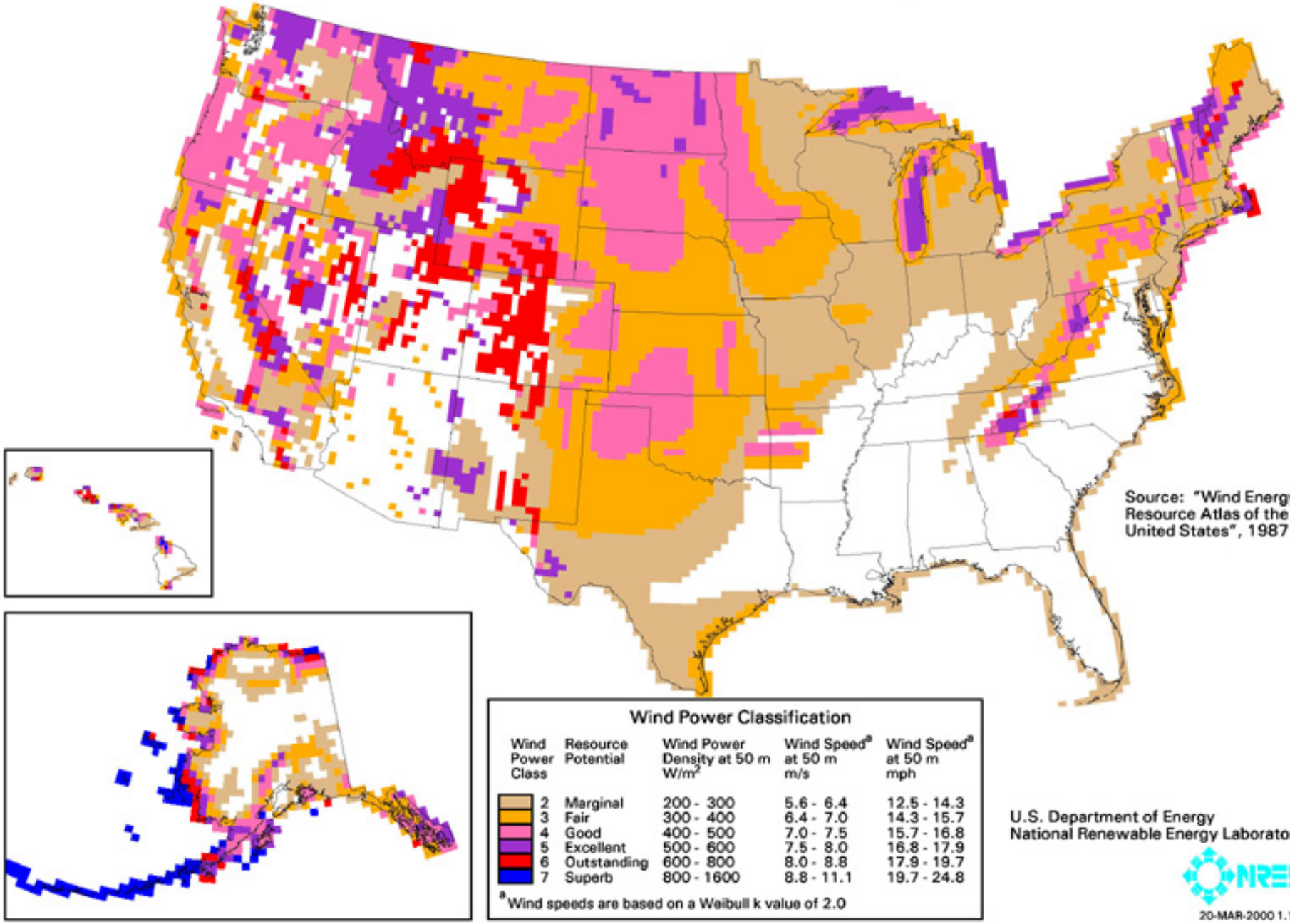
Midwest ISO Wind Energy Resources
and
Transmission Expansion Studies

Missouri Wind Energy Forum
June 25, 2008

Dale Osborn

Midwest ISO

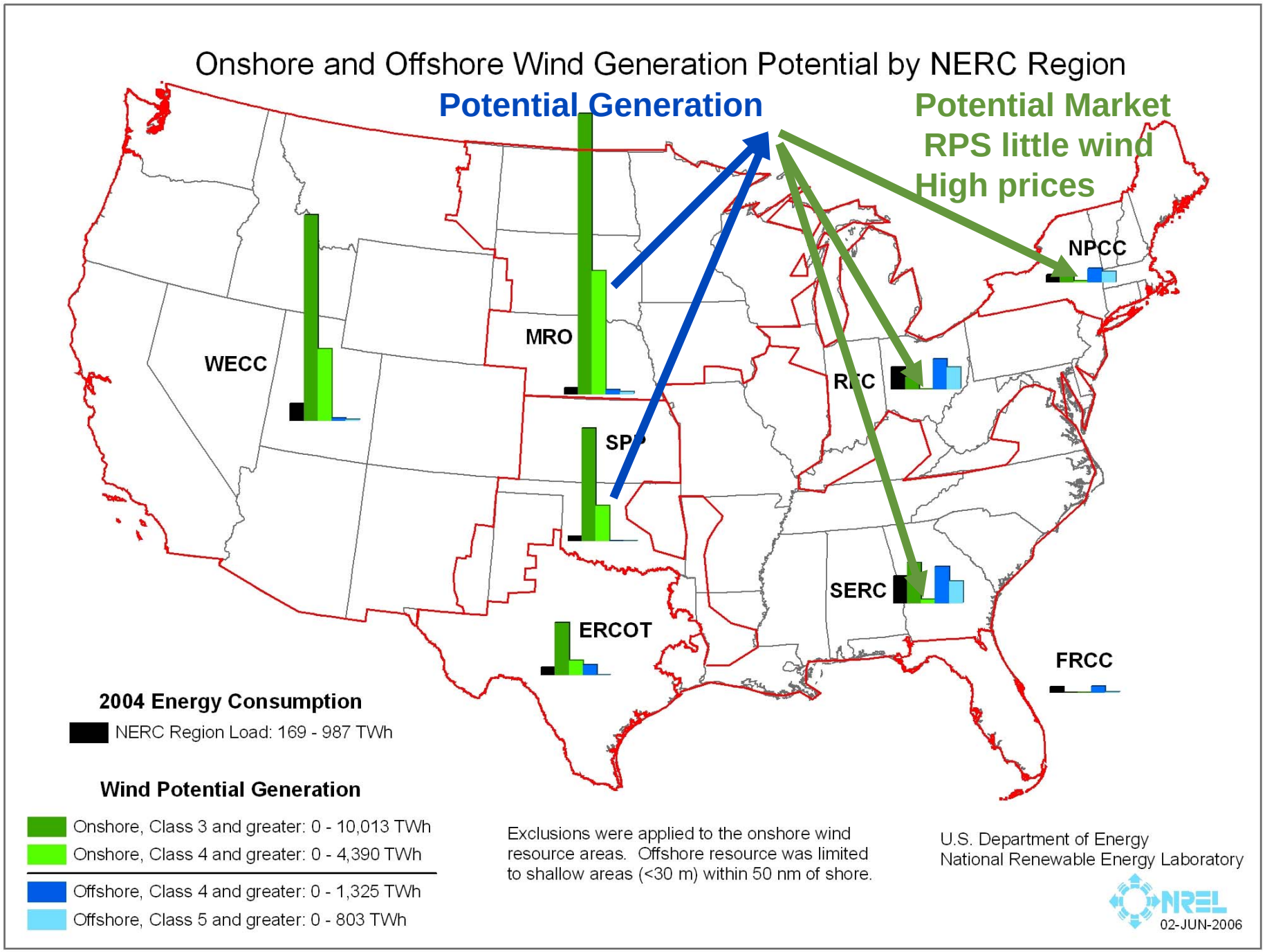
United States - Wind Resource Map



Wind Power Classification

Wind Power Class	Resource Potential	Wind Power Density at 50 m W/m^2	Wind Speed[a] at 50 m m/s	Wind Speed[a] at 50 m mph
2	Marginal	200 - 300	5.6 - 6.4	12.5 - 14.3
3	Fair	300 - 400	6.4 - 7.0	14.3 - 15.7
4	Good	400 - 500	7.0 - 7.5	15.7 - 16.8
5	Excellent	500 - 600	7.5 - 8.0	16.8 - 17.9
6	Outstanding	600 - 800	8.0 - 8.8	17.9 - 19.7
7	Superb	800 - 1600	8.8 - 11.1	19.7 - 24.8

[a] Wind speeds are based on a Weibull k value of 2.0


Onshore and Offshore Wind Generation Potential by NERC Region
Potential Generation
Potential Market
RPS little wind
High prices
WECC
MRO
SPP
ERCOT
RFC
SERC
NPCC
FRCC
2004 Energy Consumption
NERC Region Load: 169 - 987 TWh
Wind Potential Generation
Onshore, Class 3 and greater: 0 - 10,013 TWh
Onshore, Class 4 and greater: 0 - 4,390 TWh
Offshore, Class 4 and greater: 0 - 1,325 TWh
Offshore, Class 5 and greater: 0 - 803 TWh
Exclusions were applied to the onshore wind resource areas. Offshore resource was limited to shallow areas (<30 m) within 50 nm of shore.
U.S. Department of Energy
National Renewable Energy Laboratory
NREL
02-JUN-2006

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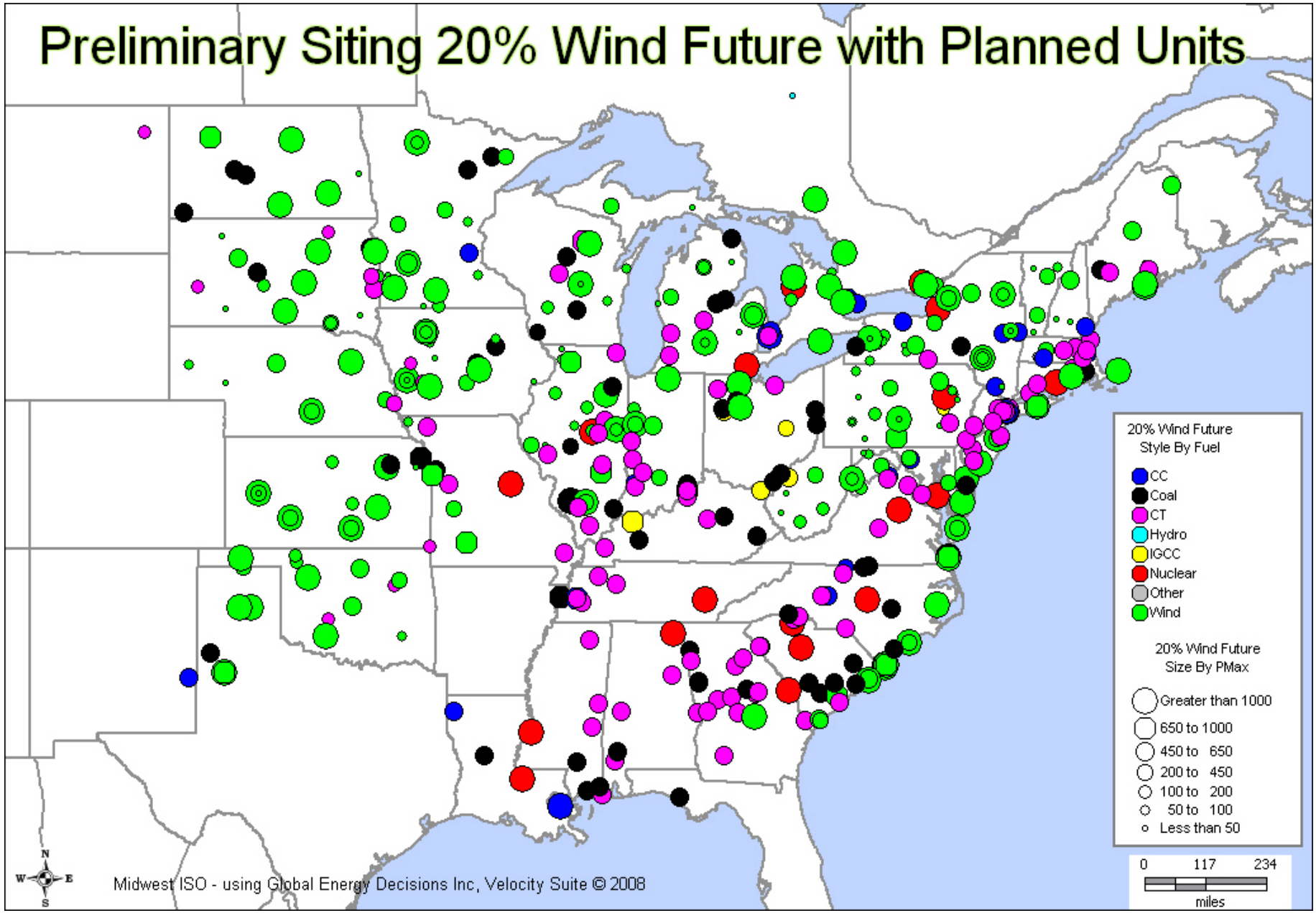
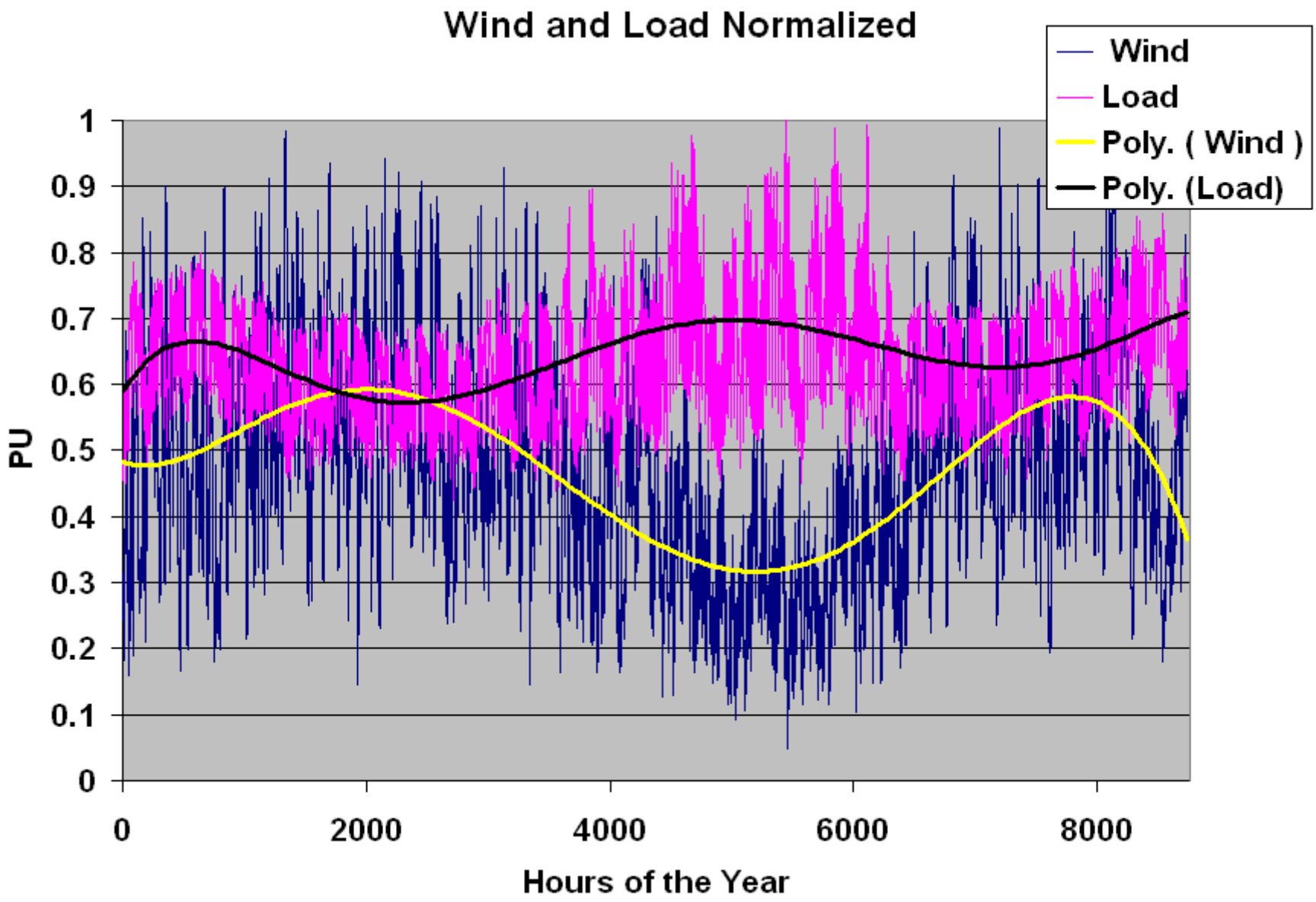
Energizing the Heartland

Preliminary Siting 20% Wind Future with Planned Units




Wind and Load Normalized
Wind
Load
Poly. (Wind)
Poly. (Load)
PU
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0
2000
4000
6000
8000
Hours of the Year

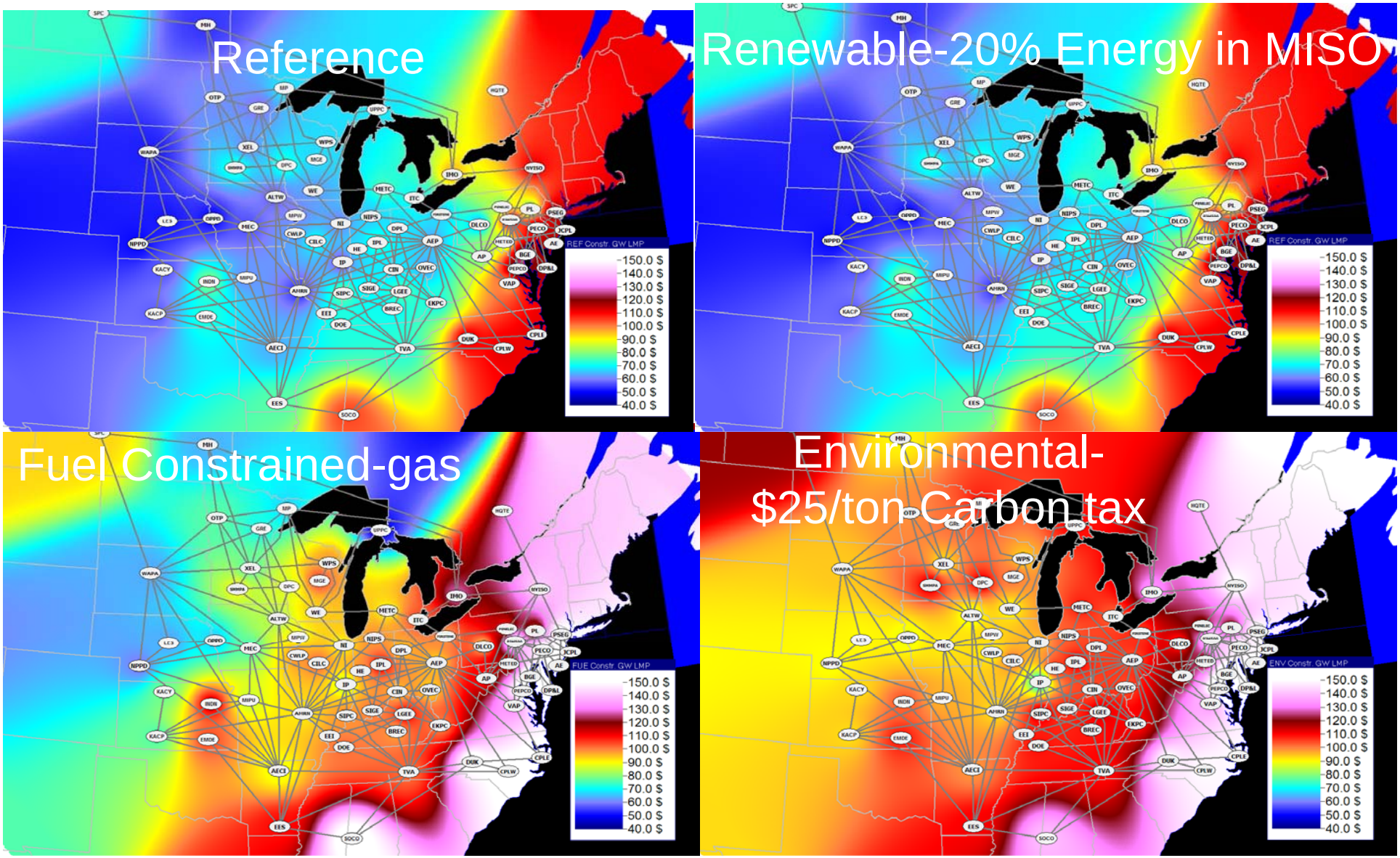
Wind is Primarily an Energy Resource and is Variable

- About 15% or less of the wind generation rating can be relied upon to produce energy when the energy is needed during the summer peak period. The 15% is referred to as a capacity credit.
- Capacity factor is the amount of energy that the wind generators produce divided by the generation capacity times 8760 hours per year. Historical capacity factors in MISO are about 33%. New 80-100 meter tower heights may yield 40-45% capacity factors.
- Wind energy displaces other fuels for 85% of the capacity factor(34% of a 40% cf). Most of the displacement is at night and in the spring and fall when prices are lower.

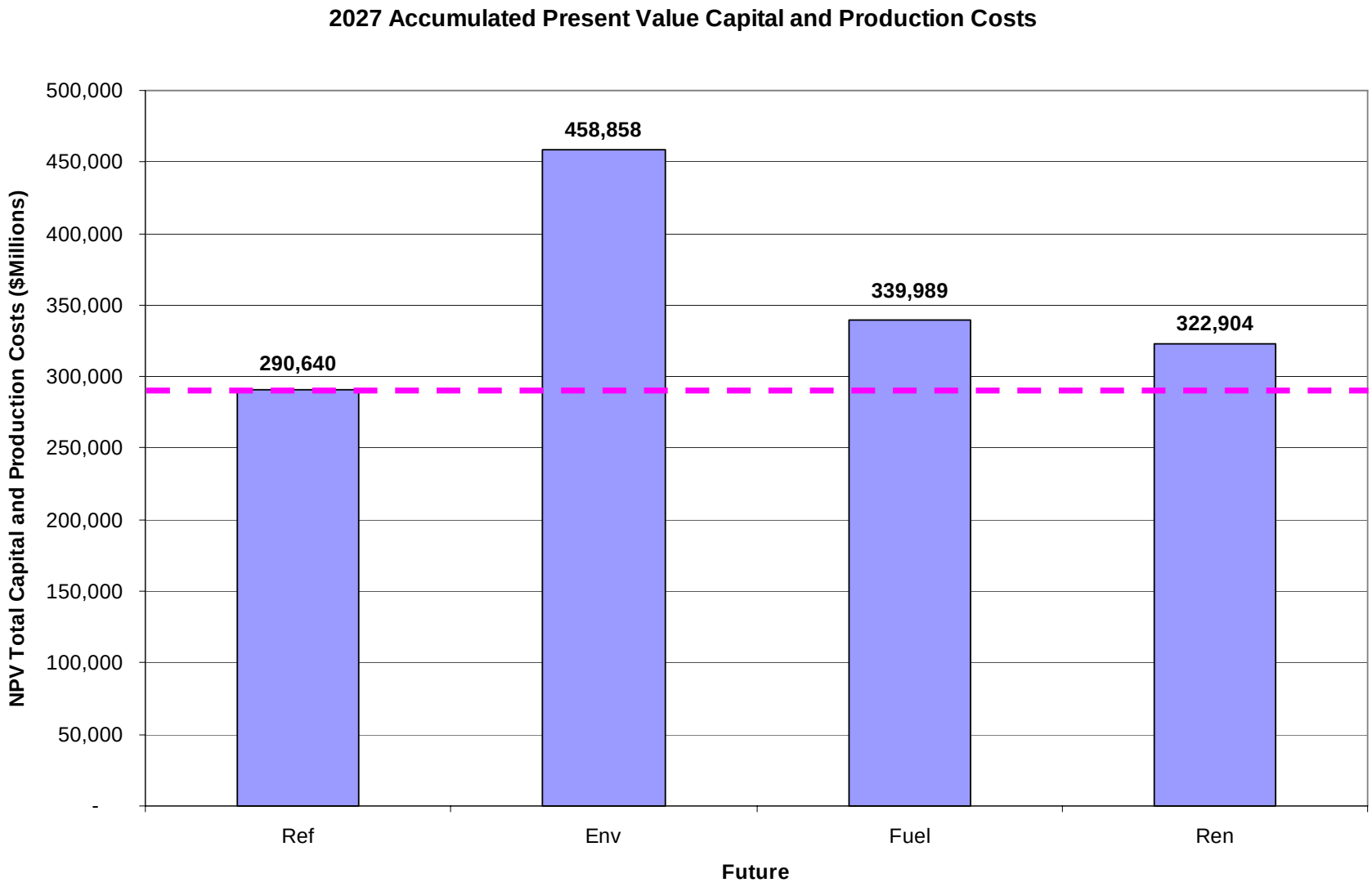
Energy displacement

- Wind energy without a Production Tax Credit costs more than the average MISO price of energy of about $42/MWh last year.
- Wind mandates provide the revenue for a wind generator to remain in business.
- Wind energy is kept by the state that has the mandate.
- Energy from other generation could be deferred or sold.
  - Near by locations have about the same price
  - East coast locations have a high price-JCSP is to determine if it is feasible to deliver displaced energy to the east coast economically. MTEP 06, 08 indicate it may be possible.

Blue – lowest prices $40/Mwh Average Generation
White-highest prices-$150/Mwh LMP



Summary slide of the LMP contour plots, slide 3.



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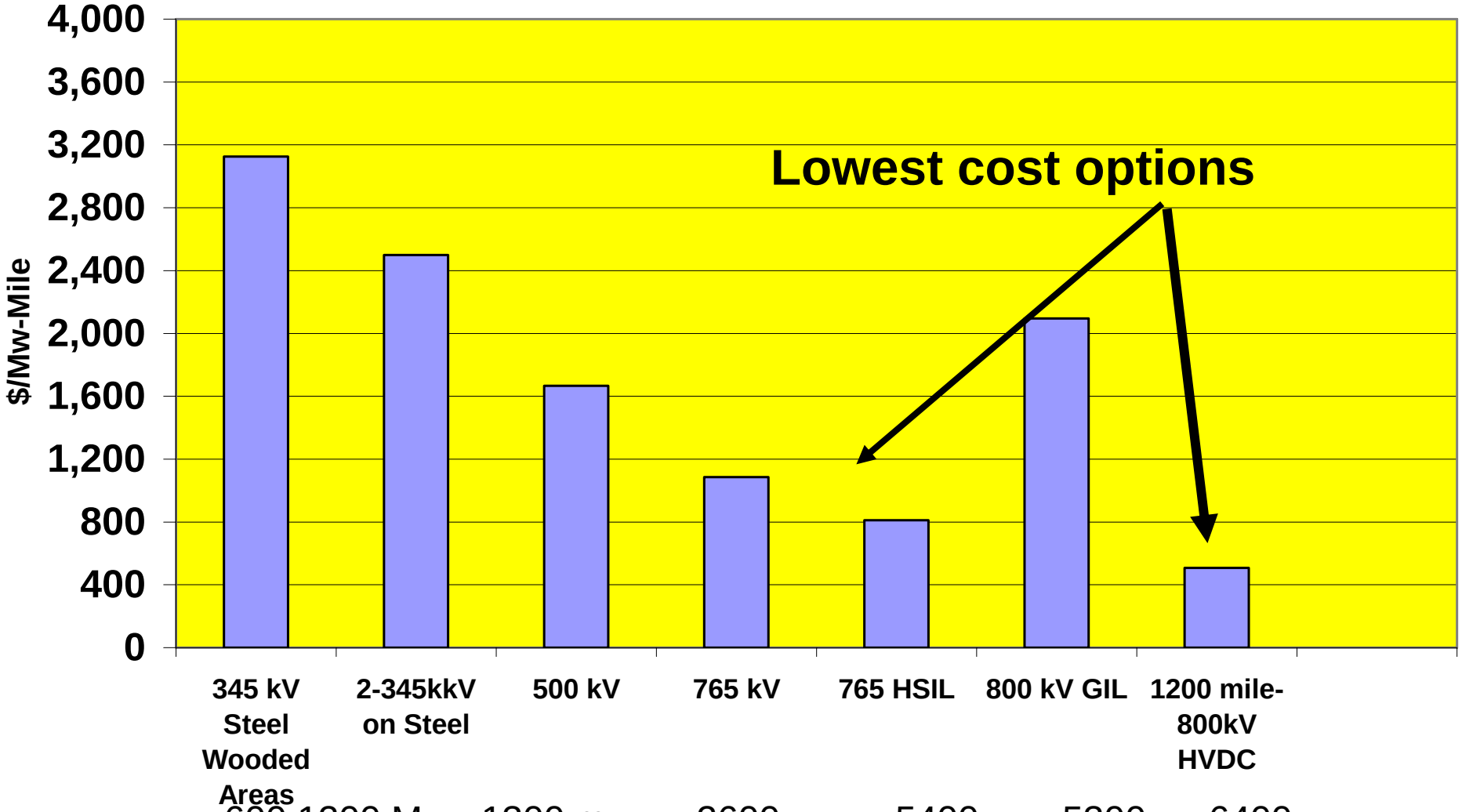
Transmission and Substation Costs per Mw-mile by Transmission Voltage And Type of Construction

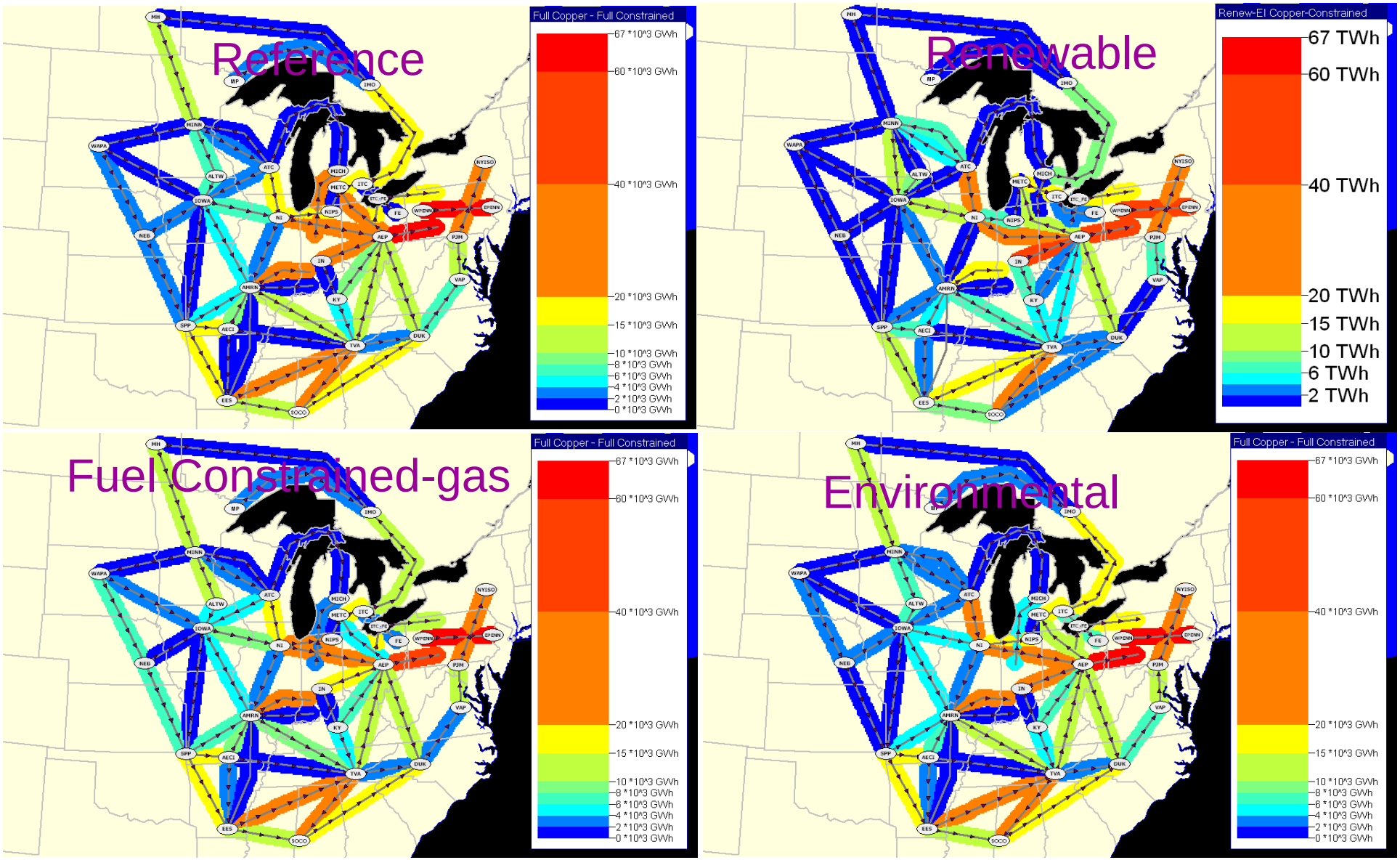


600 1200 Mw 1300 mw 2600 5400 5300 6400

Target typical planned loading Mw, use economics to choose voltage

Red-heaviest energy transfer
Blue-least energy transfer

Transmission Capacity Expansion Locations



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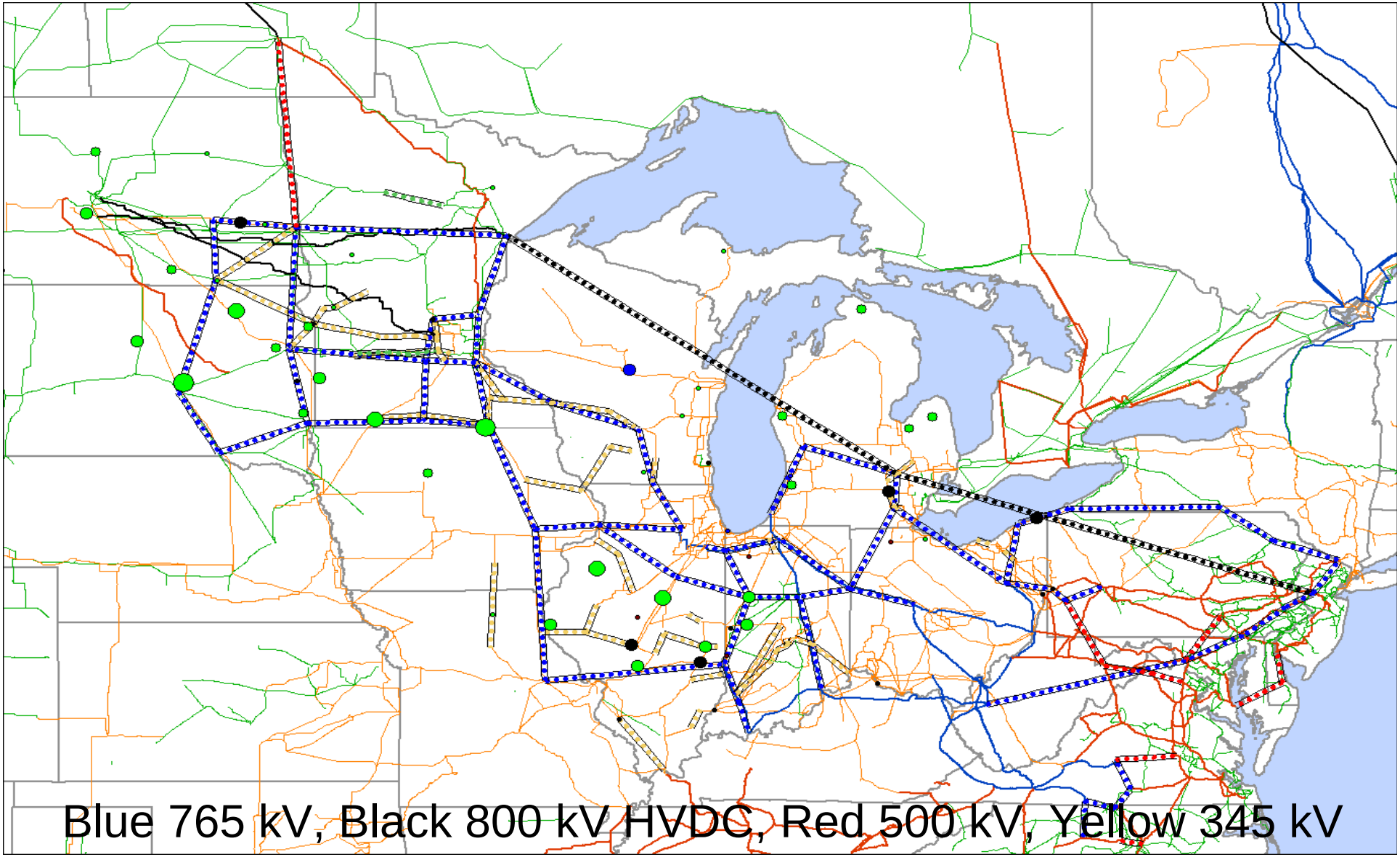
Example Transmission Expansion for MTEP 08 Renewable Future

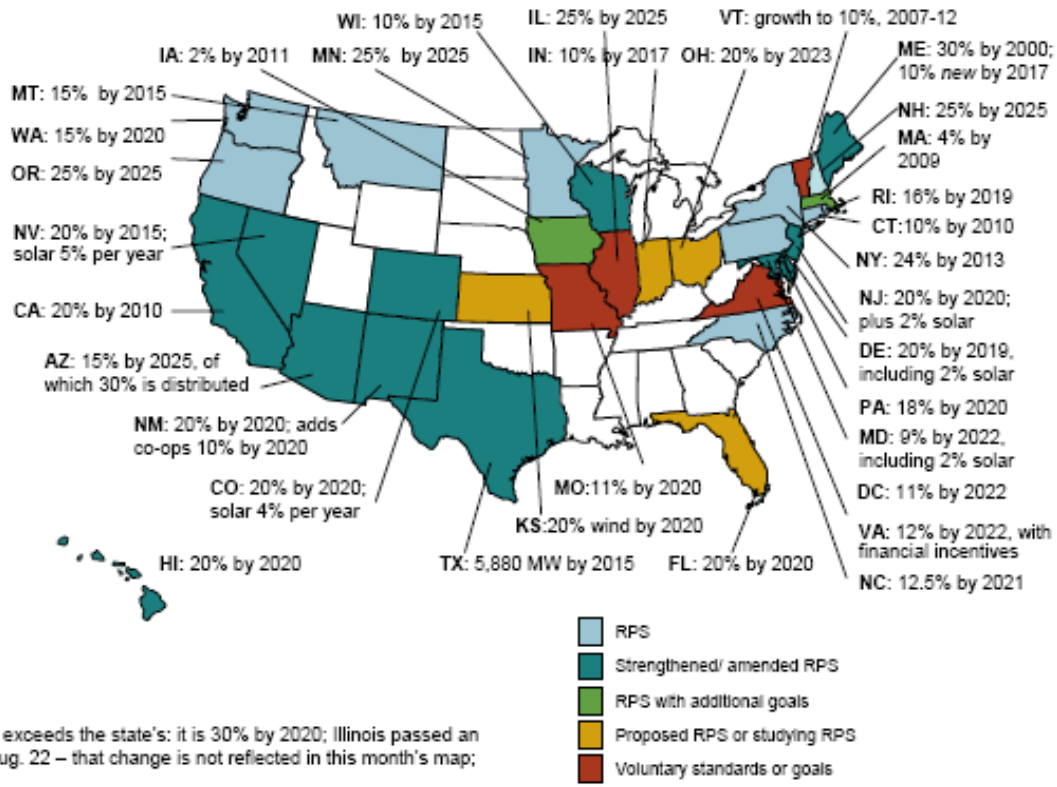


Mandates

- State mandates are supplied by wind generation bidding to supply the wind energy and associated capacity.
  - The price of delivered wind is the cost of generation plus the cost of transmission. The lowest cost delivered generation is usually chosen.
  - Wind usually only competes with other wind for mandate energy.
  - About 15,000 MW of wind mandates exist in MISO. Missouri has a goal, but not a mandate.

Renewable Energy Portfolio Standards (RPS)

- A RPS requires a percent of energy sales or installed capacity to come from renewable resources.
- If Illinois' Governor signs enacted legislation, 25 states and DC will have renewable energy standards. Three others set goals. This summer, North Carolina enacted an RPS, Delaware doubled its requirement, Maine turned a recent goal into law, and Missouri enacted a goal.
- States that adopted transmission planning and cost recovery policies to support new renewable generation include California, Colorado, Minnesota, New Mexico and Texas.



Notes: Minnesota's requirement for Xcel Energy exceeds the state's: it is 30% by 2020; Illinois passed an RPS that was not signed by its Governor as of Aug. 22 – that change is not reflected in this month's map; Alaska has no RPS.
Sources: Derived from data in: EEI, EIA, LBNL, PUCs, State legislative tracking services, Database of State Incentives for Renewables and Efficiency, and the Union of Concerned Scientists.

Updated August 22, 2007

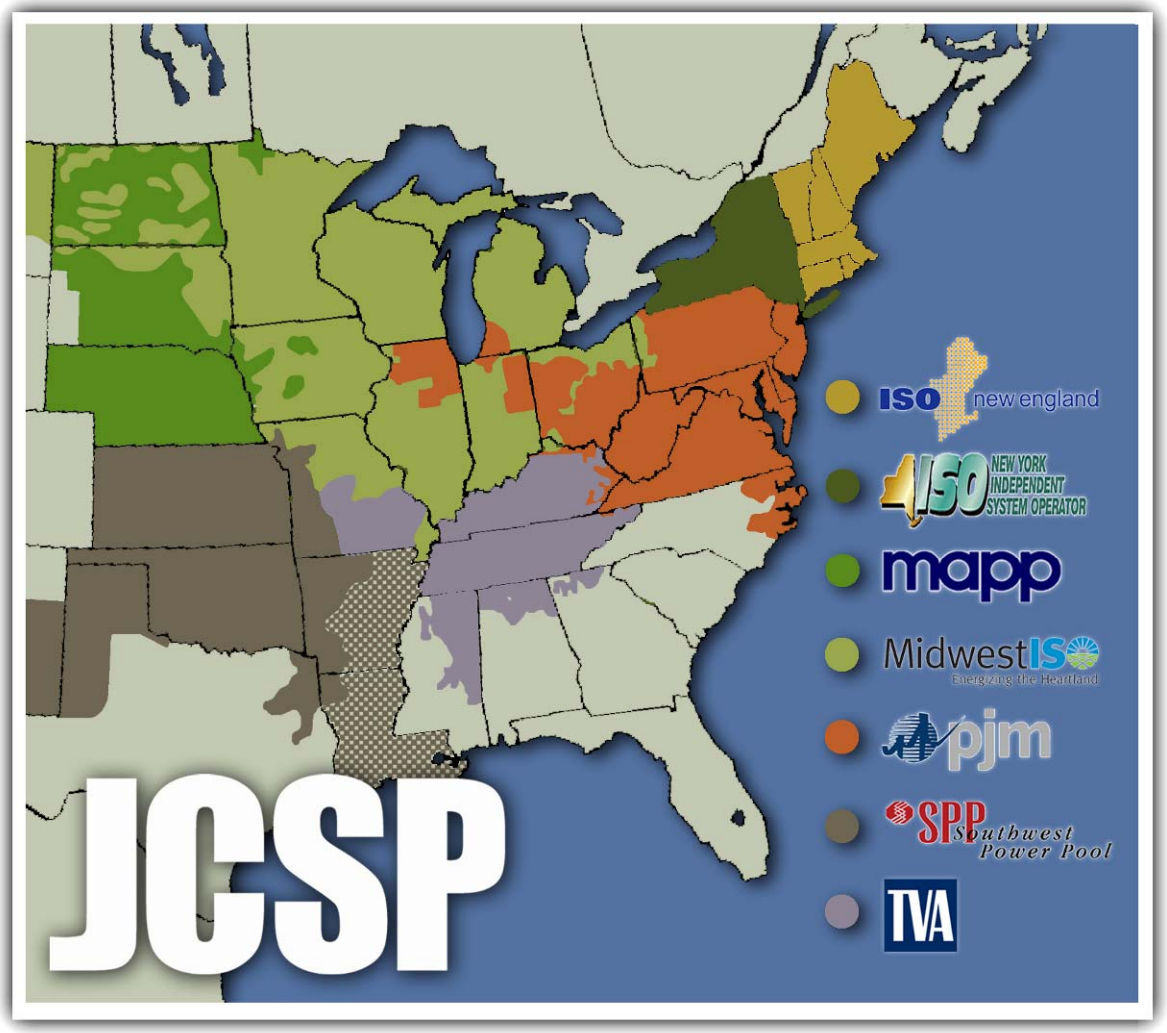
1109

JCSP

- Design and economical conceptual transmission expansion plans to the year 2024 for
  - 5% U.S. Eastern Interconnection wind energy-present wind mandate levels
    - 63,000 MW total-15,000 MW in MISO
  - 20% U.S. Eastern Interconnection wind
    - 260,000 MW total-90,000 MW in MISO

Slide 2, 6 -who is the JCSP

JCSP study is scheduled for completion end of 2008



JOINT COORDINATED SYSTEM PLANNING

Department of Energy Office of Energy Efficiency and Renewable Energy and the National Renewable Energy Laboratory Studies Coordinated with the JCSP

- DOE-NREL has commissioned a study to provide time synchronized wind data for the JCSP area for the years 2004, 2005, 2006
  - Allows the evaluation of the impact of neighboring wind on other systems
  - Allows to evaluation of geographic diversity
- DOE-NREL has commissioned a wind integration study for the JCSP area to study the short term affects of wind generation on the existing and future generation operation including planning reserves, curtailment of gas, oil and coal generation.

Types of Midwest ISO Studies involving wind generation

- Generation Interconnection-state mandates
- Transmission Service Requests
- Target Studies- Generation Outlet Study-s
- Midwest ISO Transmission Expansion Studies
  - Reliability Studies
  - Economic Studies
    - Futures
- Multi Regional studies- JCSP

Generation Interconnection Queue Process Information

- A Tariff is a set of rules that govern how an RTO such as the Midwest ISO operates.
- Federal Energy Regulatory Commission (FERC) approves the tariffs.
- There is a tariff for the interconnection of generation including wind generation.
- Everyone is treated according to the rules of the tariff.
- Tariffs can be changed through a stakeholder process and approval by FERC.

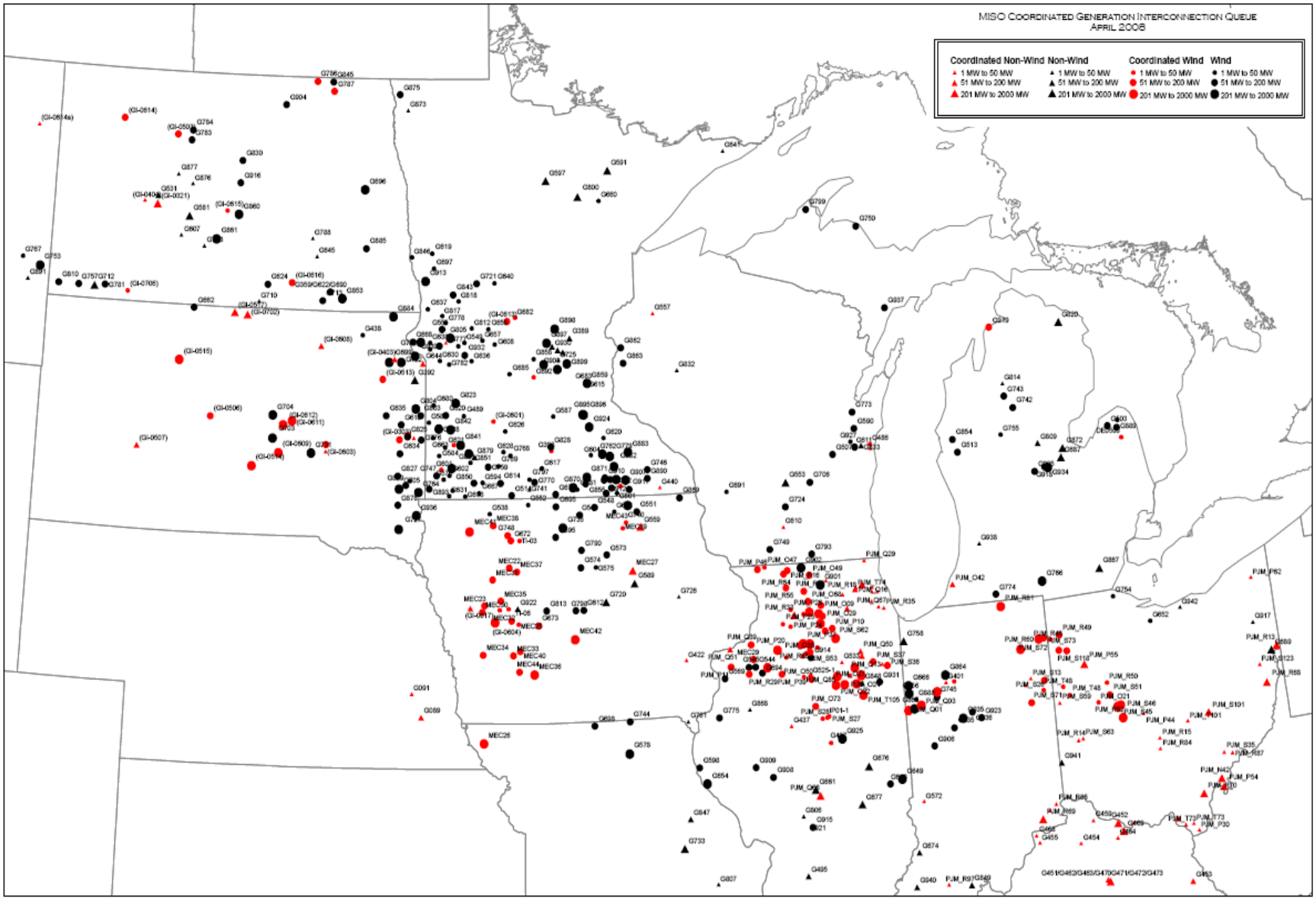
Location of Queue and Tariff information for Generation Interconnection

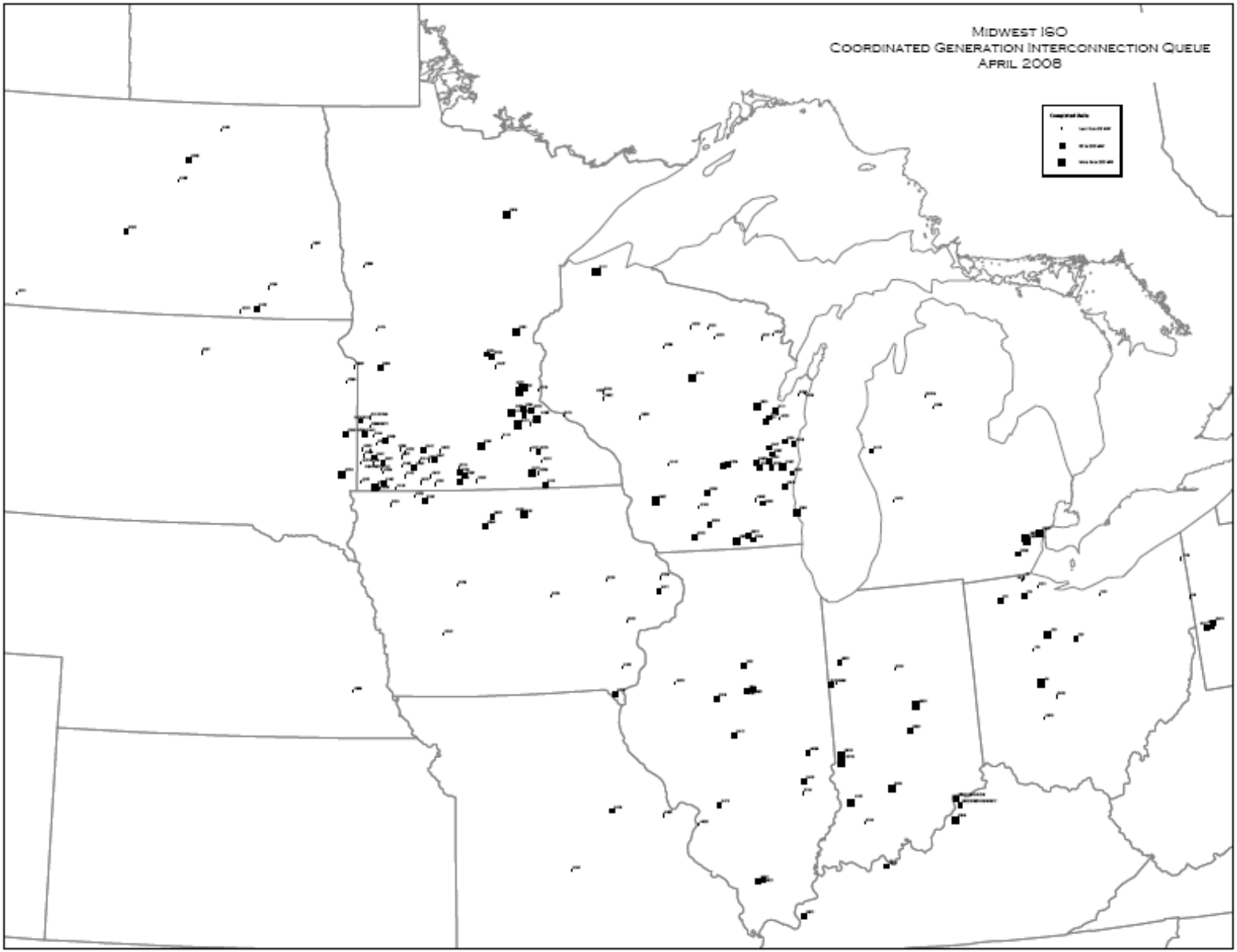
http://www.midwestmarket.org/page/Generator+Interconnection

http://www.midwestmarket.org/publish/Folder/67519_1178907f00c_-7fff0a48324a

Queue Reform page can be accessed from Generator+Interconnection page

Generation Queue – about 68,000 MW




Midwest ISO
Coordinated Generation Interconnection Queue
April 2008

JCSP-DOE-NREL-MISO Study Schedule

- JCSP end of 2008
- DOE-NREL Wind Data- July 1,2008
- DOE-NREL Wind Integration –Mid 2009
- MTEP 08- October 2008- studies finishing
- MTEP 09-October 2009-studies starting
- MTEP 10-October 2010- starts Jan 2009
- Interconnection studies are rolled into MTEP