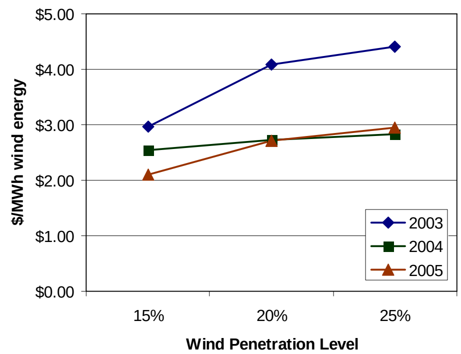
Operating Cost Impacts

- For 3500 to 5700 MW of wind generation delivered to MN load (15 to 25% of retail electric energy sales in 2020):
  - An increase of 12 to 20 MW of regulating capacity;
  - No increase in contingency reserves;
  - An increase of 5 to 12 MW in five minute variability;
  - Incremental operating reserve costs of $0.11 per MWh of wind generation (20% wind case);
- No significant congestion issues attributable to wind generation and no periods of negative LMPs under the assumed transmission expansion

Operating Cost Impacts

The total wind integration operating cost ranges from a low of $2.11 to a high of $4.41 per MWh of wind generation delivered to Minnesota utilities

All-in operating cost (includes regulation, load following, unit commitment, uncertainty & variability)



Summary

- The addition of wind generation to supply 15, 20, & 25% of Minnesota retail electric energy sales can be reliably accommodated by the electric power system.
- The total integration operating cost for up to 25% wind energy delivered to Minnesota customers is less than $4.50 per MWh of wind generation.

  Key drivers include:
  - A geographically diverse wind scenario;
  - The large MISO energy market;
  - Functional consolidation of balancing authorities;
  - Sufficient transmission.

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The full study is posted on the
Minnesota Public Utilities Commission web site.

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