

MICHIGAN WIND ENERGY TRANSMISSION STUDY – PHASE II

STUDY SCOPE

06-24-09

1 Purpose

There are currently several studies already taking place or under consideration with the intent of analyzing the interconnection of wind resources within the Lower Peninsula of Michigan. These studies include:

- Michigan Wind Energy Transmission Study I (study work done)
- Michigan Wind Energy Transmission Study II
- Michigan Wind Energy Resource Zones Board (WERZB) Transmission Study
- Various Midwest ISO Generation Interconnection Studies
- The Midwest ISO Regional Generation Outlet Study (RGOS) II

This study will combine the Michigan Wind Energy Transmission Study Phase II and the Michigan WERZB Transmission Study by utilizing various input assumptions developed via input from the Michigan Planning Consortium Renewable and Other Generation Integration Working Group and the Michigan WERZB as described in this scoping document.

To the extent possible, depending on the various study timeframes the results of this Michigan-centric study will be utilized to provide input into the various Midwest ISO Generation Interconnection studies and RGOS II.

While this analysis will focus on thermal loading, in some areas voltage, short circuit and/or transient stability concerns can also be of considerable importance and possibly drive additional system upgrades. Because actual installed generator reactive capabilities and dynamic parameters can vary significantly between the various wind generation manufacturers, and we don't have the specifics on which units may actually be installed, this study will not be utilized to determine the voltage, short circuit or transient stability implications.

2 Description of Study

This study will focus on the areas designated as Wind Energy Resource Zones (designated areas) by the Michigan WERZB. While project proposals will be optimized for the ITC Holdings (Michigan) area as a whole, the primary focus will be on exporting wind generation from the designated areas to the rest of the MECS (ITCT and METC) control area and/or the rest of the Midwest ISO market. Existing projects identified in the Midwest ISO processes will be utilized as appropriate.

2.1 Model Development

All system models will be built starting with the Midwest ISO market Regional Merit Order dispatch (RMD) 2009 MTEP model for 2014 with all approved Appendix A projects included. This model will be used for the systems outside of Michigan.

2.1.1 System Topology

Because the Midwest ISO MTEP model will include future projects, the METC and ITC systems will be removed from the model and the ITCT and METC system "as is" model will be inserted. Thus the starting point will be the system as it exists today.

This model includes detailed Detroit Edison (DTE) and Consumers Energy (CE) subtransmission system models and the Wolverine Power Cooperative networked facilities. The Detroit Edison system was last updated in January of 2009 with a 2009 summer model obtained from DTE on

2.1.3 System Reactive Load

All base cases (cases without future generation) will be screened for voltage criteria violations. If voltage violations are identified, reactive compensation devices, specifically capacitors will be placed on both the subtransmission and transmission systems in order to allow the system to maintain acceptable voltage levels (95% with all facilities in-service and 92% after any one single contingency). It is assumed that these devices would be added as necessary and identified in other short term studies. Any reactive additions will be documented in the study report.

Because the majority of the analysis for this study will be performed utilizing DC solution methodologies, voltage and reactive requirements for the future generation will not be determined. As stated above, these requirements would be heavily dependant on the types of machines actually installed.

2.1.4 Existing Generation & Interchange

In the base case that will be utilized, generators in the ITCT and METC footprints along with all other generators within the Midwest ISO market will be dispatched by the Midwest ISO to economically¹ to serve load within the Midwest ISO market.

While any existing wind units within Michigan will be dispatched as they are in the Midwest ISO MTEP study process, in order to determine the impacts of the future wind generation on the ability of the existing generation to be delivered to the system, existing wind generation and existing network resources in close proximity to the wind generation under study will be dispatched on. This generation will be made up by utilizing the economic order list from the MTEP 09 FTP site.

2.1.5 Michigan Ontario Interface

The ITCT system is interconnected to Canada via four tie lines located on the eastern side of the ITCT system, referred to as the B3N, L51D, L4D, and J5D. These four tie lines are (or will be) able to be controlled via phase shifting transformers.

The Michigan-Ontario phase shifters will be modeled as controlling flow in all models utilized in this study and adjusted to hold flows on the Michigan-Ontario interface to specific values as described in Table 2.1.7 below.

Total flow across this interface will be distributed 1/6, 1/3, 1/3, and 1/6 across the B3N, L4D, L51D, and J5D respectively².

2.1.6 Other Assumptions

One other phase shifting transformer exists within the ITCT and METC systems. The Caniff phase shifter is located in Detroit on the Caniff end of the Caniff to the Stephens 345 kV circuit. Its angle will be fixed at -3 degrees in all of the models.

St. Clair unit #6 in the ITCT system can operate on either the 345 kV or 120 kV system. In this analysis, St. Clair unit #6 will be modeled in its typical operating configuration on the 345 kV system.

¹ The Midwest ISO utilizes a merit order list in order to develop an economic dispatch for the entire Midwest ISO market.

² This is typically done for study purposes and does not represent what may or may not occur in real time operations.

2.2 Study Methodologies

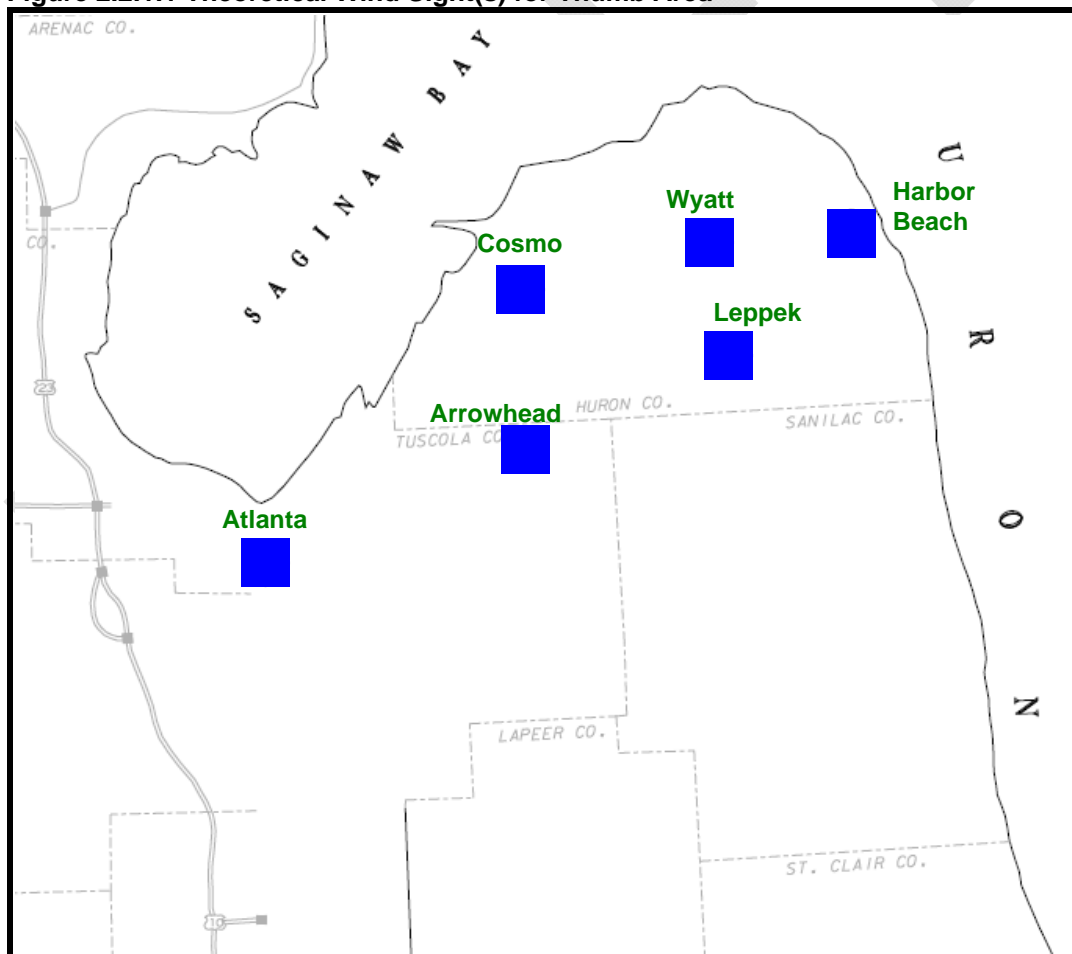
First, a traditional first contingency transfer analysis will be utilized to determine one (or several) sets of system upgrades that will support the future wind in the designated areas. This will be referred to as the systematic transfer analysis. Once the system upgrades required have been identified, single contingency analysis will be utilized to determine the robustness of the upgrades identified in the systematic transfer analysis.

2.2.1 Systematic Transfer Analysis

First contingency incremental transfer capability (FCITC) analysis will be utilized to determine where overloads begin to develop as the Michigan wind is transferred to units within the Midwest ISO market. For this analysis, the model with approximately 900³ MWs flowing from Michigan to Canada will be utilized.

Figure 2.2.1.1 through 2.2.1.4 below depict the theoretical wind sights that will be utilized for the systematic transfer analysis from the four regions that were initially recommended for designation as a Wind Energy Resource Zones by the Wind Energy Resource Zones Board.

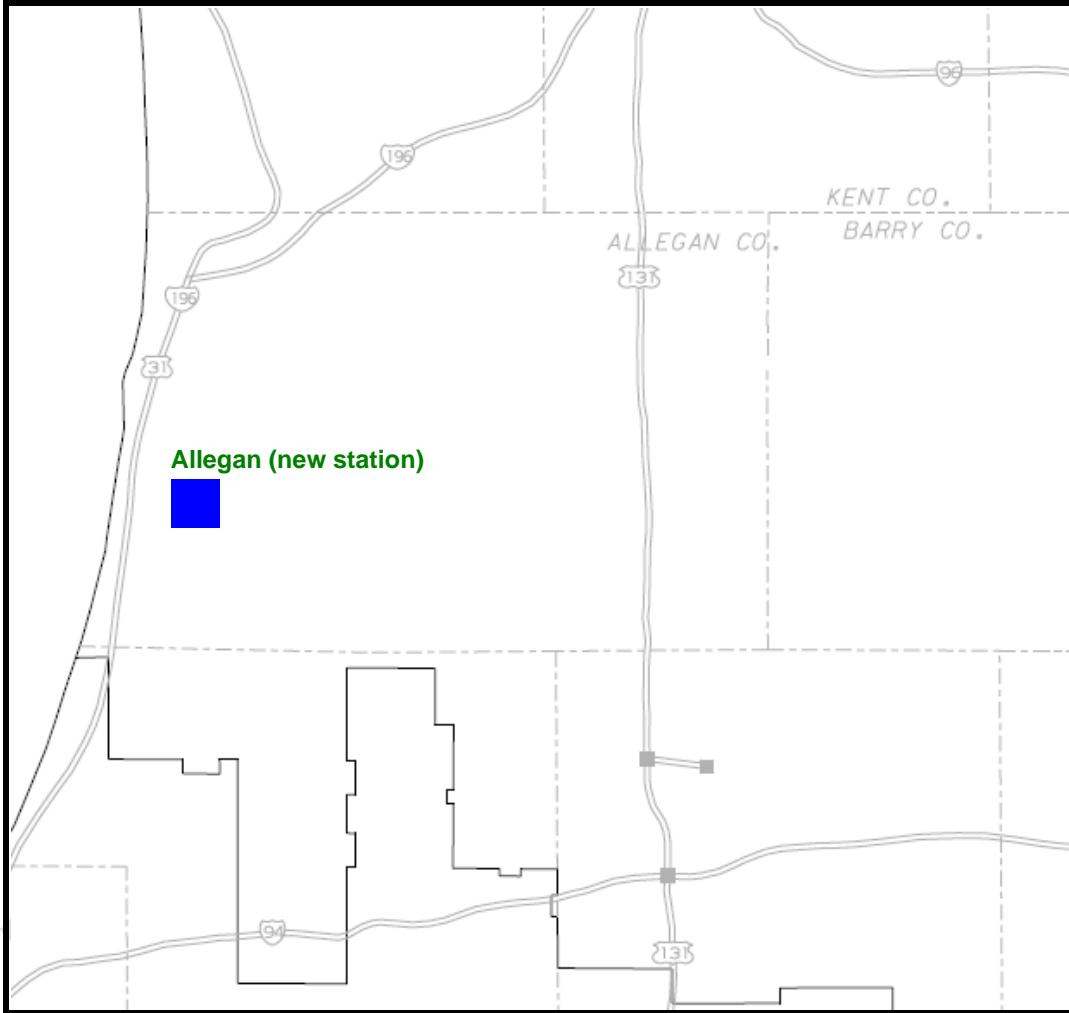
Figure 2.2.1.1 Theoretical Wind Sight(s) for Thumb Area



³ The Midwest ISO typically sets the flow from Michigan to Canada to the value of the total firm rights on this interface. In the 2009 Midwest ISO models this value will be approximately 900 MWs flowing from Michigan to Canada.

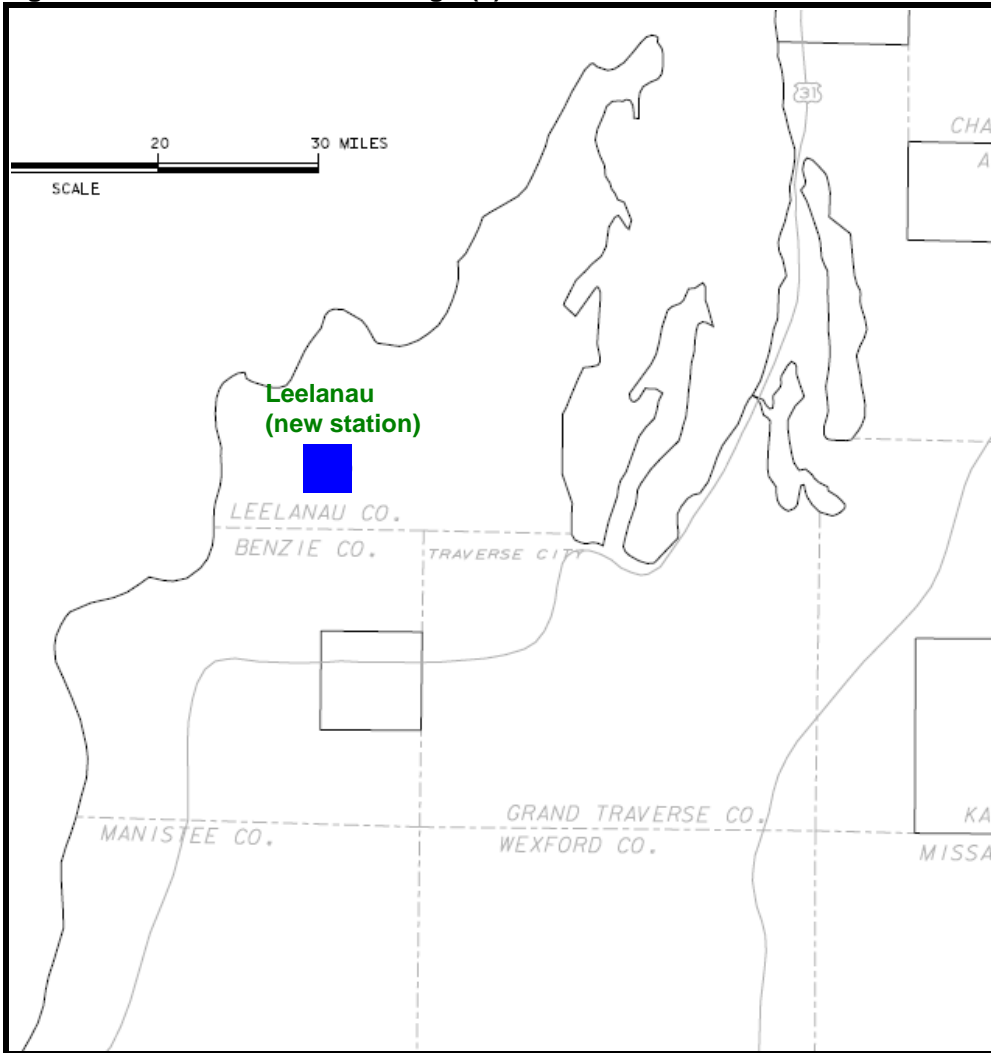
In the Thumb area the Michigan Wind Energy Resource Zones Board determined the theoretical minimum nameplate capacity was 2,367 MWs while the theoretical maximum nameplate capacity was 4,236 MWs spread throughout Huron, Bay, Saginaw, Sanilac and Tuscola counties. The power output for the Thumb area will be spread evenly between the 6 sites identified in Figure 2.2.1.1 above.

Figure 2.2.1.2 Theoretical Wind Sight(s) for Southwestern Area



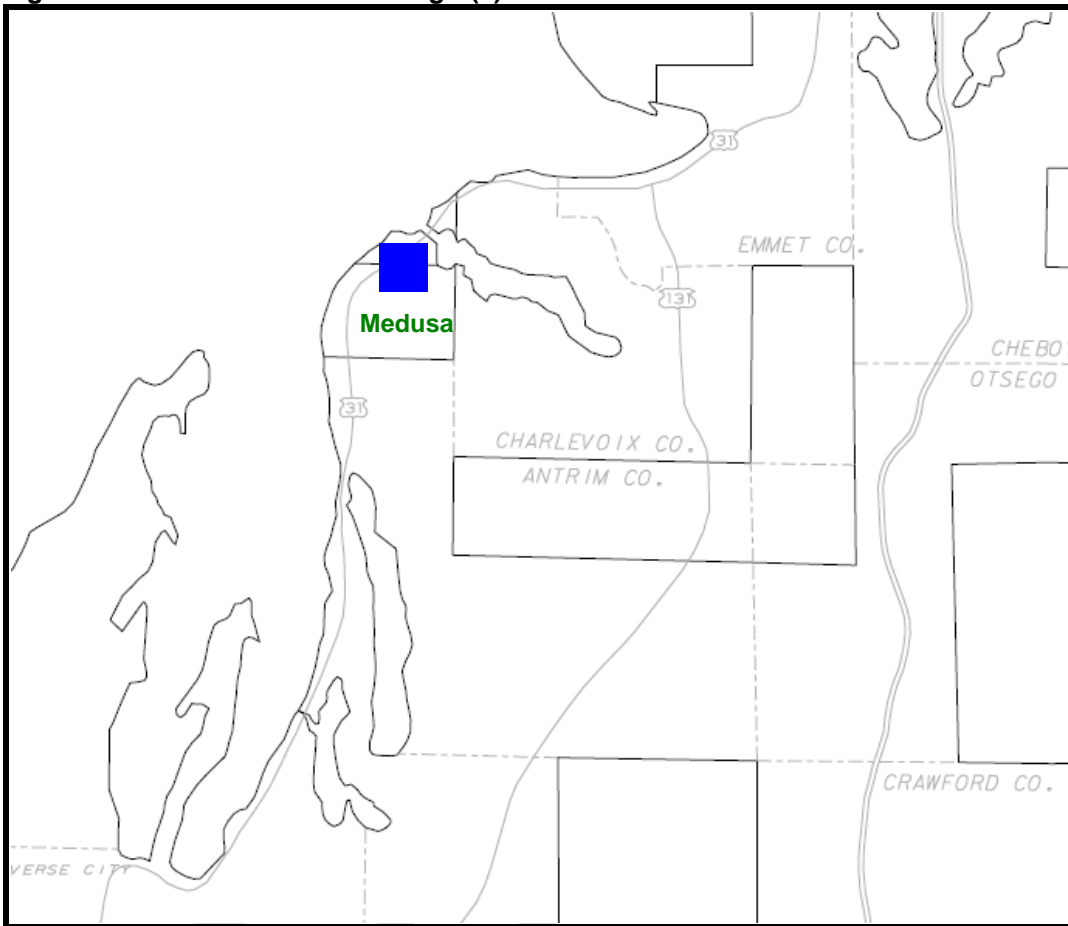
In the Southwestern area, consisting of Allegan County, the Michigan Wind Energy Resource Zones Board determined the theoretical minimum nameplate capacity was 249 MWs while the theoretical maximum nameplate capacity was 445 MWs. The power output for the Southwestern Michigan area will be exported from the one site identified in Figure 2.2.1.2 above.

Figure 2.2.1.3 Theoretical Wind Sight(s) for Northwestern Area 1



In the lower Northwestern area, consisting of Benzie, Leelanau and Manistee Counties, the Michigan Wind Energy Resource Zones Board determined the theoretical minimum nameplate capacity was 652 MWs while the theoretical maximum nameplate capacity was 1,167 MWs. The power output for the lower Northwestern Michigan area will be exported from the one site identified in Figure 2.2.1.3 above.

Figure 2.2.1.4 Theoretical Wind Sight(s) for Northwestern Area 2



In the upper Northwestern area, consisting of Antrim and Charlevoix Counties, the Michigan Wind Energy Resource Zones Board determined the theoretical minimum nameplate capacity was 163 MWs while the theoretical maximum nameplate capacity was 292 MWs. The power output for the lower Northwestern Michigan area will be exported from the one site identified in Figure 2.2.1.4 above.

Two different sinks will be considered. First, power will be transferred to the Midwest ISO market (including the MECS control area) by scaling up generation at the theoretical wind sights and scaling down generation at all of the on line generation in the Midwest ISO footprint. Next, power will be transferred to the MECS control area only by scaling up generation at the theoretical wind sights and scaling down generation at all of the on line generation in the MECS footprint.

Along with considering two different sinks, two different source transfer methodologies will be utilized. First, the theoretical wind generation will be scaled up proportionally so that all of the wind zones will reach their theoretical maximums (as defined by the Wind Energy Resource Board) simultaneously. Next, each zone will be individually scaled to its theoretical maximum while the other zones will be held to no power output. This will help to determine the upgrades required when each zone is generating power individually and when all of the zones are outputting power to the system simultaneously.

Each of the sink transfer methodologies will be paired up with each of the source transfer methodologies. The transfer source and sink pairs are defined in Table 2.2.1.1 below.

Table 2.2.1.1 Transfer Source/Sink Scenarios

Transfer Number	Source	Sink
1	All Michigan Wind	Midwest ISO Market
2	Thumb Area	Midwest ISO Market
3	Southwest Area	Midwest ISO Market
4	Lower Northwest Area	Midwest ISO Market
5	Upper Northwest Area	Midwest ISO Market
6	All Michigan Wind	MECS Control Area
7	Thumb Area	MECS Control Area
8	Southwest Area	MECS Control Area
9	Lower Northwest Area	MECS Control Area
10	Upper Northwest Area	MECS Control Area

Projects will be developed for the scenarios that transfer from each individual zone to the Midwest ISO market and tested for robustness in the other transfer scenarios.

2.2.2 Project Robustness Test

The projects developed in the systematic transfer analysis described above will be then be inserted into the rest of the models developed for this analysis and further tested for robustness as described below.

2.2.2.1 Interconnection & Sinks

Three different scenarios will be considered for sinking the wind from the designated zones.

First, as the future wind generation is placed on-line, generation throughout the Midwest ISO market will be backed down in merit order. The merit order list on the MTEP 09 FTP site will be used to determine what generation will be backed down.

Next, as the future wind generation is placed on-line, generation throughout Michigan will be backed down in merit order (considering units in the ITCT and METC footprints only). The last Michigan merit order list obtained by ITC Holdings will be utilized to implement this.

Finally, as the future wind generation is placed on-line, the Ludington units will be backed down and/or switched to pumping mode to absorb the wind generation.

Both the minimum and maximum nameplate MW amounts will be tested.

2.2.2.2 Contingencies Analyzed

All single (NERC Category B) contingencies for ITCT, METC, subtransmission facilities in close proximity to the designated area(s) and selected contingencies involving the surrounding system(s) will be considered for this analysis. Single contingencies defined from operating device to operating device will be considered for the ITCT and METC systems while single branch (node to node from a loadflow modeling standpoint) contingencies will be considered for the subtransmission system(s).

The outage of any generator results in the need to increase generation elsewhere in order to keep the load and generation in balance. When generation is modeled as forced out as part of a contingency, the “make up” generation will be assumed to come from the system inertia of the Midwest ISO market.

In some instances, transmission contingencies result in load being moved, either automatically or manually, from one portion of the system to another. This is referred to as

load throwover. As appropriate and practical, load throwovers will be considered in this analysis.

Per the ITCT and METC planning criteria shut down plus contingency scenarios should be analyzed at load levels up to 85% of the system peak load. Because shutdown plus contingency analysis allows for system redispatch between the shutdown and contingency events and this study will not be utilized to determine redispatch options, shutdown plus contingency analysis will not be considered.

2.2.2.3 Monitored Facilities

All ITCT and METC facilities (including ITCT and METC tie lines) will be monitored along with all other transmission and subtransmission facilities in close proximity to the designated area(s).

2.2.2.4 AC/DC Analysis

Because, as stated above, we do not yet know the details of the interconnecting machines, the bulk of the analysis performed in this study will be performed utilizing DC analysis. AC analysis will be used to verify individual results as deemed appropriate.

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2.3 Tables of Cases

Table 2.3.1 Base Case Utilized for Systematic Transfer Analysis

Case Name	Flow from MI into Ontario ⁴	ITC Load + Losses ⁴	ITC Generation Total ⁴	METC Load + Losses ⁴	METC Generation Total ⁴	Wind Dispatch % of Nameplate	Ludington Status ⁵
MTEP09_2014SP_AppA_RMD_mecs_fix.sav	900	11,000	11,460	10,400	12,460	0%-100%	6 Gen

Table 2.3.2 Cases with Wind Dispatched to Midwest ISO Market

Case Name	Flow from MI into Ontario ⁴	ITC Load + Losses ^{Error!} <small>Bookmark not defined.</small>	ITC Generation Total ⁴	METC Load + Losses ⁴	METC Generation Total ⁴	Wind Dispatch (% of Nameplate)	Ludington Status ⁵
miso_min_peak_0.sav	0	11,000		10,400		20%	6 Gen
miso_min_peak_in.sav	1000	11,000		10,400		20%	6 Gen
miso_min_peak_out.sav	-2000	11,000		10,400		20%	6 Gen
miso_min_80_peak_0.sav	0	8,800		8,320		100%	6 Gen
miso_min_80_peak_in.sav	1000	8,800		8,320		100%	6 Gen
miso_min_80_peak_out.sav	-2000	8,800		8,320		100%	6 Gen
miso_min_80_peak_pump_0.sav	0	8,800		8,320		100%	5 Pump
miso_min_80_peak_pump_in.sav	1000	8,800		8,320		100%	5 Pump
miso_min_80_peak_pump_out.sav	-2000	8,800		8,320		100%	5 Pump
miso_max_peak_0.sav	0	11,000		10,400		20%	6 Gen
miso_max_peak_in.sav	1000	11,000		10,400		20%	6 Gen
miso_max_peak_out.sav	-2000	11,000		10,400		20%	6 Gen
miso_max_80_peak_0.sav	0	8,800		8,320		100%	6 Gen
miso_max_80_peak_in.sav	1000	8,800		8,320		100%	6 Gen
miso_max_80_peak_out.sav	-2000	8,800		8,320		100%	6 Gen
miso_max_80_peak_pump_0.sav	0	8,800		8,320		100%	5 Pump
miso_max_80_peak_pump_in.sav	1000	8,800		8,320		100%	5 Pump
miso_max_80_peak_pump_out.sav	-2000	8,800		8,320		100%	5 Pump

⁴ All values in approximate megawatts (MW).

⁵ Currently only 5 units can operate in pumping mode.

Table 2.3.3 Cases with Wind Dispatched to Michigan

Case Name	Flow from MI into Ontario ⁴	ITC Load + Losses ⁴	ITC Generation Total ⁴	METC Load + Losses ⁴	METC Generation Total ⁴	Wind Dispatch (% of Nameplate)	Ludington Status ⁵ above ⁵
mich_min_peak_0.sav	0	11,000		10,400		20%	6 Gen
mich_min_peak_in.sav	1000	11,000		10,400		20%	6 Gen
mich_min_peak_out.sav	-2000	11,000		10,400		20%	6 Gen
mich_min_80_peak_0.sav	0	8,800		8,320		100%	6 Gen
mich_min_80_peak_in.sav	1000	8,800		8,320		100%	6 Gen
mich_min_80_peak_out.sav	-2000	8,800		8,320		100%	6 Gen
mich_min_80_peak_pump_0.sav	0	8,800		8,320		100%	5 Pump
mich_min_80_peak_pump_in.sav	1000	8,800		8,320		100%	5 Pump
mich_min_80_peak_pump_out.sav	-2000	8,800		8,320		100%	5 Pump
mich_max_peak_0.sav	0	11,000		10,400		20%	6 Gen
mich_max_peak_in.sav	1000	11,000		10,400		20%	6 Gen
mich_max_peak_out.sav	-2000	11,000		10,400		20%	6 Gen
mich_max_80_peak_0.sav	0	8,800		8,320		100%	6 Gen
mich_max_80_peak_in.sav	1000	8,800		8,320		100%	6 Gen
mich_max_80_peak_out.sav	-2000	8,800		8,320		100%	6 Gen
mich_max_80_peak_pump_0.sav	0	8,800		8,320		100%	5 Pump
mich_max_80_peak_pump_in.sav	1000	8,800		8,320		100%	5 Pump
mich_max_80_peak_pump_out.sav	-2000	8,800		8,320		100%	5 Pump

Table 2.3.4 Cases with Wind Dispatched to Ludington

Case Name	Flow from MI into Ontario ⁴	ITC Load + Losses ⁴	ITC Generation Total ^{Error!} <small>Bookmark not defined.</small>	METC Load + Losses ⁴	METC Generation Total ⁴	Wind Dispatch (% of Nameplate)	Ludington Status ⁵
lud_min_peak_0.sav	0	11,000		10,400		20%	
lud_min_peak_in.sav	1000	11,000		10,400		20%	
lud_min_peak_out.sav	-2000	11,000		10,400		20%	
lud_min_80_peak_0.sav	0	8,800		8,320		100%	
lud_min_80_peak_in.sav	1000	8,800		8,320		100%	
lud_min_80_peak_out.sav	-2000	8,800		8,320		100%	
lud_min_80_peak_pump_0.sav	0	8,800		8,320		100%	
lud_min_80_peak_pump_in.sav	1000	8,800		8,320		100%	
lud_min_80_peak_pump_out.sav	-2000	8,800		8,320		100%	
lud_max_peak_0.sav	0	11,000		10,400		20%	
lud_max_peak_in.sav	1000	11,000		10,400		20%	
lud_max_peak_out.sav	-2000	11,000		10,400		20%	
lud_max_80_peak_0.sav	0	8,800		8,320		100%	
lud_max_80_peak_in.sav	1000	8,800		8,320		100%	
lud_max_80_peak_out.sav	-2000	8,800		8,320		100%	
lud_max_80_peak_pump_0.sav	0	8,800		8,320		100%	
lud_max_80_peak_pump_in.sav	1000	8,800		8,320		100%	
lud_max_80_peak_pump_out.sav	-2000	8,800		8,320		100%	

3 Timeline

Table 4.1 Study Timeline

Wind Zones Study Timeline (2009)	April	May	June	July	Aug	Sep	Oct	Nov
Develop Input Assumptions (MPC)								
Develop Models								
Develop Transmission Plans								
Test & Refine Transmission Plans								
Develop Report & High Level Costs								

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