

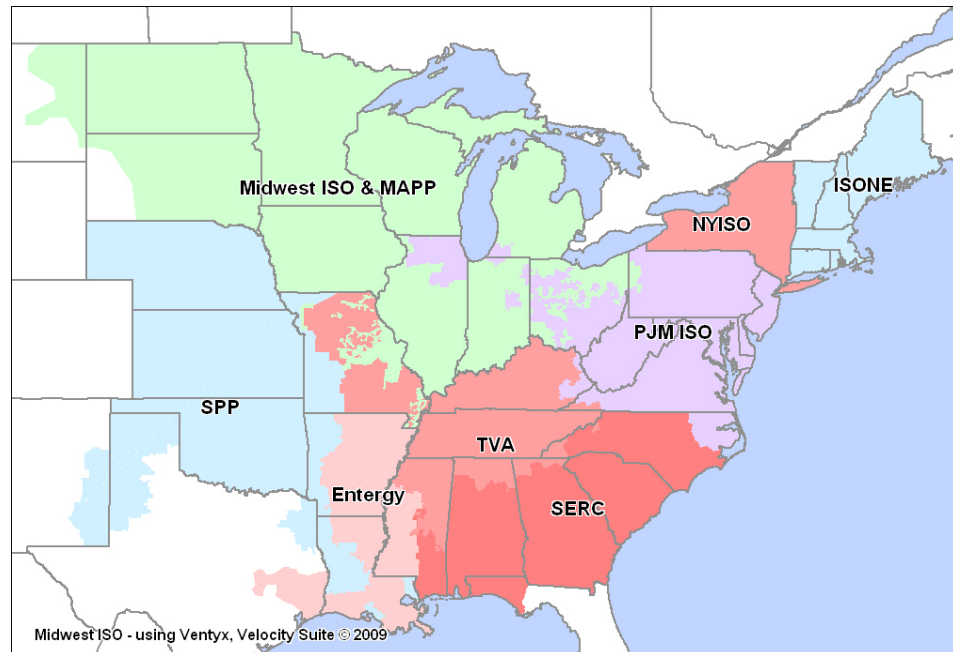
Eastern Wind Integration and Transmission Study

Great Lakes Regional Wind Energy
Workshop
March 1, 2010

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National Renewable
Energy Lab

EWITS Analysis - What is Needed to Integrate 20% Wind in the Eastern Interconnect?

- Evaluate the power system operating impacts and transmission associated with increasing wind energy to 20% and 30%
- Build upon prior wind integration studies and related technical work;
- Coordinate with current regional power system study work;
- Produce meaningful, broadly supported results
 - Technical Review Committee



Technical Review Committee

- Includes representation from the following organizations

New York Independent System Operator (NYISO)

Xcel Energy

Southern Company

PJM Interconnection

Southwest Power Pool(SPP)

U.S. Department of Energy

Midwest ISO (MISO)

Michigan Public Service Commission

Area Power Pool (MAPP)

American Wind Energy

Association (AWEA)

Federal Energy Regulatory Commission (FERC) – observer status

North American Electric Reliability Corporation (NERC)

CapX 2020 (Great River Energy)

Windlogics

National Renewable Energy Lab

General Electric (GE)

Regulatory Assistance Project

University College Dublin

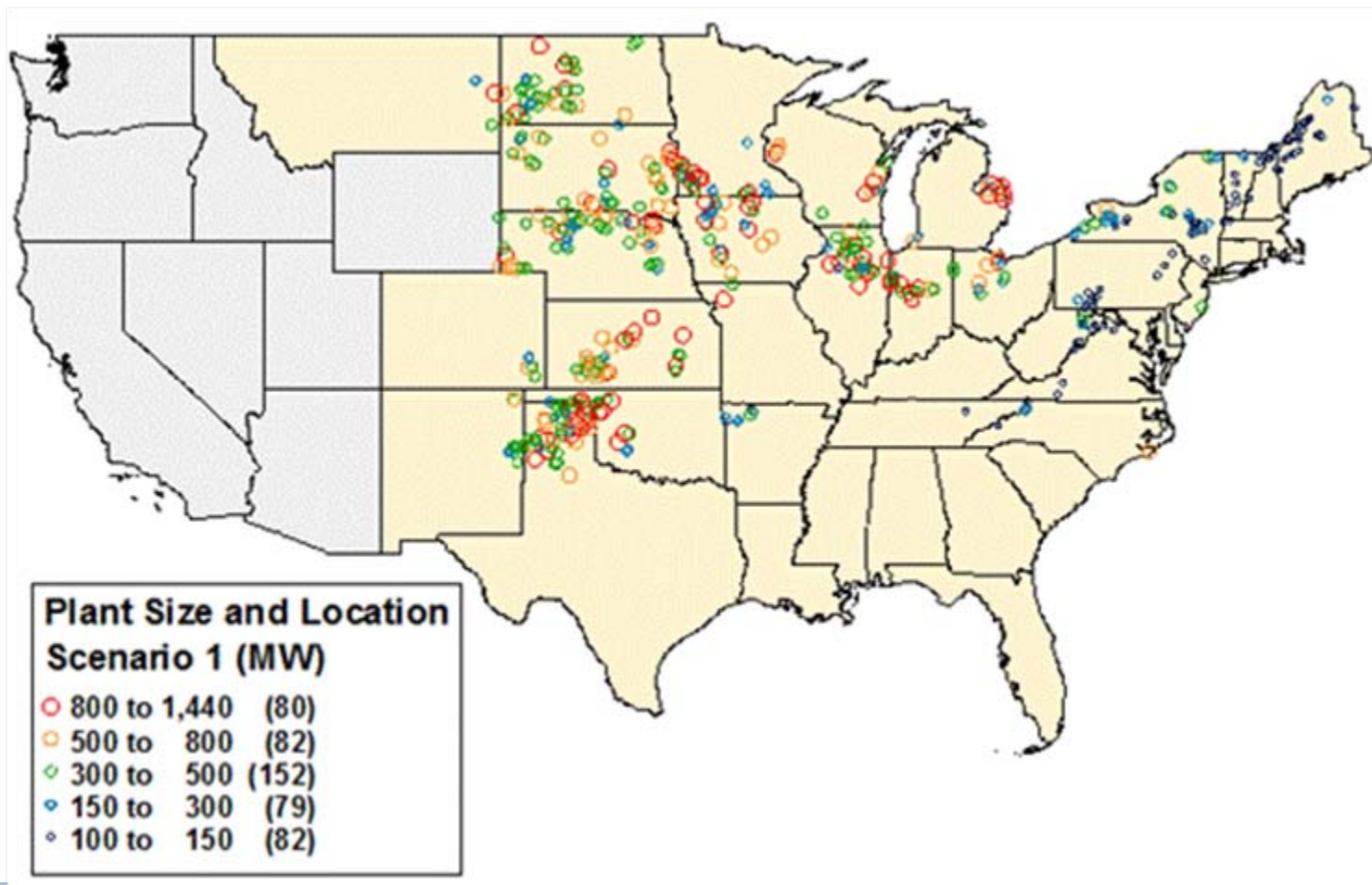
Organization of MISO States (Wisconsin Public Service Commission)

EWITS Analysis Provides Detailed Information on

- Wind generation required to produce 20% and 30% of the projected electric energy demand over the U.S. portion of the Eastern Interconnection in 2024
- Transmission concepts for delivering energy economically for each scenario
- Economic sensitivity simulations of the hourly operation of the power system with wind generation, future market structures and transmission overlay
- The contribution made by wind generation to resource adequacy and planning capacity margin

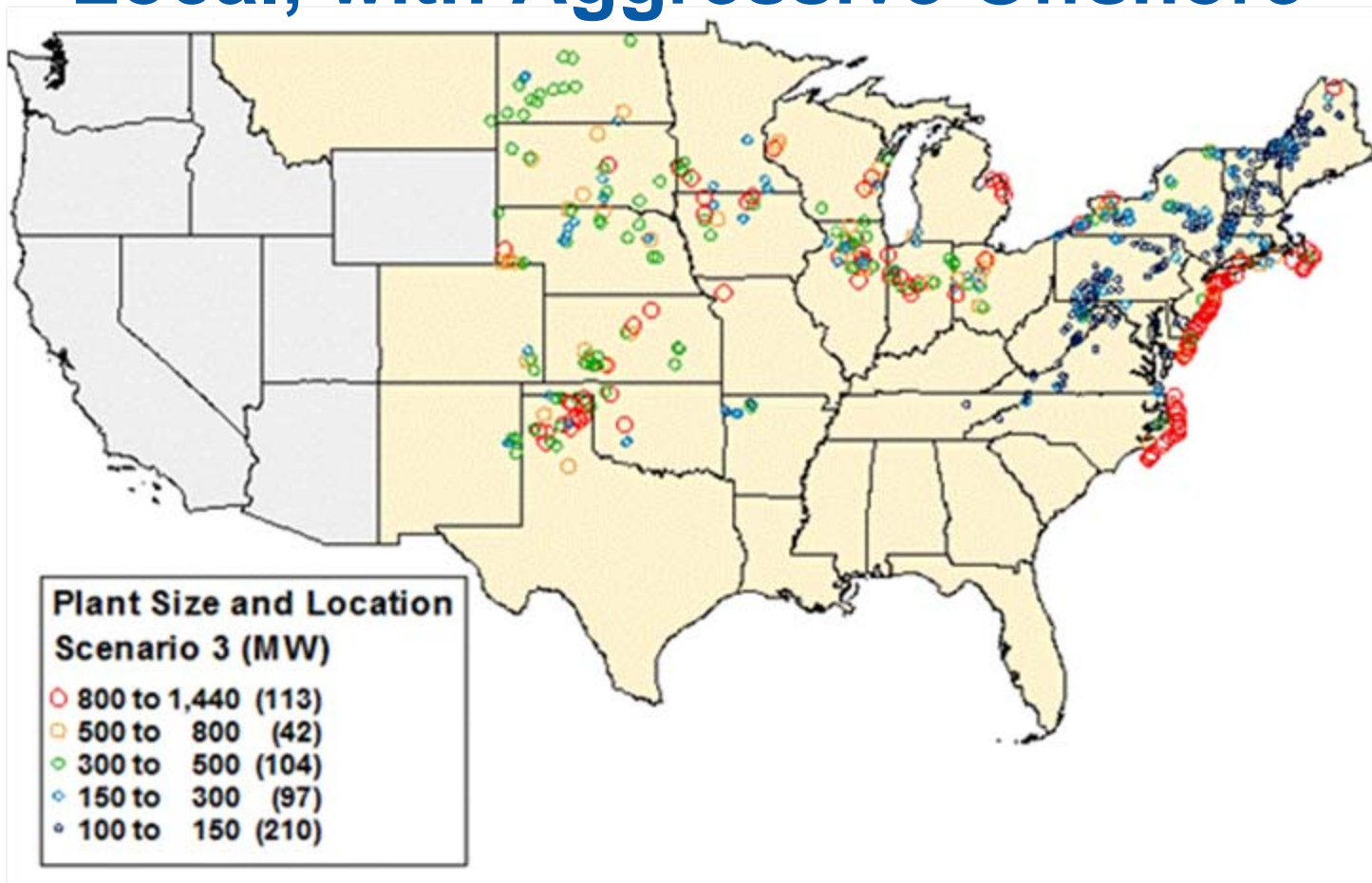
Scenario 1 – 20%

“High Capacity Factor, On shore”

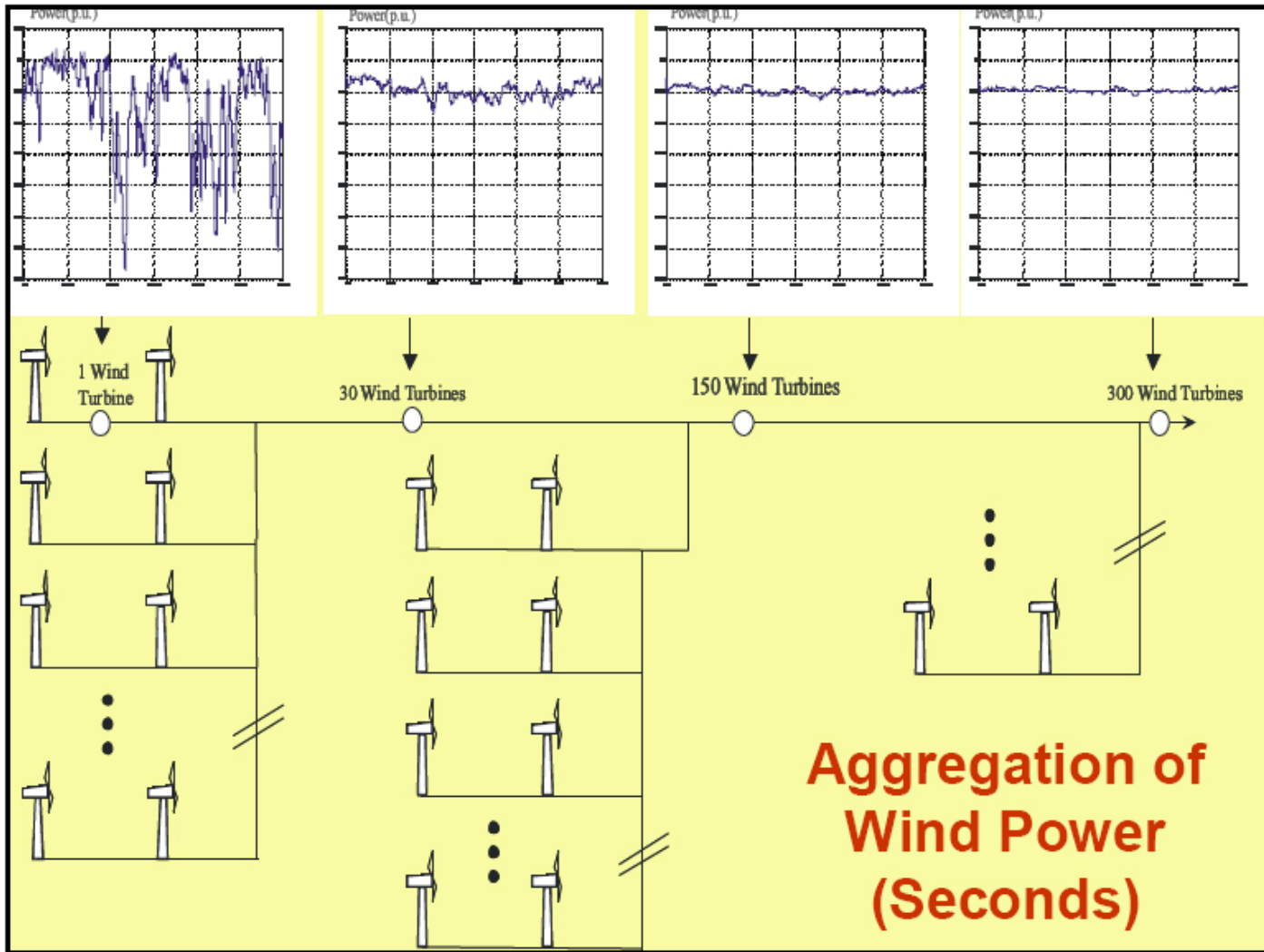


Scenario 3 - 20%

“Local, with Aggressive Offshore”



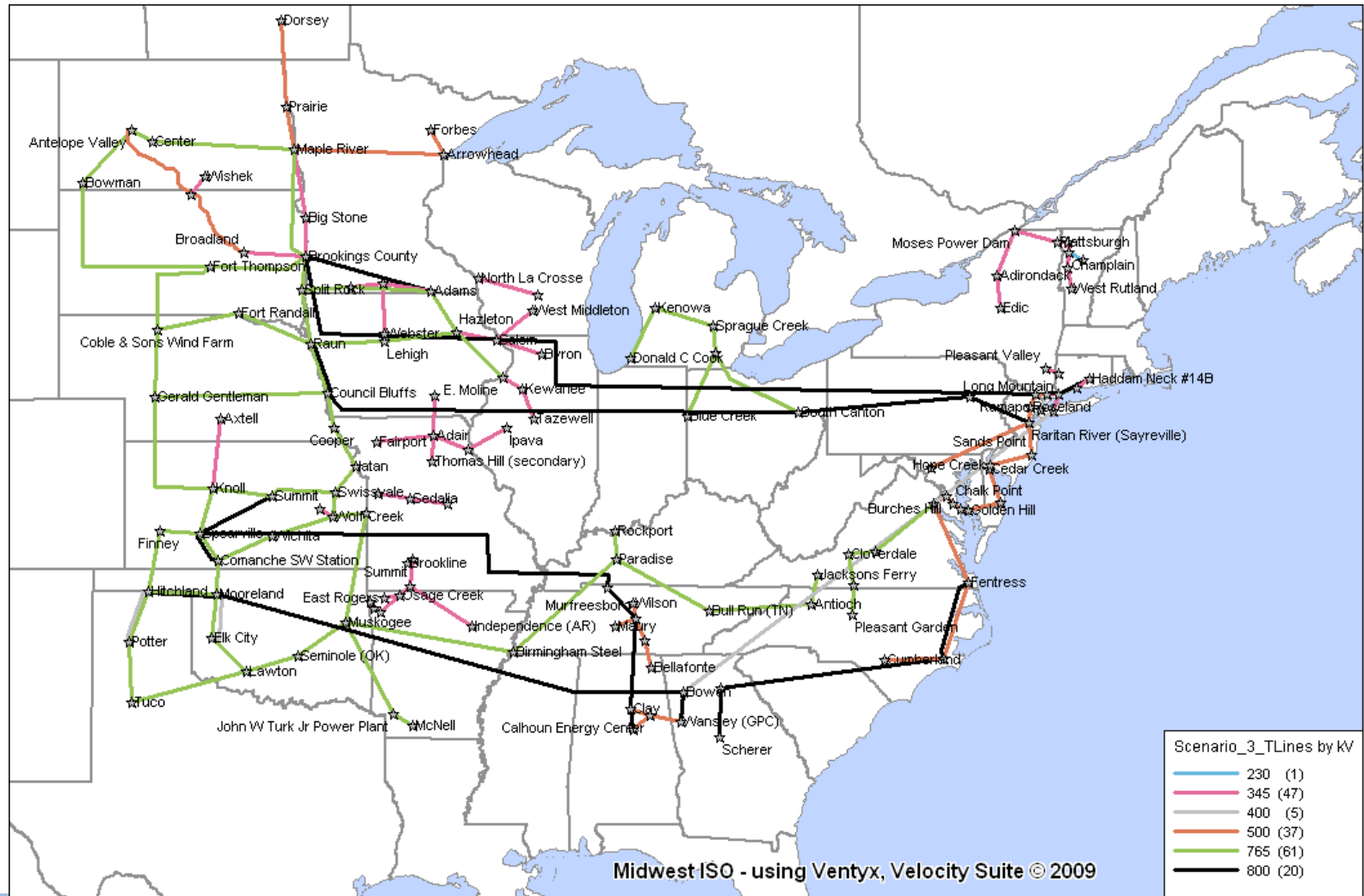
The Power of Aggregation and Geographic Diversity



Key Task - Transmission

- High levels of new transmission are needed across the 4 scenarios
 - **Some transmission elements are common to all overlays**
- Reference case, 20% and 30% wind scenarios all require a significant transmission build out, otherwise they are not feasible
- Transmission reduces variability and provides capacity benefits in its own right, and enhances the reliability contribution of wind generation
- The conceptual transmission overlays consist of multiple 800kV HVDC and EHV AC lines

Transmission Overlay for Scenario 3



EWITS Conclusions

- 20 and 30% wind penetrations are technically feasible with significant expansion of the transmission infrastructure.
 - New transmission will be required for all the future wind scenarios in the Eastern Interconnection,
- Without transmission enhancements, substantial curtailment of wind generation will occur
- Interconnection-wide costs for integrating large amounts of wind generation are manageable with large regional operating pools, where benefits of load and wind diversity can be exploited and large numbers of supply resources are efficiently committed and dispatched.

EWITS Conclusions

- Transmission helps reduce the impacts of the variability of the wind and....
 - Reduces wind integration costs
 - Increases reliability of the electrical grid
 - Helps make more efficient use of the available generation resources
- Costs for aggressive expansions of the existing grid are significant, but they make up a relatively small piece of the total annualized costs in any of the scenarios studied
- Wind generation displaces carbon-based fuels, directly reducing carbon dioxide (CO₂) emissions

The results of this study pose some interesting policy and technology development questions

- Could the levels of transmission, including the reference case, be permitted and built and what is a realistic time frame?
- What is the best process for siting transmission for wind?
 - HVDC long distance transmission with high voltage collector systems
 - Offshore Transmission collector system
- Would a different renewable profile or transmission overlay arise from a bottom-up planning process?
- How can states and the federal government best work together on regional transmission expansion?

EWITS Schedule & Contacts

- <http://www.nrel.gov/ewits>
- Development of Phase II of EWITS in first quarter 2010
- Roll out January 20th, Washington DC.
- Contact: Dave Corbus at David.Corbus@nrel.gov