ESTIMATING FUTURE WIND ENERGY DEVELOPMENT IN MICHIGAN FOR THE 2008 MICHIGAN WIND ENERGY TRANSMISSION STUDY[1]

PRELIMINARY ANALYSIS FOR PUBLIC REVIEW AND COMMENT

NOT FOR CITATION OR QUOTATION

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Introduction

Michigan Public Service Commission Staff is coordinating efforts with the Michigan Wind Working Group, Midwest Independent Transmission System Operator (MISO), American Transmission Company (ATC), Michigan Electric Transmission Company/ITC Transmission (collectively, ITC),[2] to develop possible scenarios for utility-scale wind energy development in Michigan. The scenarios provide input for a wind energy transmission study, Michigan Wind Energy and Transmission Study (MI-WETS), which is being undertaken in 2008 by Michigan transmission owning companies (ATC and ITC), in cooperation with the Wind Working Group. To the extent practical, this effort is an open source project, open to peer review. Comments, suggestions, and refinements are welcomed.

The MI-WETS is a scoping study, to be used for informational purposes only. It is intended to identify at a high-level the conceptual electric transmission needs to accommodate various scenarios for Michigan wind energy development. It is not a generation interconnection study. Nor is it a transmission plan, to identify specific system upgrades. Moreover, the study is not examining any distribution system upgrades needed to accommodate potential wind energy installations.[3] The modeling activity is based on a series of assumptions, including but not limited to quantities and locations of wind energy development that might or might not come to fruition in the future. Thus, the results of the MI-WETS should be understood to represent only a first estimate and partially educated guess of the possible relationships between significant expansion of utility-scale wind energy and the needs for associated system upgrades for the transmission grid in Michigan.

Modeling Overview

MI-WETS builds upon ongoing modeling activities by Michigan's independent transmission companies, ITC and ATC. The modeling approaches used by ITC for the

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[1] See http://www.michigan.gov/mpsc/0,1607,7-159-16377_47107_48701---,00.html for the web page associated with this workgroup.

[2] References to ITC in this document refer to both ITC Transmission and Michigan Electric Transmission Company, which are both operating companies of ITC Holdings.

[3] A footnote will be used here to define, for unfamiliar audiences, the difference and distinction between electricity transmission versus distribution.

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Lower Peninsula and ATC for the Upper Peninsula are not the same, but both approaches focus on identifying reliability-based transmission needs to accommodate different amounts of wind generation that might be installed in each transmission company's service territory.

In the Upper Peninsula, ATC is conducting generating interconnection studies to examine the feasibility of and system impacts from interconnecting three wind generation projects that are presently included in the MISO interconnection queue.[4] The locations of these wind facilities are discussed in the section below, Projected Wind Development Locations. ATC will use standard assumptions and methodologies to conduct these studies in accordance with their FERC-approved tariffs. The studies focus on the 2009/2010 timeframe, which corresponds to the estimated in-service dates of the three wind farm projects. For purposes of MI-WETS, ATC will be synthesizing the information from these interconnection studies and using its engineering judgment and operating experiences to draw general conclusions about the opportunities for and challenges to integrating wind in different locations in the Upper Peninsula. ATC's service territory covers almost the entire UP, with the exception of a small area in the far northwestern corner of the UP, which is served by Xcel Energy (Northern States Power).

ATC will also provide some conceptual guidance about the likely effects of any future offshore wind farm development in northern Lake Michigan, that might seek interconnection with ATC's system.[5] At this time, ATC is not going to conduct any modeling of offshore wind, but from a transmission system's point of view, there is no effective difference between onshore and offshore wind: The wind energy will be modeled as being injected into the grid at some point onshore. Given the rather modest capacity of the existing transmission system in Michigan's Upper Peninsula, ATC anticipates major system improvements will be required in order to accommodate an additional 500 MW of wind generation being interconnected anywhere along the southern UP, which is where any offshore wind farm in the northern-most portions of Lake Michigan would be likely to interconnect.

Separately, ITC is developing a transmission model for the combined ITC and METC footprints in Michigan's Lower Peninsula. ITC's model captures all of Michigan's Lower Peninsula with the exception of AEP's Indiana-Michigan territory in the far southwestern corner of the LP.

ITC's analysis is comparable to a high level system impact study that will identify areas where the transmission system may need to be strengthened to accommodate the potential electricity flows from the proposed new wind generation. Load-flow analysis including a snapshot in time of the system peak case, and separate snapshots in time of shoulder or

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[4] A footnote will be inserted, for the lay reader, to explain basics about the MISO Queue and provide a link to learn more.

[5] All readers should understand there are no plans at present for offshore wind energy development in Michigan waters of the Great Lakes. Michigan could receive a proposal at any time, however. In order to be prepared and insure due diligence, Michigan has begun to investigate permitting requirements for offshore projects and a preliminary list of issues and concerns is being developed. Information about this effort can be obtained from the Michigan Wind Working Group. See http://www.michigan.gov/eorenew.

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off-peak cases will be completed with the proposed wind generation sited in the future model. Those modeling results will identify the areas in the transmission system that would appear to need upgrades, or possible new transmission solutions based upon the resulting flows from the new generation in the model.

ITC's model started with the 2007 series of the NERC MMWG (Multiregional Modeling Working Group) model for 2013. ITC then made adjustments to the load in the model until it reached a system peak of 26,000 MW for the combined ITC and METC territory. By way of comparison, the estimated peak load for the Lower Peninsula in 2008 is approximately 23,000 MW. In ITC's model, adjustments using historical data and load forecasts are made to distribute load growth throughout the region. The system peak of 26,000 MW was chosen by ITC to reflect conditions that would be expected in roughly the next six to ten years. Transmission upgrades that are expected to be in service in the next six to ten years are also included in ITC's model.

Electricity Demand Forecast

Michigan's 21st Century Electric Energy Plan published in January 2007 included electricity demand forecasts for the state of Michigan.[6] The system peak load of 26 GW in ITC's model roughly corresponds with the 2017 – 2018 timeframe in the Michigan 21st Century base case forecast for lower Michigan.

Since the time that Michigan's 21st Century plan was developed, both Detroit Edison and Consumer's Energy have lowered their projected demand forecasts. In a recent rate case filed by Detroit Edison, U-15244, Edison stated that "Based on the 2006 temperature-normalized peak of 12,687 MW and a forecast service area system peak demand of 12,544 MW in 2016, an average compound annual peak growth rate of -0.1% is expected."[7] Consumers Energy has also lowered its peak demand forecast, as evidenced in that company's recent Balanced Energy Initiative filing in docket U-15290, which states: "The BEI uses a conservative customer peak demand growth of 1 percent a year, while the 21st Century Energy Plan used 1.2 percent for a comparable number."[8]

Based upon the reductions in forecasted peak demand by Michigan's major utilities, it should be noted that the 26 GW system peak level may not occur until later than the ten year timeframe that ITC is projecting. However, forecasting is not an exact science and as the forecast gets farther out in time, more uncertainty surrounds the forecast. Regardless of when or whether Michigan hits the projected 26 GW, the results of the modeling will show what transmission upgrades will be necessary due to the assumptions of this analysis, including the added generation at the specified load levels, and those results will be informative even if they may be applicable to a range of future years due to uncertainty in the forecast.

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[6] Michigan's 21st Century Electric Energy Plan, Appendix Volume II, p. 95 – 97, http://www.michigan.gov/documents/mpsc/energyplan_appendix2_185279_7.pdf.
[7] http://efile.mpsc.cis.state.mi.us/efile/docs/15244/0166.pdf, p. AFC-21.
[8] http://efile.mpsc.cis.state.mi.us/efile/docs/15290/0035.pdf, p. 23.

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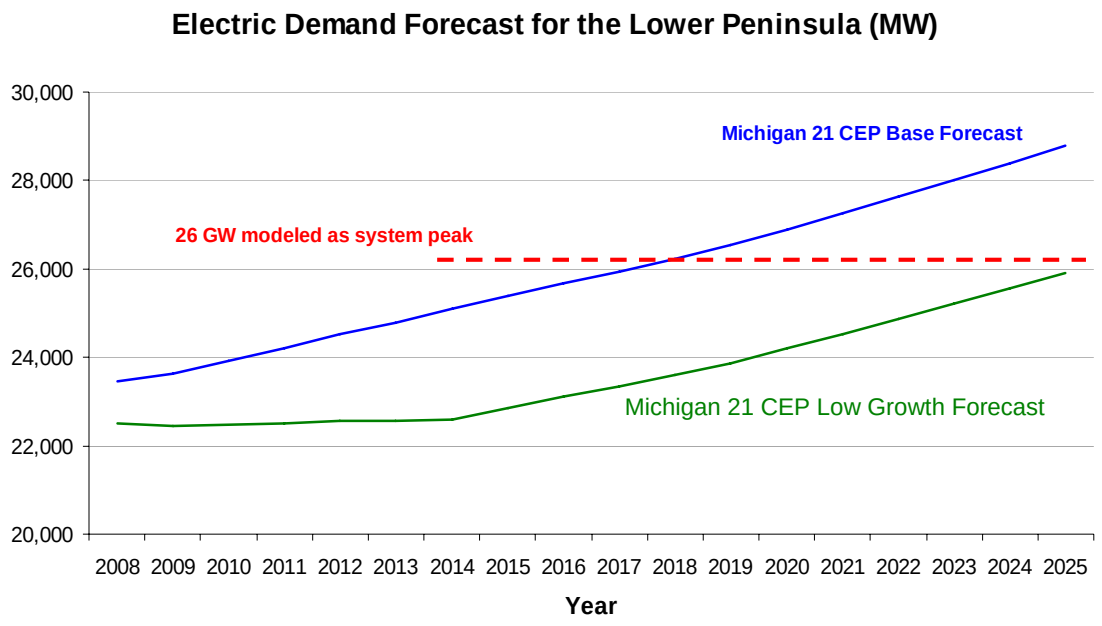
The following graph depicts the peak demand forecasts from Michigan's 21st Century Electric Energy Plan for the Lower Peninsula coupled with the peak demand assumption for this analysis.

MPSC Staff also reviewed preliminary load forecast information for lower Michigan that was published on MISO's website for the Joint and Coordinated System Plan study. Although MISO will be publishing a revised data set very soon, the preliminary data shows that forecast tracking in between the forecasts depicted on the graph above from Michigan's 21st Century Electric Energy Plan.



NOTE: Relevant ATC forecasting assumptions will be discussed here, for the Upper Peninsula.

Wind Energy Production Forecasts

Modeling scenarios for MI-WETS for the Lower Peninsula are based on the installation of 1,500 MW, 3,000 MW and 4,500 MW of wind capacity, coincident with an electric power peak demand of 26,000 MW. Michigan's Lower Peninsula is presently forecast to reach this level of demand sometime roughly between 2017 and 2024. The three wind energy futures are referred to in the MI-WETS modeling as low, medium, and high wind scenarios. In addition, as discussed in more detail below, a fourth sensitivity analysis assumes that two 500 MW offshore wind farms will be added to the Lower Peninsula high wind scenario.

For the Upper Peninsula, approximately 520 MW of wind generation is studied. In addition, a preliminary descriptive assessment is completed, based on the assumption that

an additional 500 MW of offshore wind might be interconnected to the transmission grid in the Upper Peninsula.

The amount of wind to be located in Michigan under the high wind scenario appears to match fairly closely the proposed assumptions used by MISO in its Midwest ISO Transmission Expansion Plan (MTEP) 2009 planning process.[9] The 35% annual average capacity factor for Michigan utility-scale wind energy production is also consistent with MISO's proposed assumption for MTEP 2009 and with the best currently available information.

Projected Wind Development Locations

Projected locations for wind development must be identified to model the transmission needs. A detailed, micro-level siting study is not conducted for the MI-WETS. Given the research team's time and resource constraints, the many uncertainties associated with contemplated or planned future wind energy developments, and other factors; publicly available information from the MISO generation interconnection queue was the primary source of data used to develop assumptions related to potential Michigan wind generation quantities and locations. As discussed further below, the approaches used for the Upper Peninsula and the Lower Peninsula differ somewhat, but both approaches rely on the MISO queue as a primary source of information, with adjustments made based on the research team's educated guesses.

Upper Peninsula:

For the purpose of the MI WETS, ATC agreed to study transmission needs associated with approximately 520 MW of wind in the Upper Peninsula, with the locations and megawatt amounts of the wind corresponding to pending interconnection requests in the MISO queue. This breaks down as follows:

County	**Point of Interconnection**	**MW (Nameplate Capacity)**
Marquette	Presque Isle – National 138 kV line	200
Houghton	69 kV Atlantic substation	120
Delta	Indian Lake – Perkins 138kV double-circuit line	200

[9] MISO's MTEP 2009 is being conducted in coordination with the U.S. Department of Energy's Eastern Interconnection Wind Integration Study and the Joint Coordinated System Plan of MISO, PJM, Tennessee Valley Authority, and the Southwest Power Pool. A report on this modeling and associated analytical work is expected to be completed by the end of 2009. <link for more information>

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Lower Peninsula:

For all three wind scenarios (1,500 MW, 3,000 MW, 4,500 MW) for the Lower Peninsula, the following assumptions are used:

- Locations of wind generation are based on pending interconnection requests in the MISO generation interconnection queue as of March 2008; these requests cover the following Michigan counties: Sanilac/Huron, Oceana/Manistee, Charlevoix, Missaukee, Gratiot/Saginaw, Osceola, Mason, Hillsdale, and Kent/Ottawa.[10] Sites that were either adjacent to or in the exact same location were aggregated. Some of the interconnection requests within each county are fairly spread out within the specific county and are actually geographically closer to intercom-necttion requests in other counties. For example, the same interconnection point (a 120 kV substation in the area) is used for modeling multiple interconnection requests in the Cadillac area (Missaukee, Wexford, and Osceola Counties).
- Nameplate MW capabilities were obtained by extrapolating the current MISO generation queue generation sites to meet the 1,500 MW, 3,000 MW, and 4,500 MW targets. Thus, if 10% of the MW of total wind interconnection requests in Michigan's Lower Peninsula is in a particular county, that county is modeled as having 10% of the MW of wind in each of the three scenarios. (See alternatives to this approach discussed below.)

In addition to the three scenarios outlined above, a sensitivity including offshore wind will be analyzed. The offshore sensitivity will add to the high wind scenario 500 MW of offshore wind in southern Lake Michigan, and another 500 MW of offshore wind in the general area of Saginaw Bay, in Lake Huron.

The general geographic breakdown of wind projects in each of the scenarios and the offshore sensitivity is as follows. These amounts do not reflect adjustments based on the scaling factors discussed below.

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[10] Information on interconnection requests in the MISO queue is available at www.midwestmarket.org (select "Planning" | "Generation Interconnection" | "Midwest ISO Generator Interconnection Queue – Without Withdrawn Projects").

Locations and MW Amounts under Low, Medium, and High Wind Scenarios
Base (No Scaling Factors)

County/Area	#MW in MISO Queue by County/Area	Low Scenario (MW)	Medium Scenario (MW)	High Scenario (MW)	Offshore Sensitivity (MW)
Charlevoix	120	72	144	216	216
Mason	220	132	265	397	397
Osceola	270	162	325	487	487
Oceana	140	84	168	253	253
Muskegon 1	100	60	120	180	180
Muskegon 2	120	72	144	216	216
Grand Rapids North	300	180	361	541	541
Gratiot	300	180	361	541	541
Midland	320	192	385	577	577
Hillsdale	300	180	361	541	541
Thumb	305	183	367	550	550
Offshore – Southern Lake Michigan					500
Offshore – West-central Lake Huron					500
Lower Peninsula Total	2,495	1,500	3,000	4,500	5,500

As an alternative to distributing the wind generating facilities in direct proportion to the pending interconnection requests in the MISO queue as shown above, scaling factors may be used to re-distribute the MW amounts by county or area based on factors such as historical queue information, wind siting projections used by MISO for long-term planning, land use patterns, stakeholder input, and perceived community interest in wind development. The scaling factors increase, decrease, or keep constant the proportional MW amount of wind coming from a particular county or area relative to the MW amount of wind currently in the queue. The research team has thusfar devised the following scaling factors:

- Increase by a factor of 2.5 times the quantity of wind in the Thumb area.
- Decrease by a factor of 0.75 the quantity of wind in Western Michigan (Osceola, Mason, Ottawa /Grand Rapids), Charlevoix County, Hillsdale County, and Gratiot County/Midland area.

The most significant change as a result of these scaling factors is the increase in the Thumb area for purposes of this study. This result is generally consistent with stakeholder-reviewed siting assumptions used in MTEP 09 and other MISO planning studies, which project a greater amount of wind to be located in the Thumb area. It also

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appears that the Thumb area has considerably greater opportunities for wind development compatible with existing land use practices and generally widespread community support for wind development. Moreover, there was previously more than double the MW amount of wind interconnection requests in the Thumb area than the current 305 MW in the MISO queue. Numerous developers withdrew interconnection requests from the queue after the initial system upgrades were estimated; however, such behavior may not be indicative of future development due in part to a change in FERC-approved cost allocation policy in ITC's area that will socialize network upgrade costs under certain conditions, thereby reducing costs assigned to the generator.[11]

The adjusted MW amounts, with the proposed scaling factors applied, for the three study scenarios are shown in the table below. Attachment 1 (separate Excel worksheet file) provides additional details on this scaling approach and maps depicting the distribution of wind capacity using the proposed scaled and non-scaled approaches.

Locations and MW Amounts - Adjusted Based on Proposed Scaling Factors*

County/Area*	MISO Queue (MW)	Proposed Scaling Factors for MI WETS	Low Scenario (MW)	Medium Scenario (MW)	High Scenario (MW)
Charlevoix	120	0.75	54	108	162
Mason	220	0.75	99	198	298
Osceola	270	0.75	122	243	365
Oceana	140	No change	84	168	253
Muskegon1	100	No change	60	120	180
Muskegon2	120	No change	72	144	216
GR North	300	0.75	135	271	406
Gratiot	300	0.75	135	271	406
Midland	320	0.75	144	289	433
Hillsdale	300	0.75	135	271	406
Thumb	305	2.5	458	917	1375
Lower MI Total			**1,500**	**3,000**	**4,500**

Amounts for 1,000 MW offshore sensitivity are not shown. In the proposed offshore sensitivity analysis, 1,000 MW of offshore wind production would be modeled, in two groups of 500 MW each, modeled for installation in two different locations in Michigan (500 MW in the southern end of Lake Michigan, far enough offshore to not be visible

[11] *See* 120 FERC 61,220 (2007), *International Transmission Company*, Docket No. ER07-1141, Order Accepting Proposed Tariff Sheets (Sept. 7, 2007). Rehearing of this order is pending. <link?>

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from the shore in Illinois, Indiana, or Michigan, and another 500 MW generally near the mouth of Saginaw Bay). Assuming much of the potential for onshore wind energy development will be completed before developers would attempt the challenges associated with offshore projects, the offshore sensitivity is based on the idea of adding the two 500 MW offshore wind projects to the high scenario MW and locations as shown in the table.

The appropriate scaling factors to use for this purpose are judgment calls and stakeholder comment is welcome, particularly on:

(1) whether scaling factors should be used for all or some of the scenarios (e.g., only the medium and high) and, if so, whether adjustments to the proposed scaling factors are warranted; and
(2) whether additional counties that may have good wind siting potential but do not have pending interconnection requests in the queue should be modeled with appropriate adjustments to other sites (e.g., elimination or reduced MW). For example, in the MISO studies discussed below, there are hypothetical wind units sited in the northern Lower Peninsula, where there are no pending queue requests (e.g., Cheboygan County).

Relationship to Siting Approaches for MISO Planning Studies

MISO is responsible regional transmission planning in its footprint, which includes the majority of Michigan.[12] With stakeholder input, MISO has developed various assumptions and scenarios related to wind development as part of several on-going transmission planning studies. Three key studies of potential importance to Michigan include:

- **MTEP 08 Long Term Futures Study** – Long-term transmission planning study using various generation scenarios to estimate the costs, benefits, and reliability impacts of high-voltage transmission overlay systems across the MISO footprint and additional areas.
- **MTEP 09 Long Term Futures Study / Joint Coordinated System Plan (JCSP)** – Long-term study similar to MTEP 08, with revised assumptions and broadened scope to include the Eastern Interconnection,[13] except Florida. Transmission analysis being conducted in coordination with the DOE's Eastern Interconnection Wind Integration Study.
- **Review of ITC/AEP's Proposed 765 kV Project** – Economic, reliability, and load deliverability analysis of proposed transmission project that would create a high-voltage (765 kV) loop through Michigan's Lower Peninsula and connect to AEP's existing 765 kV network in Michigan and Ohio.

[12] See map at http://www.midwestmarket.org/page/About%20Us.
[13] The Eastern Interconnection is one of three synchronized grids in the US. The other two are ERCOT (Texas) and the Western Interconnection. <explain in layperson language what it means to be a "synchronized grid">

These MISO studies, particularly the MTEP long-term studies, have a broader geographic scope than MI WETS, and are focused primarily on estimating the economic benefits and costs of extra-high voltage transmission overlay systems (500 and 765 kV) using a production cost modeling tool.[14] As discussed earlier in this report, MI-WETS is focused on identifying at a conceptual level the minimum transmission needs to reliably interconnect different amounts of wind generation in Michigan. MI-WETS will use power flow models to identify the reliability impacts from integrating wind.

Like the MI-WETS, these MISO planning studies estimate the MW amounts and locations of wind development in Michigan for transmission modeling purposes. MISO's assumptions for Michigan are similar, but not identical to, the assumptions used for MI-WETS. A comparison of key assumptions related to wind development is provided in the table below.

When comparing MI-WETS to these MISO studies, the following observations should be noted:

- The "renewable" scenarios for MISO's studies show approximately 4,500-5000 MW of new wind in Michigan, which is consistent with the MI-WETS "high scenario" for the Lower Peninsula (4,500 MW) plus the 520 MW to be studied in the Upper Peninsula. The time periods for the studies (~ 2016-2022) are also generally consistent.

- The siting of the wind generation in MISO's studies is based on interconnection requests, wind potential, and other factors; the siting locations correspond roughly to the MI-WETS siting assumptions discussed above although a greater proportion of the wind MW capacity is located in the Thumb area in MISO's studies, particularly if the MI-WETS does not using scaling factors to increase the amount from this area. In addition, some of MISO's studies assume a greater amount of wind being located in the northern Lower Peninsula. A breakout of the MW of wind capacity by regions in the state for the different studies is shown below. Maps showing the wind siting locations for MTEP 08 and MTEP 09 / JCSP are available at <these will be posted on the WindStudy website as soon as possible. See http://www.michigan.gov/mpsc/0,1607,7-159-16377_47107_48701---,00.html>.

[14] Reliability screening of MISO's long-term conceptual transmission plans will also be conducted to determine the reliability issues caused or solved by the overlay transmission plan, refine the transmission plan, and determine reactive requirements.

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Comparison of Modeling Assumptions Related to Wind and Transmission Studies

Study	Assumed MW Amounts	Siting Approach	Modeling Time Period
MI-WETS	LP – 1,500 MW, 3,000 MW, and 4,500 MW UP – 520 MW[15]	General locations based on interconnection requests; MW extrapolated to meet MW scenarios. See above.	~ 6 – 10 years
MTEP 08 – Renewable scenario (20% wind across MISO footprint by 2020)	LP – 4,500 MW UP – 300 MW	Based on queue projects with interconnection agreement and hypothetical units identified through stakeholder process.	2008–2027 planning period; wind installed in MI by 2018
MTEP 09 / JCSP – Renewable scenario (20% wind across Eastern Interconnect except FL by 2024)	LP – 4,114 MW UP – 1,067 MW*	Siting represents multi-county aggregation and not projects in the queue. Siting done with DOE assistance using unpublished work.	2009–2028 planning period; wind installed in MI by 2022**
Review of ITC/AEP 765 kV Proposed Project	Base / reference case – 1,502 MW in LP	Locations based on select queue projects; MW based on queue information, with some aggregation based on geographic proximity.	2016 and 2021
	Renewable case – 4,582 MW (LP + UP)	3,382 MW is sited using methodology for base case (discussed above); remaining 1,200 MW hypothetical wind projects in the Thumb and West MI identified through MTEP 2008.	

* Does not include 1000 MW of wind interconnecting to Plains substation near the Wisconsin-Michigan border.
** The modeled wind generation in the Lower Peninsula comes on-line by 2015.

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[15] Note for DRAFT Reviewers: MPSC Staff has initiated conversation with ATC about whether and how to conduct something like low, medium, and high wind energy scenarios for the UP, similar to the modeling ITC is conducting for the LP but tied more directly to the existing interconnection requests. Comments and suggestions are welcomed from work group participants to help inform this aspect of the MI-WETS. For example, one option could possibly be for ATC to model 1, 2, or 3 of the UP requests in the queue, as representing low (1), medium (2), and high (all 3) projects being completed at the requested MW sizes. Another option could be to use scaling factors (as proposed for the ITC service territory modeling), to model low, medium, and high fractions of each of the three projects already indicated in the MISO queue.

Geographic Distribution of Wind Capacity (MW) under High / Renewable Scenarios - MI-WETS and MISO Studies

Region	MI-WETS (no scaling)	MI-WETS w/ Proposed Scaling	MTEP 08	MTEP 09 / JCSP	ITC 765 kV Project - Renewable Case
UP	502	502	300	1,067	520
Thumb	550	1,375	1,800	2,103	612
West	2,074	1,718	1,800	935	2,410
North / Northeast*	216	162	900	481	120
Mid-Michigan**	1,118	839	0	519	620
South (Hillsdale)	541	406	0	76	300
Total MW	**5,002**	**5,002**	**4,800**	**5,181**	**4,582**

* Includes Cheboygan, Charlevoix, and Grand Traverse Counties.
** Includes Gratiot, Saginaw, and Midland area.

Other Modeling Assumptions

Wind Output Assumptions

The transmission modeling for the Lower Peninsula assumes 15% wind output from all identified wind sites during the summer peak load case. The shoulder or off-peak load cases (80% or 60% load levels) assume 100% wind output. These assumptions are consistent with the assumptions used by MISO to analyze the reliability impacts of the MTEP 2008 conceptual, high-voltage overlay transmission plans.

Baseload and other Non-Wind Generation Assumptions

The model for the Lower Peninsula will include the following additional non-wind proposed generation:

Type	Location	Size
Coal	Bay City, Midland, Saginaw Area	800 MW
Combined cycle (natural gas)	Thetford (near Flint)	500 MW
Coal	Rogers City (in Presque Isle County, on Lake Huron)	600 MW

In addition, for purposes of this study, Consumers Energy Weadock Units 7 and 8 are assumed to be retired.

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A proposed Fermi III nuclear facility is not included, primarily because of the six to ten year timeframe of the model in this study. A new nuclear unit may need additional time for approval and construction and the Fermi site is generally thought to be geographically far enough away from the proposed wind sites that between wind generation at the modeled locations and a contemplated new Fermi III nuclear plant only modest interactions are anticipated for the transmission system.

The MI-WETS will also include a sensitivity analysis with no new non-wind generation in the model for the Lower Peninsula.

Consistent with the methodology used for generation interconnection studies, the only new, non-wind generation projects to be included in the model for the Upper Peninsula would be projects with a signed interconnection agreement. No such projects exist at this time.

Planned and Proposed Transmission Projects in Base Model

The base model for the Lower Peninsula includes transmission projects that have been approved by the MISO Board of Directors or are in the review process to be considered for approval by the board in MISO's current planning cycle, which will be completed in 2008 (i.e., MTEP 08).

Relationship of Models to Proposed Michigan Renewable Portfolio Standard

Three different possibilities for wind growth in the Lower Peninsula are considered; defined as low, medium, and high wind scenarios. In addition, a fourth sensitivity based on the high wind scenario contemplates additional offshore wind energy production. Some of the assumptions surrounding these scenarios for wind growth potential in the State of Michigan are as follows.

All of the wind production forecasts assume:

1. A Michigan RPS reaches 10% by the end of 2015. Michigan begins with a 3% renewable energy contribution from existing sources at the end of 2007, and increases in equal annual increments to reach 10% by the end of 2015.
2. An average capacity factor for utility scale wind generators in Michigan is estimated to be 35%.

The **low wind energy production forecast** assumes:

1. After reaching 10% by 2015, renewable resources continue providing 10% of demand through 2025.
2. In keeping with the assumption used in modeling for the *MI-21 Plan*, wind energy is projected to supply 55% of the total produced from all renewable resources.

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3. For 2016 through 2025, increases are modeled equal to the amount of new wind necessary to maintain a 10% RPS, with wind energy continuing to produce 55% of the total kWh produced from all new renewable energy resources.
4. 1,500 MW of wind capacity is modeled, as discussed in the previous sections, to represent the low wind energy future.

The **medium wind energy production forecast** assumes:

1. A Michigan RPS reaching 10% by the end of 2015, and then continuing to increase at 1.5% per year to reach 25% by 2025, then growing at 1% per year to reach 30% by 2030.
2. Wind energy is projected to supply 90% of the total produced from all new renewable resources.
3. 3,000 MW of wind capacity is modeled, as discussed in the previous sections, to represent the medium wind energy future.

The **high wind energy production forecast** assumes:

1. A Michigan RPS reaching 10% by the end of 2015, and then continuing to increase at 1.5% per year to reach 25% by 2025, then growing at 1% per year to reach 30% by 2030.
2. Wind energy is projected to supply 100% of the total produced from all new renewable resources.
3. 4,500 MW of wind capacity is modeled, as discussed in the previous sections, to represent the high wind energy future.

The **offshore wind sensitivity** assumes:

1. All of the same assumptions as the high wind energy production forecast described above.
2. Two additional installations of offshore wind capacity with 500 MW in the general area of Saginaw Bay, and 500 MW of off the coast of Lake Michigan, roughly between Benton Harbor and Chicago.
3. 5,500 MW total of wind capacity is modeled, as discussed in the previous sections, to represent the offshore wind sensitivity.

The Upper Peninsula modeling assumes:

1. Models 520 MW of wind capacity in the UP, in addition to the above scenarios, based upon the projects that are in the MISO queue in the area.

The following chart depicts each of the possibilities outlined above for wind capacity additions in the State of Michigan, overlaid with the amount of wind capacity modeled to potentially represent those futures. The wind capacity in the model graphed below includes 520 MW for the Upper Peninsula added to the 1,500, 3,000, 4,500, and 5,500 MW modeled for the Lower Peninsula.

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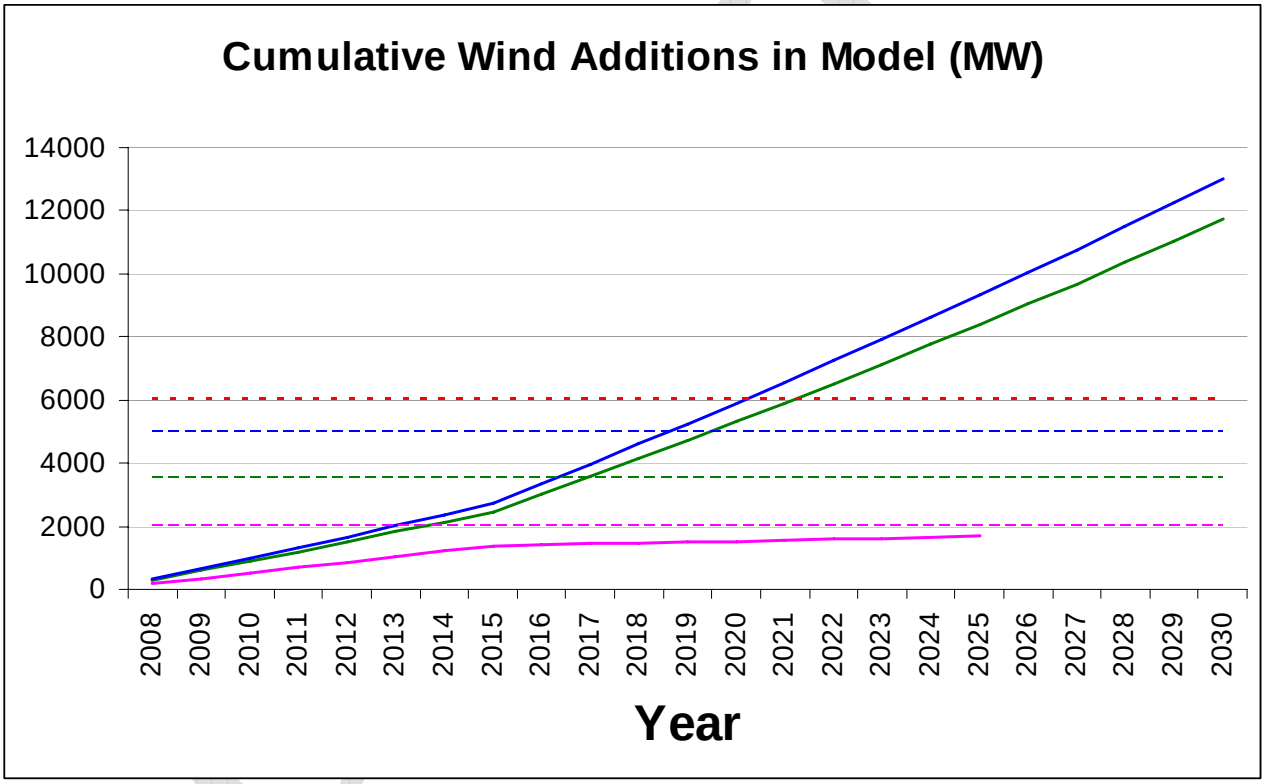
In the graph, the solid blue line represents the wind capacity additions expected for the high wind growth assumptions outlined above, and the dashed blue line represents the 5,020 MW of wind added to the models to represent the high wind scenario. The solid green line represents the wind capacity additions expected for the medium wind growth assumptions outlined above, and the dashed green line represents the 3,520 MW of wind added to the models to represent the medium wind scenario. The solid pink line represents the wind capacity additions expected for the low wind growth assumptions outlined above, and the dashed pink line represents the 2,020 MW of wind added to the models to represent the medium wind scenario. The dashed red line represents the 6,020 MW of wind added to the model to represent the offshore sensitivity.