

Integration of Wind Generation in Minnesota and the Upper Midwest -

Reliable, Economical, Achievable

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Wind Generation in Minnesota

❖ 2007 Minnesota Renewable Energy Standard (RES)

- Requires MN utilities to procure enough renewable energy (wind, solar, biomass, small hydro) to provide 25% of their retail electric energy sales by 2025, with Xcel to procure 30% by 2020
- **Installed Minnesota wind capacity: 2,965 MW (December 2012)**
 - **Wind generation: 15% of total Minnesota's annual electric energy (2013)**
- Most Minnesota utilities have already acquired enough renewable energy to meet their RES requirements for a number of years forward

❖ Upper Midwest (MISO) wind generation

- **Installed MISO wind capacity: 12,270 MW (December 2012)**
 - Record wind peak: 10,012 MW (Set 11/23/12; ~25% of gen output at the time)
- **Wind generation: 6% of total MISO annual electric energy (2012)**
- Full implementation of the current Upper Midwest RESs will result in only ~12% wind energy on the MISO grid (2025)
- **Increasing MN RES to 40% would result in only ~14% wind energy on the MISO grid (2030)**

Sources: MISO Management Presentation to BOD (Markets Committee) 2/15/12;
MISO Press Release 11/27/12

Wind Integration

- ❖ Variability and uncertainty are common characteristics of all power systems
 - Due to continually changing loads, imports and exports; Managed by grid operators with reserves
 - Wind generation adds incrementally to the overall variability of the power system (MISO estimates that current wind generation is responsible for only ~5% of regional power system variability; most is varying loads and imports / exports)

- ❖ Wind integration impacts are significantly reduced with the MISO markets and a strong regional grid:
 - Large, liquid, fast markets
 - Large balancing areas with a strong grid:
 - Captures significant benefits of diversity (geographic, resource, load)
 - Enables access to the physical flexibility that exists in the regional power system
 - Forecasting wind generation significantly reduces uncertainty and costs

Wind Integration

- ❖ Numerous peer reviewed studies have shown that power systems have a much greater ability to handle variable renewable energy than commonly understood.
 - None of the domestic or international wind integration studies have found a “hard limit” to wind saturation
- ❖ Studies find that the cost of integrating wind into power systems is manageable
- ❖ **The 2006 Minnesota Wind Integration assessed the operational impacts of the variability of wind generation**
 - The study found that large amounts of additional Minnesota wind generation can be reliably accommodated by the electric power system if sufficient transmission investments are made to support it.

Wind Integration

- ❖ MISO grid operators have already gained significant experience successfully integrating wind
 - Wind helps keep prices low for MISO customers and the end-user consumer
 - Output variability is being mitigated by geographic diversity
 - Wind forecasting has improved and is expected to continue improving
 - Wind has had a small impact on regulation reserves
 - Contingency reserves have never been deployed due to a drop in wind output
 - Wind contributes to peak load (2013 fleet capacity value: 13% of nameplate wind)
 - “MISO does not currently anticipate significant operational management issues in the next several years.”



Sources: MISO Management Presentation to BOD (Markets Committee) 2/15/12;
MISO Press Release 11/27/12

Regional Transmission

- ❖ Minnesota and the Upper Midwest Region have already studied and initiated significant new transmission development resulting in improved reliability, lower costs, and increased ability to integrate renewable energy.
- ❖ Minnesota utilities have done a good job with transmission:
 - Transmission study process
 - State regulatory approval (need, siting/routing)
 - Constructing the new transmission lines (on time, on budget)
- ❖ Minnesota transmission development
 - CapX Group I lines – 600 miles of new transmission that serve multiple purposes including keeping the lights on (reliability), mitigating local load serving issues and integrating a growing amount of renewable (wind) energy
 - 2009 Minnesota Renewable Energy Standard Transmission Study
- ❖ MISO transmission development
 - 2011 Multi Value Transmission Portfolio – 17 new transmission lines for the region needed for multiple purposes

