



MISO RTO and Inter RTO Transmission Planning and the use of this information by Michigan

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MISO Has Two Study Processes

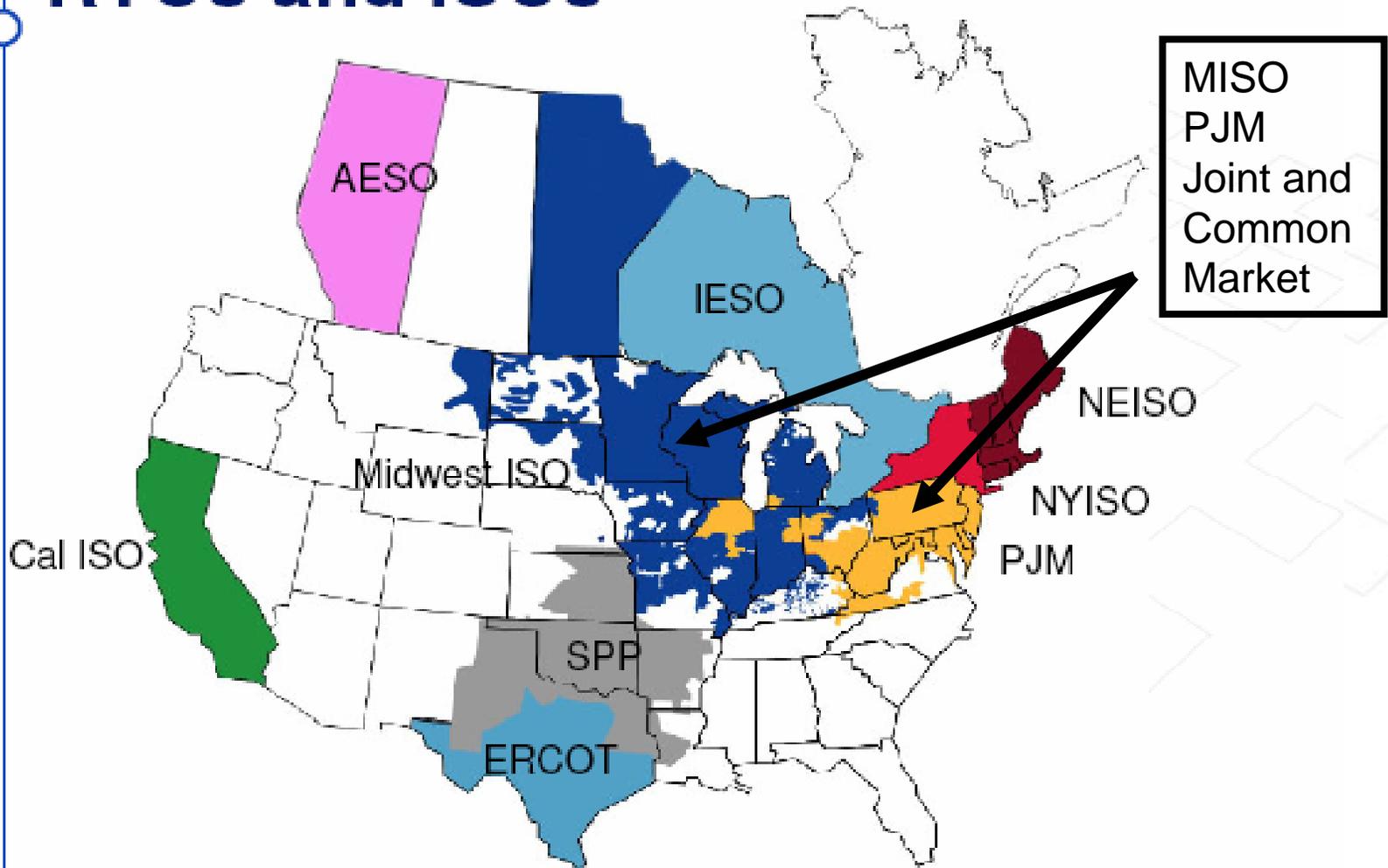
■ 1. Joint Coordinated System Plan- Design transmission expansion including neighbors

- DOE-NREL Eastern Wind Integration Study 20%, 30% wind energy
 - First study with time synchronized wind models over a wide area that allow the analysis of :
 - Energy Market economic transmission expansion
 - Competitive resources
 - Market models
 - Diversity of wind reducing power variations
 - Wind Integration costs
- Other generation futures such as wind in the north and nuclear in the south for a low carbon future

■ 2. Midwest ISO Transmission Expansion Plan -MTEP 09- 2014, 2019, 2024 years of study-

- Economic- subject to further input from the MISO Planning Advisory Committee-specific to Market benefit/cost ratio
 - Reference-most economical generation expansion
 - 20% Renewable from DOE-NREL Eastern Wind Integration Study
 - 30% Renewable from DOE-NREL Eastern Wind Integration Study
 - Environmental-\$25/ton carbon tax
 - Legislative limitations and delay
- Reliability-specific to MISO footprint
 - Transmission expansion to serve load reliably
 - Generation Interconnection Facility Studies
 - Queue Improvement
 - Open season-build it and they will come
 - Transmission Service
- Coordinated Studies
 - CAPX
 - Minnesota Renewable Energy Study
 - Ad Hoc studies

RTOs and ISOs



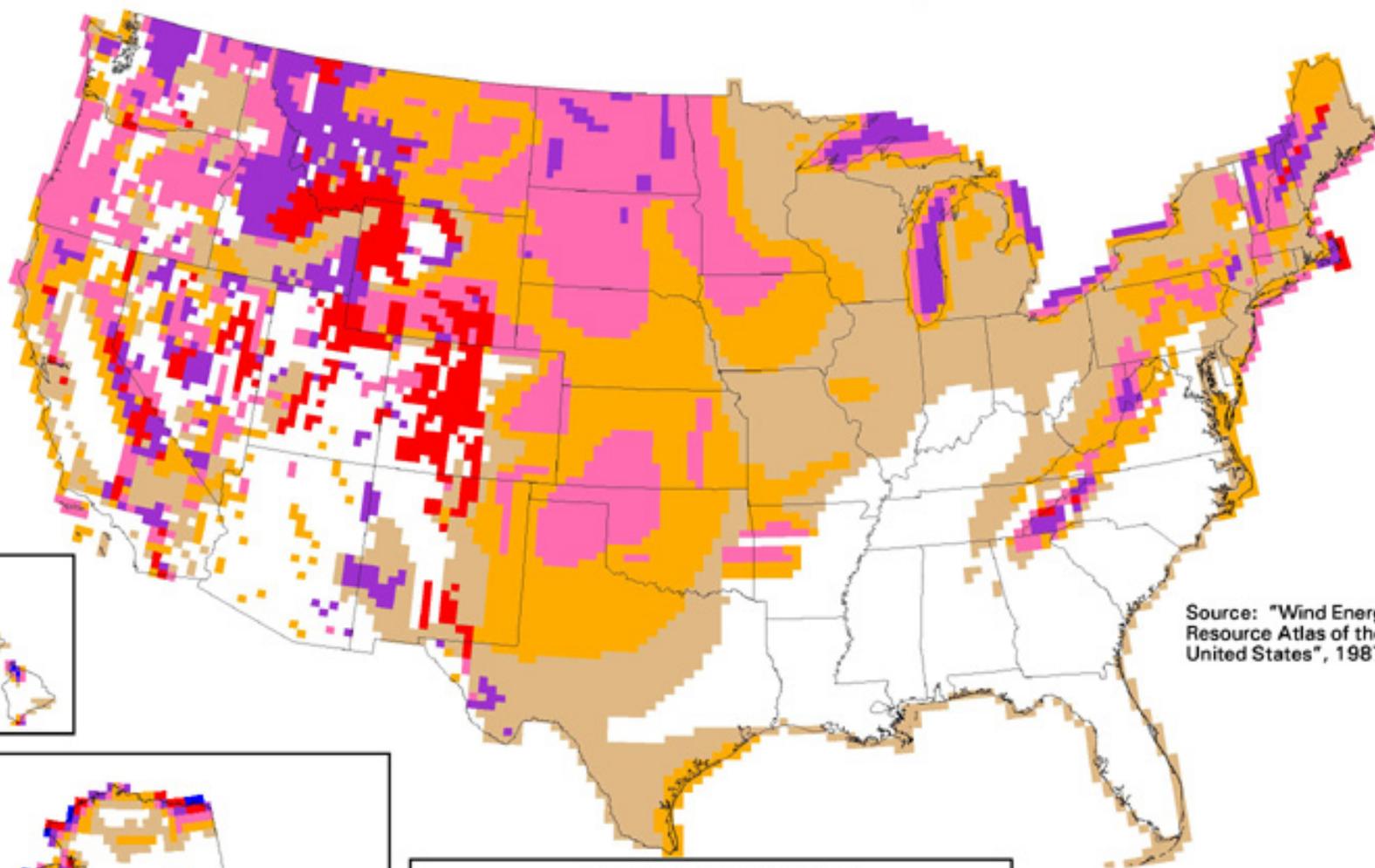
Note: ERCOT, AESO, and IESO are not RTOs

○ What is the value of MISO studies

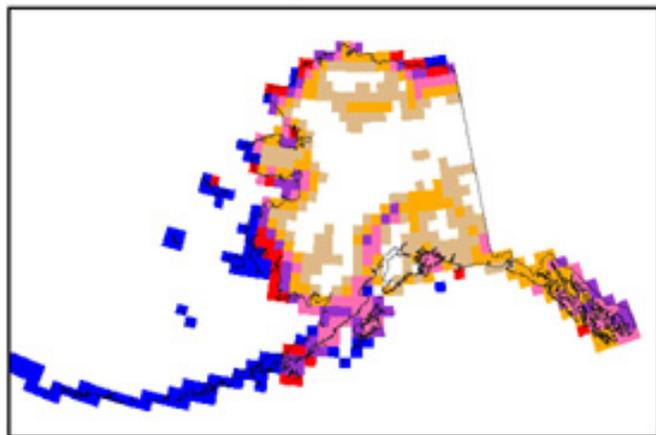
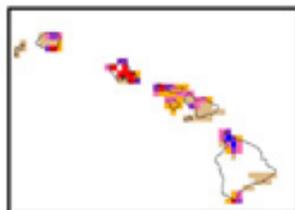
■ Provides information that enables

- Total cost of building and operating facilities
- Revenue to generators
- Business opportunity comparison
- RPS impacts
 - 10% versus 20%
 - Information to determine economic impact on customers/ generators based on the PSC treatment of generator net revenue

United States - Wind Resource Map



Source: "Wind Energy Resource Atlas of the United States", 1987



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

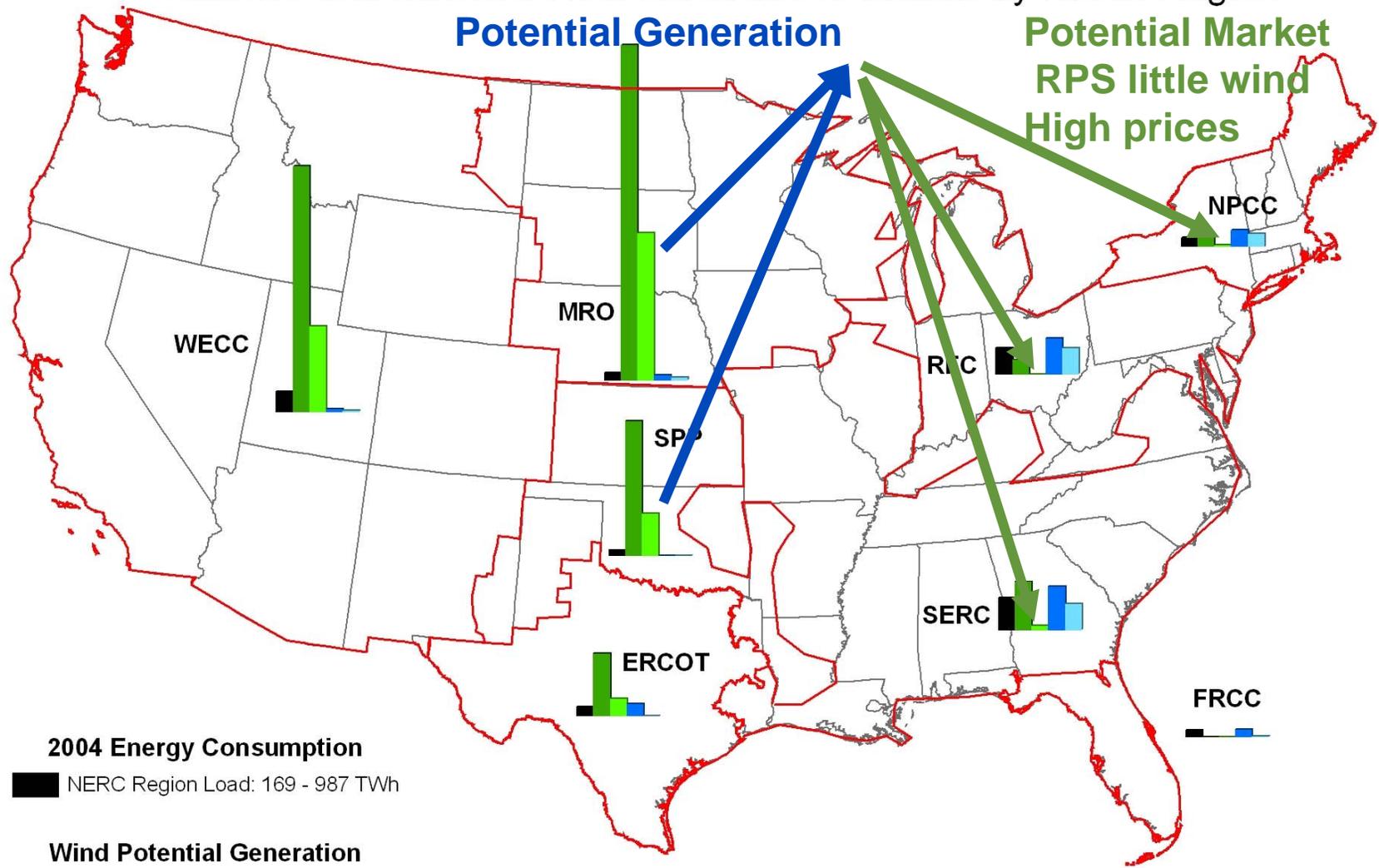
U.S. Department of Energy
National Renewable Energy Laboratory



Onshore and Offshore Wind Generation Potential by NERC Region

Potential Generation

Potential Market
RPS little wind
High prices



2004 Energy Consumption

NERC Region Load: 169 - 987 TWh

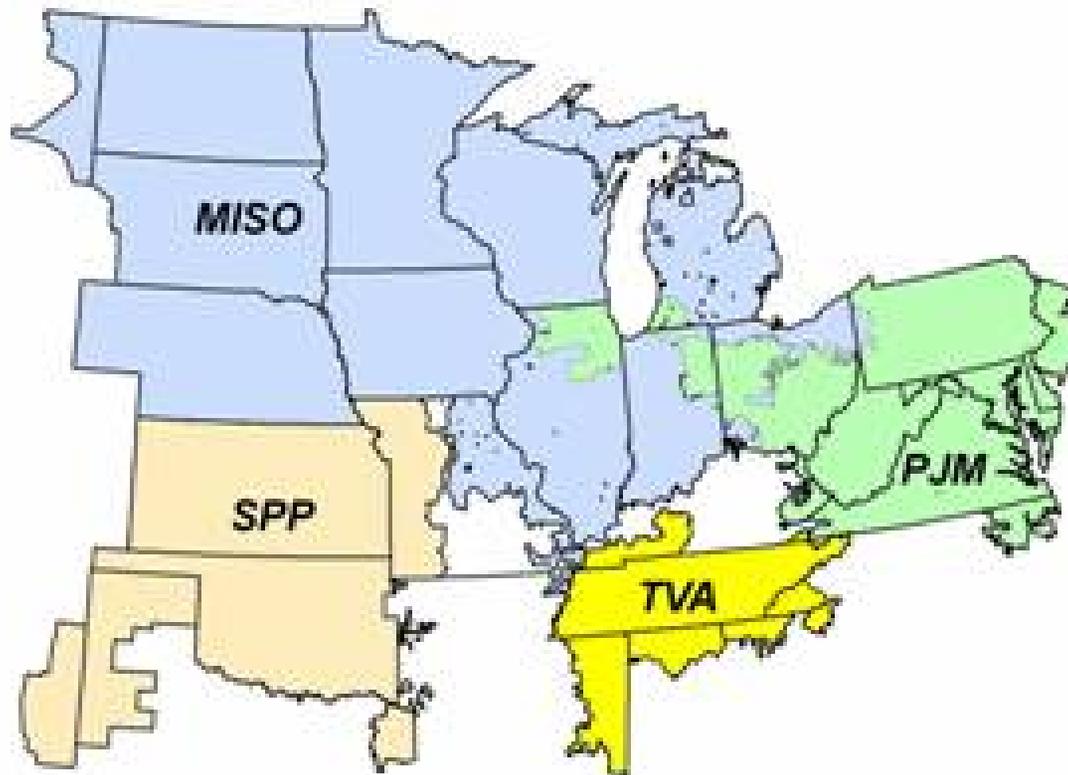
Wind Potential Generation

- 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

DOE-NREL-JCSP Area of Wind Model Development



○ Types of Markets

- Energy Market
- Ancillary Services Market
 - MISO June 2008
- Capacity Market
 - MISO does not have one, states set reserves
 - PJM has one

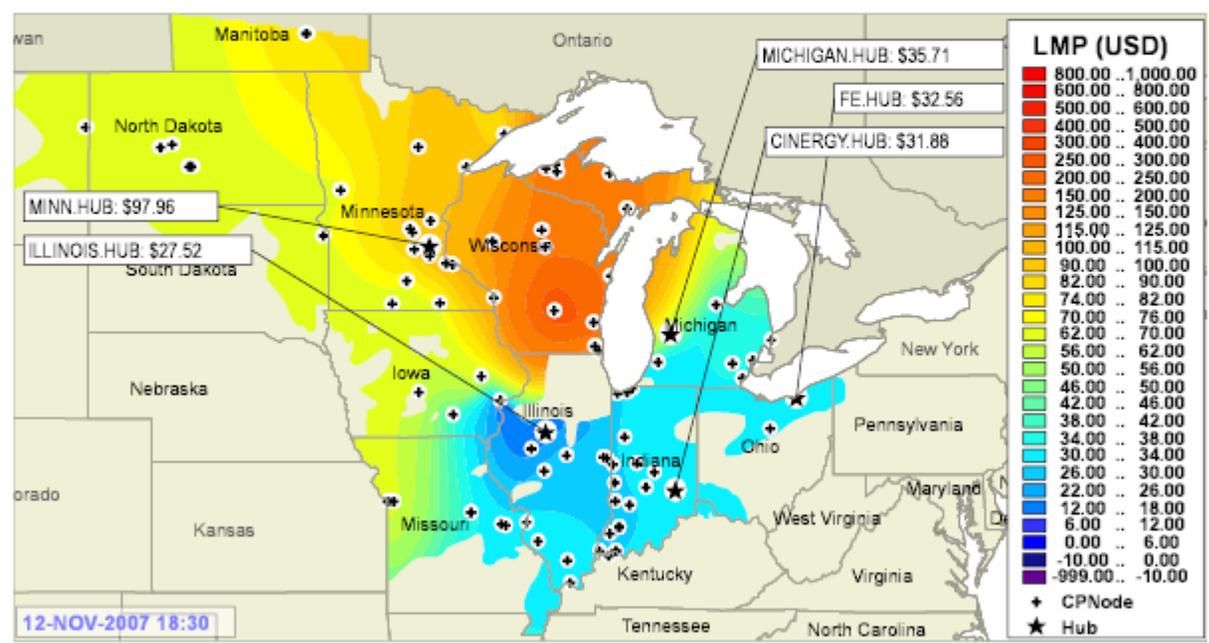
○ How an Energy Market Works

- Generators are paid the clearing price of the market minus congestion and losses
 - The clearing price is the price that must be paid to obtain enough power to cover the peak demand for a 5 minute or day ahead period
 - MISO has a clearing price
 - PJM has a clearing price
 - Energy can be exchanged between MISO and PJM without an additional transmission charge
 - Other Seams area require an additional transmission charge
 - Energy clearing prices are available from the midwestmarket.org web site

Disclaimer: The data and prices provided on this page are preliminary and should not be relied upon for settlement or other purposes. The Midwest ISO makes no representations or warranties regarding the correctness or accuracy of the data and prices provided on this page and shall not be responsible for any party's reliance on any such data or prices.

The LMP Contour map below provides a real-time map of the MISO footprint showing selected Commercial Prodes, with their respective LMP values. Each Commercial Prode is represented as a circle with the regional color dependent on the price. The map and the table will automatically refresh every 5 minutes to show the updated information.

Interactive LMP map below requires free [SVG 3.0 plug-in](#). Please install the plug-in if you do not see the LMP map.

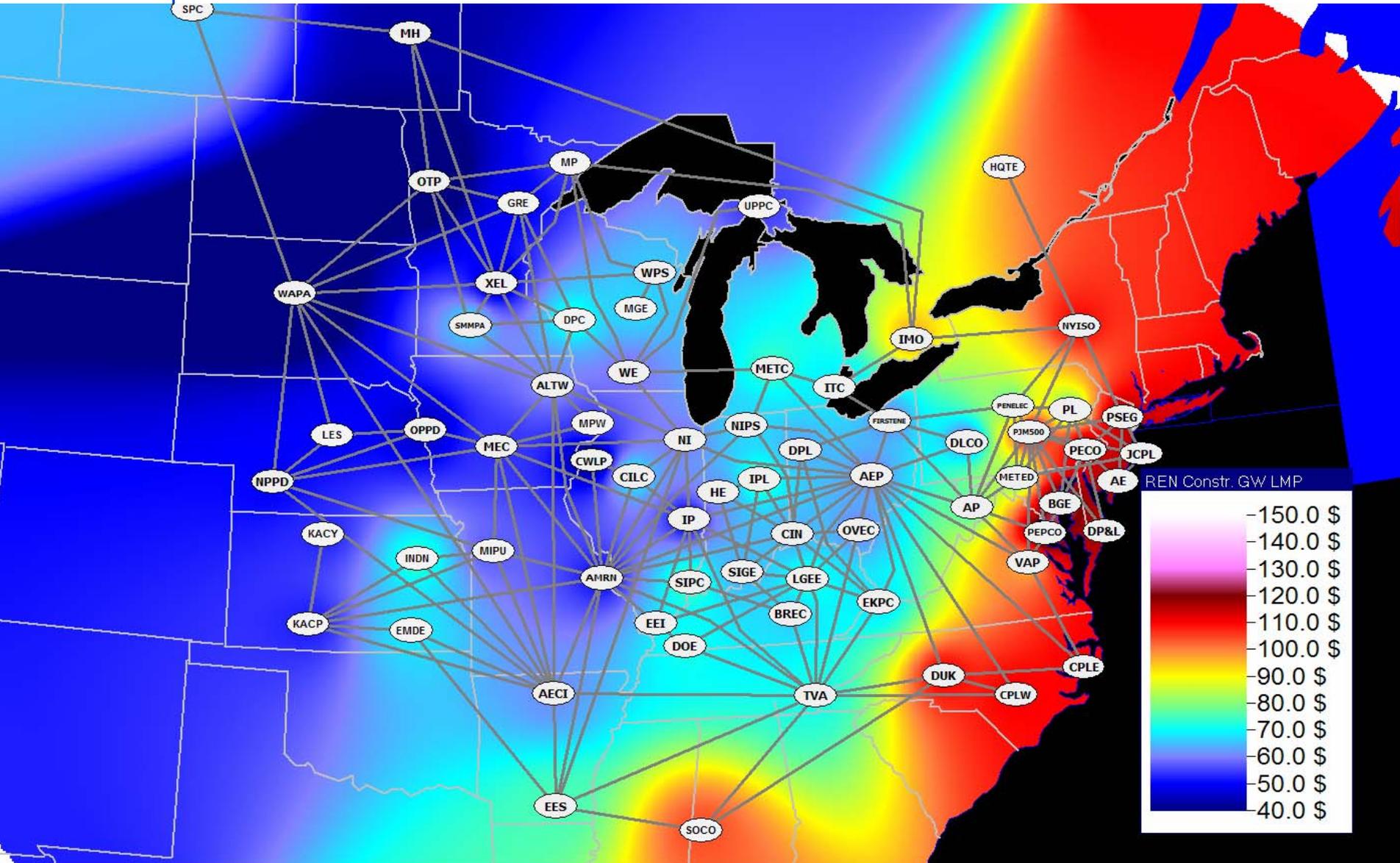


Location	Hourly Day Ahead			5-Minute Real Time			Delta			Last Hour Estimated		
	HE 19			18:30						HE 18		
	LMP	MLC	MCC	LMP	MLC	MCC	LMP	MLC	MCC	LMP	MLC	MCC
AEC	84	-3.39	-4.27	34.89	-2.79	-30.07	49.11	-0.6	25.8	50.84	-1.85	0.00
AEC7	76.78	1.21	18.52	28.77	2.12	25.65	28.82	1.18	15.28	50.88	2.68	0.00

○ Energy Markets

- Wind energy usually is a price taker on the Spot Market
 - Wind generates as much energy as possible
 - Wind receives as much revenue as possible
 - No bidding is needed
 - No balancing penalties are imposed

Transmission needs to link low prices in west to high prices in the east to produce a benefit. Benefits are returned to the generator by the Energy Market



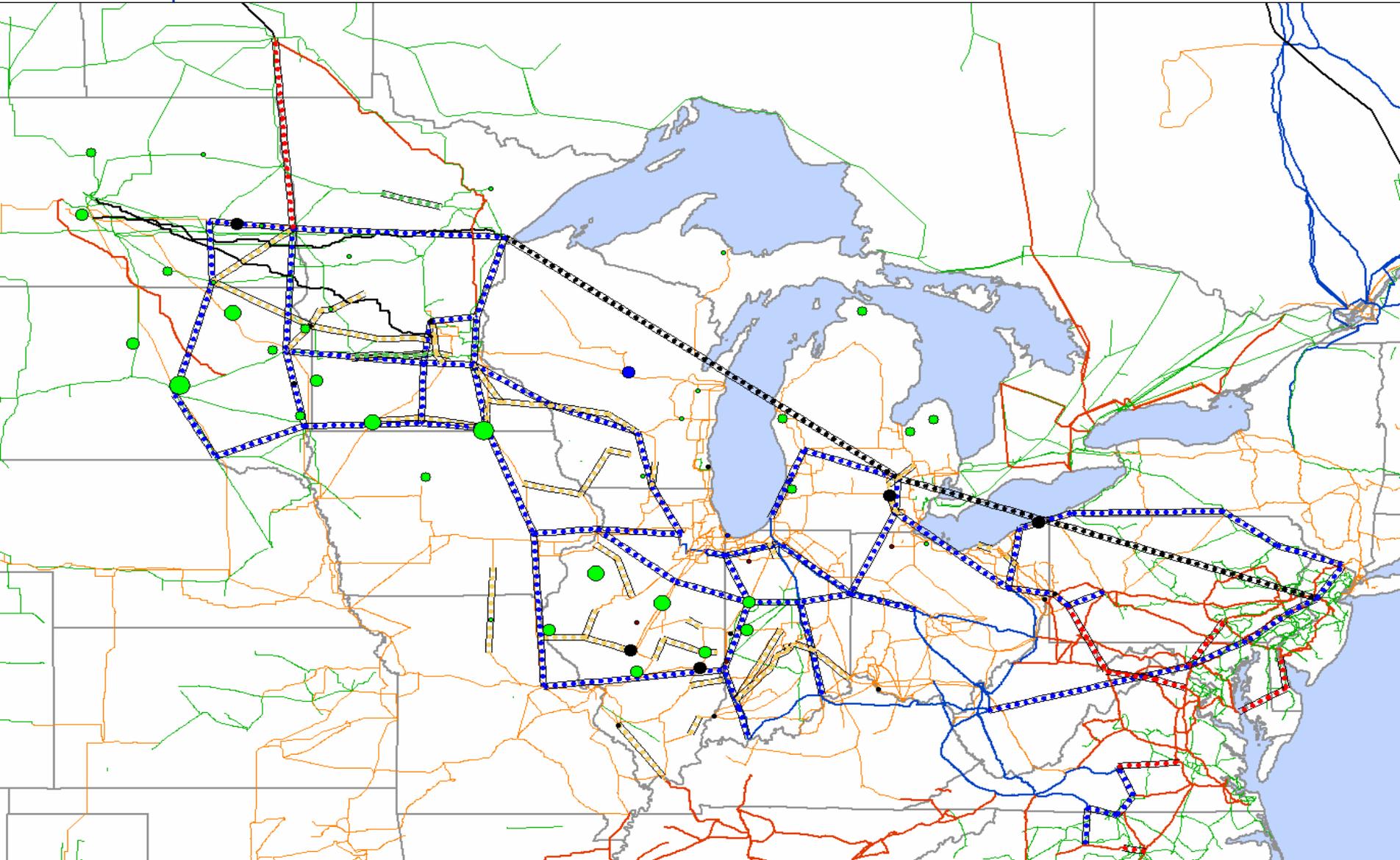
Day-Ahead to Real-Time Price Differences MISO and Neighboring Markets

	<u>Average Clearing Price</u>			<u>Average of Hourly</u>
	Day-Ahead	Real-Time	Difference	Absolute Price Difference
Midwest RTO:				
Cinergy Hub	\$43.14	\$41.56	\$1.59	\$11.81
Michigan Hub	\$46.30	\$45.28	\$1.04	\$13.59
Minnesota Hub	\$48.79	\$47.27	\$1.53	\$19.73
WUMS Area	\$50.52	\$49.47	\$1.07	\$16.32
New England ISO:				
New England Hub	\$63.49	\$62.67	\$0.83	\$11.36
Maine	\$59.32	\$58.62	\$0.70	\$10.52
Connecticut	\$70.95	\$68.60	\$2.34	\$13.92
New York ISO:				
Zone A (West)	\$51.85	\$50.01	\$1.84	\$12.81
Zone G (Hudson Valley)	\$68.02	\$67.48	\$0.54	\$18.07
Zone J (New York City)	\$75.88	\$76.03	-\$0.15	\$20.06
PJM:				
AEP Gen Hub	\$42.44	\$43.68	-\$1.24	\$9.52
Chicago Hub	\$43.89	\$44.78	-\$0.89	\$9.52
New Jersey Hub	\$57.02	\$58.27	-\$1.25	\$15.23
Western Hub	\$53.75	\$55.27	-\$1.52	\$14.68

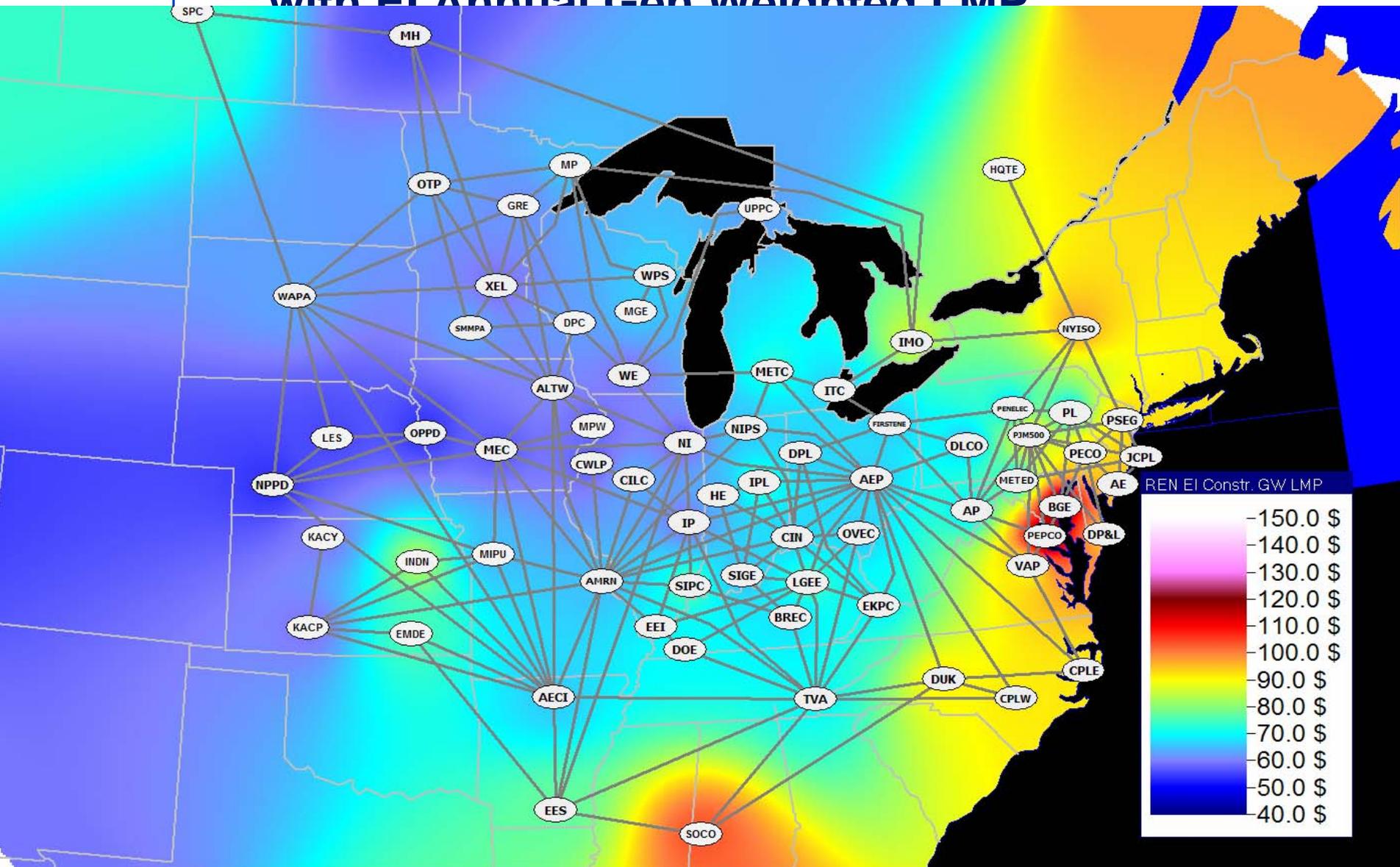
Final Skeleton – EI Overlay



MTEP08
October 5, 2007
Overlay for
Step 4 Analysis



Full Constrained Case with EI Annual Gen Weighted LMP



○ Mandates

- Wind Capital costs paid by load
- Energy surplus is sold
 - Competitive
 - Revenues to the generator
- South Dakota has a relative small amount of load compared to its generation potential to support mandates only small amounts of wind generation can be supported by an RPS in SD

○ Wind Marketing Components

- State RPS
- Energy Market Sales from surplus energy
 - Capacity credit for wind is 15%
 - Capacity factors are 35-45% in MISO
 - Difference adds to the surplus energy that is available to sell.
- Sale of in state wind capacity or other capacity to out of state markets
 - Transmission capacity to do so is necessary
 - Requires MISO-PJM coordination to reach the highest priced markets in the US

Relevance

