ITCT / METC
2008 Michigan Wind Scenarios Analysis

ITC Holdings System Planning Department

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1 PURPOSE

The ITC Holdings System Planning Department performed the assessment documented in this report as part of the company's collaborative participation in the Michigan Wind Energy Transmission Study (MI-WETS) Group. This study was performed in order to determine the transmission system impacts and possible transmission mitigations measures related to five future generation scenarios in Michigan's lower peninsula including four scenarios focusing specifically on wind power. The MI-WETS is being lead by the Michigan Public Service Commission (MPSC) Staff and has participants from the MPSC Staff, ITC Holdings, Consumers Energy, Detroit Edison, Wolverine Power, and various generation developers. This study is intended to provide the MI-WETS with a high level understanding of the types of transmission system expansions that could be required to be implemented for the various levels of specific future generation scenarios. This study will also provide insights to ITC Holdings to be used in the process of developing the company's short and long term capital expansion plans. The results discussed herein are specific to the future generation scenarios described herein and developed by the MI-WETS.

This document is NOT intended to:

- Serve as a recommendation to begin constructing any of the projects mentioned within.
- Serve as a final proposal for solving any system need(s).
- Intentionally address any system issues identified outside of this long term assessment.
- Indicate the Midwest ISO or any other entity has reviewed these projects.
- Present solutions to all possible conditions that could lead to planning criteria violations.
- Identify system issues or solutions for those issues on the lower voltage Load Serving Entities sub-transmission system(s).
- Identify system issues or solutions for those issues on neighboring transmission systems.
- Be used by outside entities to model the ITCT or METC systems in other studies.
- Represent that any engineering feasibility has been determined for the projects mentioned within.
- Serve as an interconnection study for any specific future generator or groups of generators.
- Provide any generation developers aid in siting future generation.

2 EXECUTIVE SUMMARY

2.1 BACKGROUND

The transmission system is to be planned such that it can reliably and economically deliver energy from existing and future generation to existing and future load. This study begins to explore possible future generation scenarios within the lower peninsula of Michigan. As such, it represents a step down the path of proper planning, but additional work will be required to reach the ultimate goal of developing a transmission network that efficiently moves tomorrow's more economically and environmentally efficient generation fleet to tomorrow's load. 2008 is a time of uncertainty for transmission planners. Currently the generation interconnection queue for METC and ITCT lists generation in the amount of approximately xxxxx MW including xxxx MW of proposed wind generation. This is about xx% of the existing generation fleet in the combined ITCT and METC service territories. In addition, under consideration are possible state and national mandates aimed at increasing the usage of renewable generation resources. Combined, these factors represent a potential significant shift in the generation patterns with an associated potential significant change in the required transmission expansions.

While this analysis will focus on thermal loading, in some areas, voltage considerations and/or transient stability concerns can also be of considerable importance. The addition of generation and transmission facilities would also likely increase short circuit levels throughout the ITCT and METC systems. At some locations, the voltage, transient stability, and/or increased short circuit levels may be significant and result in driving various system upgrades. This study did not determine the voltage, transient stability, or short circuit impacts of the proposed future generators or system projects. Due to all of these factors, while some of these concepts may be implemented in a manner represented herein, other concepts may undergo significant changes as additional work is done on the planning and engineering feasibility of these concepts.

2.2 DESCRIPTION OF THE STUDY

The method of analyzing the transmission system for this assessment is detailed in Section 5 below. This section describes how the results of the assessment were analyzed, and how project proposals were formulated.

The system was grouped into eleven geographically based study areas, as described in Section 2.3. Analysis was performed for the entire system and results were broken down into the specific study areas, for which projects were developed to mitigate any projected reliability criteria violations. These more detailed studies were by no means extensive or complete, thus additional study work will be required in the future to further evaluate the project proposals as to whether they are the most prudent, robust solution to each system issue. Once projects were developed for each Study Area, all of the proposed projects were added to the models and tested against the various system conditions analyzed.

Many factors can alter the selection of a project when planning a robust, reliable, and economic transmission system. Consideration should be given to additional system conditions, including but not limited to varying load levels, redistribution of load, other potential generation interconnection scenarios, various regional transfers, and any regional projects that might impact the area under study. Project proposals will also have to be reviewed with the Load Serving Entities and neighboring transmission owners such that they can evaluate the proposal's impact on their networked systems.

2.3 DESCRIPTION STUDY AREAS

The following is a list of Study Areas as defined in this study. Each was chosen to represent one geographical, continuous area with the purpose of grouping the assessment results. The areas do not represent any official service area or planning region, and have been defined as such only for the purposes of this study. While each Study Area was individually studied, projects proposed in one area were taken into account when assessing the neighboring areas.

- **Detroit** – The city of Detroit portion of ITCT, highlighted by the 120 kV cable system.
- **Down River** – The southern part of the ITCT system, including the Fermi, Monroe, River Rouge, and Trenton Channel power plants, and one 120/138 kV interconnection between ITCT and METC.

- **Flint** – The east part of the METC system, including the Hemphill, Garfield, and Thetford areas.
- **Grand Rapids** – The METC transmission system in the vicinity of Grand Rapids, including the Campbell and Tallmadge areas.
- **Kalamazoo** – The METC transmission system in southwest Michigan, including the Argenta, Battle Creek, and Holland areas.
- **Lansing** – The METC system in the center of the lower peninsula surrounding the city of Lansing, including the Oneida, Tompkins, and Bingham areas
- **Northern Michigan** – The northern and northwestern portion of the METC transmission system, including the northern 345 kV loop and the underlying 138 kV network.
- **Oakland** – The ITCT network in and around Oakland County, including the Southfield and Troy areas.
- **Saginaw** – The METC system in the Saginaw bay area, including the Tittabawassee, MCV, and Goss areas.
- **Thumb** – The ITCT network in the Thumb portion of Michigan, also including the areas around Greenwood, St. Clair, and Bunce Creek.
- **Wayne** – The ITCT system in the western portion of Wayne county and surrounding areas (not including Detroit or Downriver). This includes the areas near Wayne, Evergreen, and Hines stations.

See figure 2.3.1 below for a map showing the approximate location of the study areas.

FIGURE 2.3.1 – MAP OF APPROXIMATE LOCATION OF STUDY AREAS*

* Areas shown are approximate boundaries of study areas. Areas were developed based on groupings of system issues.

2.5 DESCRIPTION OF FUTURE GENERATION SCENARIOS

Various combinations of five future generation scenarios were analyzed. Each scenario built upon the previous. The first scenario modeled three future fossil generators, a 500 MW combined cycle plant modeled near Flint at the Thetford 345 kV station, an 800 MW coal unit modeled near Bay City at the Tittabawassee 345 kV station, and a 600 MW coal unit near Rodgers City at the Port Calcite 138 kV station. The second, third, and fourth scenarios included the three fossil units modeled in the first scenario plus 1,500 MW, 3,000 MW, and 4,500 MW of available wind resources distributed on-shore throughout the lower peninsula of Michigan, referred to as the low, medium, and high wind scenarios. The fifth scenario included the three units modeled in the first scenario along with the on-shore wind resources from the high wind scenario and an additional 1000 MW of available off-shore wind resources. The four future wind scenarios were also studied without the three fossil units. Further description of the future generation scenarios including the sighting methodology used for the wind farms can be found in Section 4 below.

As detailed in Section 4 below, the wind resources were distributed throughout the lower peninsula of Michigan based on the wind farm locations currently in the MISO Generation Interconnection queue and sized by utilizing various scaling factors provided by the MI-WETS Group.

2.6 SUMMARY OF PROJECT PROPOSALS FOR FUTURE GENERATION SCENARIOS

Below is a list of the projects that could be required for each of the different future generation scenarios analyzed. Actual system needs would depend on the specific location and size of each of the future generators along with the interaction between each of the future units.

TABLE 2.6.1 – SUMMARY OF PROJECTS NECESSARY TO INTERCONNECT FUTURE GENERATION SCENARIOS

Area	Project	Base	Fossil Units	Low Wind No Fossil	Medium Wind No Fossil	High Wind No Fossil	High Plus Offshore Wind No Fossil	Low Wind Plus Fossil	Medium Wind Plus Fossil	High Wind Plus Fossil	High Wind Plus Offshore & Fossil
Detroit											
N/A											
Down River											
Down River	Monroe to Bay Shore #2										
Down River	Monroe to Bay Shore #3										
Flint											
Flint	Bell Road to Cornell										
Flint	Blinton to Halsey										
Flint	Halsey to Hemphill										
Flint	Blackfoot to Hemphill & Thetford to Hemphill 230 kV										
Flint	Latson to Dean to Oakland										
Flint	Oakland to West Fenton Junction										
GR											
Grand Rapids	Beals Road to Dorr Cornners 138 kV									Yes	Yes
Grand Rapids	Beals Road to Wealthy 138 kV									Yes	Yes
Grand Rapids	Cleveland to Savidge to Sternberg 138 kV			Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Kalamazoo											
Kalamazoo	Argenta Area Project	Yes									
Kalamazoo	Cook to Palisades #3										
Kalamazoo	Cook to Palisades #4										
Kalamazoo	Argenta to Tallmadge Uprate										
Kalamazoo	Barry to Bradley Uprate										
Kalamazoo	Gains to Aubil Lake Uprate										
Kalamazoo	Morrow to Parkville Uprate										
Kalamazoo	Verona to Barnum Uprate										
Kalamazoo	Seamless to Cement Uprate										
Kalamazoo	Bradley to Abbil Lake Uprate										
Kalamazoo	Argenta to Kenowa Uprate										
Kalamazoo	Argenta to Riverview Uprate										
Kalamazoo	Barry to Warner Uprate										
Kalamazoo	Warner to Morrow Uprate										
Kalamazoo	Leoni to Blackstone Uprate										

Lansing											
Lansing	Sprague Switching Station and New Goss to Sprague 345 kV Circuit		Yes					Yes	Yes	Yes	Yes
Lansing	Van Atta Tap to Tihart 138 kV		Yes			Yes	Yes	Yes	Yes	Yes	Yes
N. Michigan											
N. Michigan	Rogers City Project		Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N. Michigan	Amber to Donaldson Creek 138 kV					Yes	Yes			Yes	Yes
N. Michigan	Becker Tap to Cobb 138 kV					Yes	Yes			Yes	Yes
N. Michigan	Donaldson Creek to White Lake to Cobb 138 kV				Yes	Yes	Yes		Yes	Yes	Yes
N. Michigan	White Lake to Dupont 138 kV					Yes	Yes			Yes	Yes
N. Michigan	Chase to Mecosta 138 kV									Yes	Yes
N. Michigan	Tippy to Chase 138 kV		Yes					Yes	Yes	Yes	Yes
N. Michigan	White Lake Station Equipment					Yes	Yes			Yes	Yes
N. Michigan	Emmet to Livingston 138 kV				Yes	Yes	Yes		Yes	Yes	Yes
N. Michigan	Riggsville to Mcgulpin 138 kV		Yes				Yes	Yes	Yes	Yes	Yes
N. Michigan	McGulpin Station Equipment								Yes	Yes	Yes
N. Michigan	MeGulpin to Straits 138 kV Circuits		Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Oakland											
Oakland	Hancock-Bloomfield 120kV										Yes
Saginaw											
Saginaw	Midland Area Project	Yes		Yes		Yes	Yes	Yes	Yes	Yes	Yes
Saginaw	Alma to Begole 138 kV				Yes	Yes	Yes		Yes	Yes	Yes
Saginaw	Alma to Vestaburg 138 kV					Yes	Yes			Yes	Yes
Saginaw	Karn to Saginaw River 138 kV		Yes		Yes	Yes	Yes	Yes	Yes	Yes	Yes
Thumb											
Thumb	Wyatt 230 kV Station										
Thumb	Wyatt to Tuscola 230 kV Circuit										
Thumb	Wyatt to Greenwood 230 kV Circuit										
Thumb	Greenwood to Bunce 230 kV										
Thumb	East Side 230 kV Work										
Thumb	West Side 230 kV Work										
Thumb	Tuscola to Hampton to Thetford Tap										
Thumb	Hunters Creek to Stratford										
Thumb	345 kV Loop – Atlanta to Wyatt to Greenwood										
Wayne											
Wayne	Upgrade Madrid Transformer										

2.7 NEXT STEPS

This 2008 study is a first step towards developing a robust transmission system that can serve existing and future load with existing and future generation, specifically new renewable generation located within the Lower Peninsula of Michigan. Additional study work will be necessary to further develop the projects identified in this study. These projects will continue to be tested against future scenarios to ensure that they represent the most robust long term solutions to each problem area. For example, there is approximately xxxx MW of generation in the MISO generator interconnection queue. The projects proposed in this report could be tested against different combinations of those generator interconnections, to determine the sensitivity of the projects to the proposed generation. The projects described in this report could potentially be modified based on the results of these additional studies.

3 STUDY AREA ASSESSMENTS FOR FUTURE GENERATION SCENARIOS

3.1 DETROIT AREA

No future generation was placed in the Detroit area. Overloads in this area have generally driven by load growth and are impacted by the possibility of local generation being decommissioned in the future.

3.2 DOWN RIVER AREA

While none of the future generators were placed in the Down River area, additional interconnections with systems to the south would be required to support the export of large amounts of generation from Michigan. The addition of both a second and third 345 kV circuit from ITCT's Monroe station to First Energy's Bay Shore station would help to allow more power to be exported from the ITCT system. Another option would be to implement the proposed 765 kV project. This project would allow for a significant amount of power transfer throughout the area.

It should be noted that there is a large nuclear plant in the MISO generator interconnection queue proposing to locate in the Down River Area at the existing Fermi sight that was not modeled in this analysis. This unit will likely add significantly to the amount of power flowing south out of the ITCT system. This interconnection request is currently in the System Impact Study phase of the MISO generator interconnection process. Any projects in this area will need to be coordinated with the final results of the interconnection study for this proposed nuclear unit.

Any projects in the Down River area will need to be coordinated with all neighboring utilities.

3.3 FLINT AREA

Circuits in the Flint area were impacted by both the future fossil units and the future Wind Farms. One of the three future fossil units, a 500 MW combined cycle plant, was placed at the Thetford 345 kV bus in the Flint area and an 800 MW coal plant was placed just north of the Flint area in the Saginaw (Bay City) area at the Hampton 345 kV bus. Along with the placement of these future fossil units, a significant amount of wind generation was sited to the west, east, and north of Flint. The wind generation to the east of Flint was placed at two busses, the Begole 138 kV and Nelson Road 345 kV bus. The wind generation to the north of Flint was placed at the Hampton 345 kV bus. This site represented the off-shore wind generation in the Saginaw Bay. The wind to the east of Flint was placed in the north central region of the Thumb.

The placement of this wind generation resulted in several overloads in the Flint area. Some overloads were made significantly worse with the inclusion of the fossil fuel units. Most identified overloads exist for shutdown plus contingency events in shoulder peak conditions when the Wind Farms are dispatched at 100% of their nameplate capability. However, there were also some overloads identified at peak load conditions with the wind farms dispatched to 15% of their nameplate capabilities.

Projects identified in this area include:

- Tapping one of the 345 kV circuits from Thetford to Hampton with a 345 kV circuit from the Tuscola 230 kV station (via 345/230 kV transformer).
- Upgrading various station equipment and reconductoring or rebuilding several existing circuits.

3.4 GRAND RAPIDS AREA

There were three future wind farms placed in what was defined as the Grand Rapids area. One was placed at the Kenowa 345 kV bus, one at the White Lake 138 kV bus, and one at the Donaldson Creek 138 kV bus. Two wind farms were placed just north of the Grand Rapids area in Northern Michigan; one at the Pere Marquette 138 kV bus and another at the Oscela 69 kV bus. To the east of Grand Rapids, a future wind farm was placed at the Nelson Road 345 kV bus in what was defined as the Saginaw area and another wind farm was located at the Benton Harbor 345 kV bus to the south west of Grand Rapids in the AEP footprint. This represented the off shore plant placed in Lake Michigan.

In order to deliver this future wind generation upgrading various station equipment and reconductoring or rebuilding several existing circuits would be required in the Grand Rapids area.

3.5 Kalamazoo Area

There was one future generator located in what was defined as the Kalamazoo area. A future wind farm was sighted in Hillsdale County at the Dowling Junction 138 kV station. Similar to the Down River area, additional interconnections with systems to the south would be required to support the export of large amounts of generation in Michigan. The addition of both a second and third 345 kV circuit from METC's Palisades station to AEP's Cook station would help to allow more power to be exported from the METC system. Another option would be to implement the proposed 765 kV project. This project would allow for a significant amount of power transfer throughout the area.

In order to deliver this future wind generation, along with additional tie capability with neighboring utilities, upgrading various station equipment and reconductoring or rebuilding several existing circuits would be required in the Kalamazoo area.

3.6 Lansing Area

While there were no future units sighted in the Lansing area, there were several overloads identified in this area as power is shipped to the south from the future units placed in the Saginaw, Thumb, and Northern Michigan areas.

Projects identified in this area include:

- Installing a new 345 kV switching station (Sprague) by cutting into the Madrid-Blackfoot 345 kV line, installing a new 345 kV line from Goss to Sprague.
- Upgrading various station equipment and reconductoring or rebuilding several existing circuits.

3.7 Northern Michigan Area

One future coal plant and three wind farms were placed in the area defined as Northern Michigan. The future coal plant was placed in the north east region (Rodgers City area), one wind farm was placed in the northwest region at the Miles Road Junction 138 kV bus, and two other wind farms were placed in the southwest region of the Northern Michigan area, one at the Pere Marquette 138 kV bus and another at the Oscela 69 kV bus.

The future coal plant placed in the Rogers City area was shown to have a significant impact on the 138 kV circuits in this area. This unit is currently under study in the MISO generator interconnection process and will most likely require significant transmission system upgrades in order to interconnect. This analysis is not meant to determine the interconnection requirements for one unit but rather to give a general feel as to how several future fossil units would interact with several future wind farms.

There are also existing transmission system performance issues in the Northern Michigan area including aging facilities in poor condition, operational voltage concerns, and heavily loaded facilities in the north and southwest regions of Northern Michigan. The proposed future coal plant and future wind farms were shown to exacerbate thermal constraints on the highly loaded 138 kV circuits in the Northern Michigan area.

In order to deliver this future wind generation upgrading various station equipment and reconductoring or rebuilding several existing circuits would be required in the Northern Michigan area.

As with the other tie facilities in the ITCT and METC systems, the two interconnections between METC and American Transmission Company (ATC) at the tip of the Northern Michigan area where shown to become heavily loaded as large amounts of power were exported from the METC system. In order to limit the flows between METC and ATC, phase shifting transformers could be placed at either the Straits or McGulpin end of the two tie lines. Another option would be to replace the overhead and cable sections of this circuit with higher rated conductor and cable.

3.8 Oakland Area

While there were no future units sighted in the Oakland area, the addition of significant amounts of future generation throughout the Lower Peninsula of Michigan was shown to educe enough incremental flow to cause heavy loading on a circuits in the Oakland area. It should be noted that the Bismarck to Troy 345 kava project and the new Oakland County project were both included in all of the models used for this study. Without these projects modeled it would be expected that further upgrades would be required in the Oakland Area.

In order to deliver this future wind generation upgrading various station equipment and reconductoring or rebuilding several existing circuits would be required in the Oakland area.

3.9 Saginaw Area

One coal unit and three wind farms were sighted in the Saginaw area. The coal unit was placed at the Tittabawassee 345 kV bus, one wind farm was placed at the Nelson Road 345 kV bus, one wind from was placed at the Begole 138 kava bus, and the third wind farm was placed at the Hampton 345 kV bus. The existing system in the Saginaw area was not able to support all of this future generation. Several circuits in the area were identified as loaded well above their emergency ratings for various contingency scenarios.

There are a number of potential solutions for the Saginaw area which include:

- Install a new 345/230 kV transformer at Richland 345 kV substation.
- Install new 230/138 kV transformers at both Bullock and Begole 138 kV stations.
- Rebuild the Begole to Richland 138 kV line on double circuit structures and add a new Begole to Richland 230 kV circuit on the same structure.
- Construct a new 12 mile 345 kV circuit from Richland to Tittabawassee.

Along with the projects above, various other station equipment would need to be replaced and several existing circuits would need to be reconductored or rebuilt.

3.10 Thumb Area

While no future Fossil units were placed directly in the Thumb area, two of the three future fossil units, the 500 MW combined cycle plant at the Thetford 345 kV bus in the Flint area and the 800 MW coal plant at the Tittabawassee 345 kV bus in the Saginaw area were modeled just to the south and west of the Thumb area. Along with the 800 MW coal plant placed at Tittabawassee, a 500 MW off-shore wind farm located in the Saginaw bay was interconnected to the Hampton 345 kV bus.

A significant amount of wind generation was placed in the north central region of the Thumb area at the Wyatt station (either at a new 230 kV or a new 345 kV bus). The existing 120 kV system in the Thumb could not support the amount of generation placed there for this study and additional transmission facilities were required in order to allow the simulation to run properly. Several options were evaluated. The first set of options included a new 230 kV station at the existing Wyatt site, currently a 120 kV switching station and two double circuit tower lines heading to the south. This set of options would require rebuilding the existing 120 kV loop to double circuit 230 kV standards and operating one or both sides at 230 kV. The second set of options included a new 345 kV station at the existing Wyatt site and two 345 kV circuits heading to the south. One circuit would connect the Wyatt 345 kV station to a new 345 kV station tapping one or both of the Hampton to Thetford 345 kV circuits just to the southwest of the Thumb area and the other would connect the Wyatt 345 kV station to the Greenwood 345 kV station in the southeast region of the Thumb. This would require rebuilding the existing 120 kV loop to double circuit 345 kV standards and operating one or both sides at 345 kV.

Along with rebuilding the existing 120 kV loop in the Thumb, the 120 kV circuits from Greenwood to Lee down to the Bunch Creek station would also need to be rebuilt. Rebuilding these circuits utilizing 230 kV double circuit tower construction standards and operating one side from Greenwood down to Bunce Creek at 230 kV would help to unload the existing 120 kV circuits in the area.

3.11 WAYNE AREA

There were no future units sighted in the Wayne area. However issues were identified as large amounts of power were exported from the wind farms in the north out of Michigan to the south. A proposed fix would be to replace the Madrid 345/120 kV transformer with a larger unit.

4 MODEL DEVELOPMENT

4.1 BASE CASE DEVELOPMENT

All cases were built starting with the 2006 series, RFC model for 2007 summer conditions. This model has all firm transfers modeled for the Eastern Interconnection. The detailed ITCT and METC model(s) representing the existing topology and peak loads projected for 2009 was inserted into the RFC model replacing the generic ITCT and METC system representation.

The Caniff phase shifting transformer is used to control flow from the Stevens station to the Caniff station. The angle on this unit was fixed at -3 degrees in all of the models developed.

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 was modeled in its typical operating configuration on the 345 kV system.

All projects currently expected to be in-service prior to 2018 were modeled in the Base case. Briefly, the projects include:

TABLE 4.1.1 – CAPITAL PROJECTS CONSIDERED FOR BASE CASE

Project	METC/ ITCT	Expected ISD	ITC Status	MISO Status	Included
Bismarck - Troy 345kV	ITCT		Budget Approved	Appendix A	Yes
Oakland Township Station	ITCT		Budget Approved	Appendix A	Yes
Coventry-Cody 230kV	ITCT		In Service	Appendix A	Yes
Placid Expansion	ITCT		Budget Approved	Appendix A	Yes
B3N Phase Shifter	ITCT		On Order	Appendix A	Yes
Placid – Durant - Genoa	ITCT		Under Const.	Appendix A	Yes
Jewel-St. Clair- Spokane	ITCT				No
Tallmadge Transformer #3	METC		Under Const.	Awaiting Approval	Yes
Tallmadge - Wealthy 138kV	METC		Under Const.	Awaiting Approval	Yes
Rogue River Junction - Rogue River 138kV	METC				
Gaylord - Livingston 138kV	METC				No
Keystone - Clearwater 138kV	METC		Under Const.	Awaiting Approval	Yes
Simpson - Batavia 138 kV	METC			Awaiting Approval	Yes
Bard Rd Cap	METC		Under Const.	Awaiting Approval	Yes
Croton Cap	METC		Under Const.	Awaiting Approval	Yes
Gaylord - Bagley 138	METC				No
HSC Phase 2 (Midland Project)	METC		Under Const.	Appendix A ???	Yes

TABLE 4.1.2 – GENERATION INTERCONNECTION PROJECTS CONSIDERED FOR BASE CASE

Project	METC/ ITCT	Expected ISD	ITC Status	MISO Status	Included
G503	ITCT		ISA	ISA	Yes

TABLE 4.1.3 – LOAD INTERCONNECTION PROJECTS CONSIDERED FOR BASE CASE

Project	METC/ ITCT	Expected ISD	ITC Status	MISO Status	Included
Marysville Decommission	ITCT			N/A	Yes
Axle	ITCT			N/A	Yes
Horn	ITCT			N/A	Yes
Hood (previously Square Lake)	ITCT			N/A	Yes
Hurst	ITCT			N/A	Yes
Hamlin	ITCT			N/A	No
Milan	ITCT			N/A	No
Kelly Rd	ITCT			N/A	No
Oakland	ITCT			N/A	No
Ashley	ITCT			N/A	No
Oakwood	ITCT			N/A	Yes
Upper Rouge	ITCT			N/A	No
Tahoe	ITCT			N/A	No
Ferndale	ITCT			N/A	No
Carmel	ITCT			N/A	No
Parmentor	METC			N/A	No
Ellis/Hile Rd	METC			N/A	No
Meridian	METC			N/A	No
Gray Rd	METC			N/A	Yes
Wabasis Junc. – Wabasis	METC			N/A	
HSC	METC		Under Const.	N/A	Yes
Baraga	METC		Under Const.	N/A	Yes
Race St.	METC			N/A	Yes
Laundra	METC			N/A	Yes
Sanderson	METC			N/A	Yes
Eppler	METC			N/A	Yes
Trillium	METC			N/A	Yes
Buskirk	METC			N/A	No
Five Mile	METC			N/A	No
N Ave	METC			N/A	No
Potvin	METC			N/A	No
Busch	METC			N/A	Yes
Huckleberry	METC			N/A	No
Pingree	METC			N/A	No
Dublin	METC			N/A	No
Emmet	METC			N/A	No
Gaines	METC			N/A	No
Horseshoe Creek	METC			N/A	No
Juniper	METC			N/A	No
Alpine	METC			N/A	No
Geddes	METC			N/A	Yes
Tirrell Road	METC			N/A	No
Van Buren	METC			N/A	Yes
Hubbard Lake	METC			N/A	No
Riggsville	METC			N/A	No
Winston	METC			N/A	Yes
Acme	METC			N/A	Yes

Load Growth

Projected peak load is a very important input into planning studies. Load forecasts are an ever changing input to the study process. At the start of this study peak loading was expected to reach around 24.5 GW in the combined ITCT and METC footprints in approximately 10 years. This is the projected system loading that was utilized for this analysis. The peak load was distributed approximately 52% on the ITCT side (about 12,153 MW) and approximately 48% on the METC side (about 11,336 MW).

Subtransmission System Models

The ITCT and METC system representation used for this study included the detailed Detroit Edison (DTE) and Consumers Energy (CE) subtransmission system models last provided by DTE and CE in 2006.

Reactive System Loading

Load modeling is comprised of two components the "real" load expressed in MWs and discussed above and "reactive" load. "Reactive" load is … As real load was scaled up from the 2009 model to meet peak projected demands in 2018, a constant ratio was kept between system real and reactive loads. No attempt was made to locate future subtransmission or distribution reactive compensation devices. It is assumed that these devices would be added as necessary.

Also, this study focused on system thermal loading and not system voltage issues. DC analysis was primarily utilized for this study.

Generation and Interchange

Generators in the METC footprint were dispatched economically, based on the last economic order list available, to serve load within the METC footprint along with some load in the ITCT footprint. Generators in the ITCT footprint were dispatched economically, based on the last economic order list available, to serve load within the ITCT footprint. Total available existing generation in the ITCT area was about 12,400 MW and total available existing generation in the METC area was about 14,800 MW. Interchange values for all of the models used for this analysis can be found in Table 4.2.4 below.

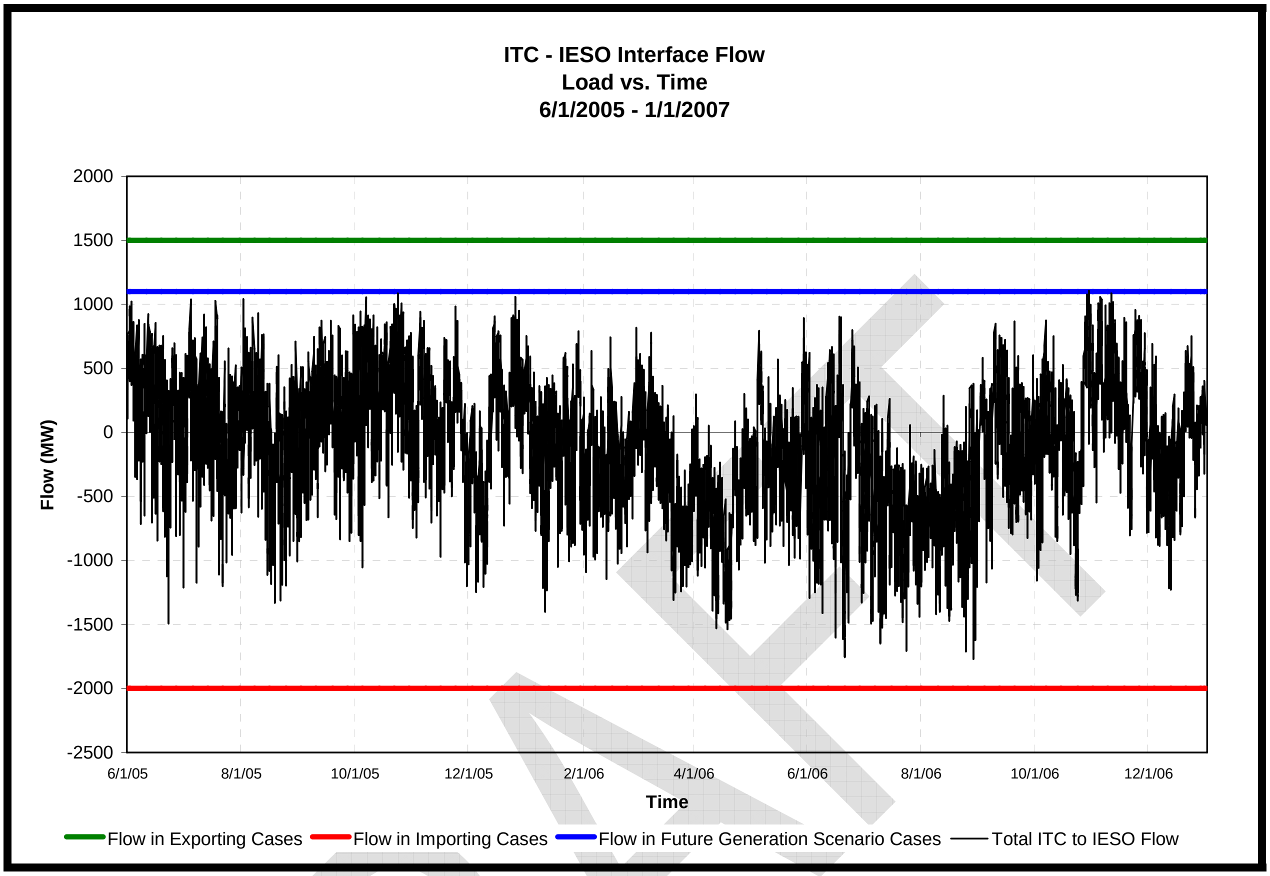
Based on the projected loading for 2009 and beyond, even if all generation in the ITCT footprint was available, a highly unlikely scenario, there would not be enough generation resources within the ITCT footprint to serve the total ITCT system load. In order to meet the projected load demands in the ITC footprint, additional power is brought in from various external resources. Some of these external resources are defined in the ERAG model building interchange table. ERAG is …. As more resources are needed additional units were turned on in the METC footprint.

Michigan Ontario Interface

In this analysis, the Michigan-Ontario phase shifters were modeled as controlling flow and were adjusted to hold flows on the Michigan-Ontario interface to specific values as described below. All four of the interconnections between and Michigan and Ontario were modeled as controlling flow in all models utilized for this study.

Because of the highly variable flows on the Michigan-Ontario interface (see Figure 4.1.1), two sets of assumptions are utilized in models; in the first set of models, flow across the interface in the direction to Michigan from Ontario is set to approximately 2000 MW's scheduled 1/6, 1/3, 1/3, and 1/6 across the B3N, L4D, L51D, and J5D respectively, in the second set of models, flow across the interface in the direction from Michigan to Ontario is set to approximately 1500 MW's scheduled 1/6, 1/3, 1/3, and 1/6 across the B3N, L4D, L51D, and J5D respectively. The interface flow between Michigan and Ontario from June 2005 through January 2007 is shown in Figure 4.1.1 below. As can be seen, 2000 MW's into Michigan and 1500 MW's into Ontario brackets the interface flow seen over this time period. It should be noted that the northernmost interconnection, the B3N, was not in-service over all but the last couple of months during the time period represented in the graph. The B3N is currently in-service operating without a phase shifting transformer which means there is now higher capability across the interface (and therefore the interface can support higher flows) than existed during the period graphed. In addition, the the B3N interconnection is is expected to be fully under phase shifter control by early 2010. At that time, the entire Michigan-Ontario interface will be phase shifter controlled.

FIGURE 4.1.1 – HISTORICAL ITC – IESO INTERFACE FLOW



In the models utilized for this analysis, flow across the Michigan-Ontario interface was held to approximately 1100 MW's from and/or through Michigan into and/or across Ontario. This was done to match the flow set across this interface in the 2007 and 2008 MISO model building. MISO has historically allocated approximately 1100 MW's of transmission rights across this interface. Flow was again split between the four ties as described above.

Shoulder Peak

Shoulder peak load models were developed for all of the future generation scenarios. Load was scaled down to 80% of the projected peak load in these models. Three quarters of the difference was balanced by decreasing the generation by merit order. One quarter of the difference was balanced by decreasing ITCT's and METC's area interchange. Cases with total system load scaled down to 80% of the forecasted peak system load and the Ludington units in pumping mode were also developed. Ludington pumping was modeled as negative generation and three quarters of this difference was balanced by importing additional flow into METC (adjusting the area interchange) and one quarter of the difference was balanced by adding additional generation, by merit order, in METC's part of the system.

4.2 FUTURE GENERATION SCENARIOS CASE DEVELOPMENT

This analysis focused on interconnecting three levels of wind resources in the Lower Peninsula of Michigan, low, medium, and high wind penetration with 1,500 MW, 3,000, MW, and 4,500 MW of nameplate wind generation spread across the Lower Peninsula in each of the three scenarios respectively as depicted in Table 4.2.3 and Figures 4.3.1 through 4.3.6 below. A fourth scenario was also evaluated assuming the 4,500 MW of wind resources scenario plus an additional 1,000 MW of wind located offshore and split into two 500 MW wind farms.

Two sets of base cases were developed for these future wind generation scenarios. The first set assumed three new non-wind resources would also be in-service and the second set assumed only the wind resources.

Baseload and other Non-Wind Generation Assumptions

For the first set of future generation models, generation in the Lower Peninsula included additional non-wind resources as described in Table 4.2.1 below.

TABLE 4.2.1 – LOCATIONS AND MW AMOUNTS FOR FUTURE NON-WIND RESOURCES

Type	Location	Modeled at Bus	Size
Coal	Bay City, Midland, Saginaw Area	Tittabawassee 345 kV	800 MW
Combined cycle (natural gas)	Thetford (near Flint)	Thetford 345 kV	500 MW
Coal	Rogers City (in Presque Isle County, on Lake Huron)	Port Calcite 138 kV	600 MW

While there is a proposed Fermi III nuclear facility in the MISO queue, it was not included in this analysis, primarily because of the approximately ten year out timeframe of the models utilized in this study. A new nuclear unit may need additional time for approval and construction.

Wind Farm Assumptions

For all four wind scenarios (1,500 MW, 3,000 MW, 4,500 MW, and 4,500 MW plus 1,000 MW Offshore) for the Lower Peninsula, the following assumptions were utilized:

- Locations of the wind resources were based on pending interconnection requests in the MISO generation interconnection queue as of May 2008; these requests cover the following Michigan counties: Sanilac/Huron, Oceana/Manistee, Charlevoix, Missaukee, Gratiot/Saginaw, Osceola, Mason, Hillsdale, and Kent/Ottawa.
- Sites that were either adjacent to each other 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 interconnection requests in other counties. For example, the same interconnection point 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. Once this was done, scaling factors were applied, as described below, to each location in order to model the amount of wind for each specific location appropriate as determined by the Michigan Wind Energy Transmission Study (MI-WETS) group.

The general geographic breakdown of wind projects in each of the scenarios and the offshore sensitivity is as follows. The MW amounts in Table 4.2.2 below do not reflect adjustments based on the scaling factors used to develop the models and discussed further below.

TABLE 4.2.2 – LOCATIONS AND MW AMOUNTS UNDER LOW, MEDIUM, AND HIGH WIND SCENARIOS (NO SCALING)

County/Area	#MW in MISO Queue by County/Area	Low Scenario (MW)	Medium Scenario (MW)	High Scenario (MW)	Offshore Sensitivity (MW)
Charlevoix	120	72	145	217	217
Mason	220	133	265	398	398
Osceola	270	163	325	488	488
Oceana	140	84	169	253	253
Muskegon	100	60	120	181	181
Grand Rapids North	420	253	506	759	759
Gratiot	300	181	361	542	542
Midland	320	193	386	578	578
Hillsdale	300	181	361	542	542
Thumb	300	181	361	542	542
Offshore – Southern Lake Michigan					500
Offshore – West-central Lake Huron					500
Lower Peninsula Total	2,495	1,500	3,000	4,500	5,500

Scaling factors were used to re-distribute the MW amounts by county or area based on factors such as historical queue information, wind sighting 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 MI-WETS group 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, and Gratiot County/Midland area.
- Decrease by a factor of 0.5 the quantity of wind in Hillsdale County.

The most significant change resulting from these scaling factors was the increase in MW's in the Thumb area. This resulted in the amount of wind generation in the thumb being generally consistent with stakeholder-reviewed sighting assumptions used in MTEP 09 and other MISO planning studies. It also appears that the Thumb area has considerably greater opportunities for wind development compatible with existing land use practices and general 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 after the initial group study determined the costs of system upgrades needed to support the large amounts of wind generation in the Thumb area would be extensive.

The adjusted MW amounts, with the scaling factors applied, for the three study scenarios are shown in the Table 4.2.3 below. Geographical locations for the wind farm sites can be found in Figures 4.3.1 through 4.3.6 below.

Table 4.2.3 – Locations and MW Amounts Adjusted by Scaling Factors

County/Area*	MISO Queue (MW)	Proposed Scaling Factors for MI WETS	Modeled at Bus	Low Scenario (MW)	Medium Scenario (MW)	High Scenario (MW)
Charlevoix	120	0.75	Miles Road Junction 138 kV	55	109	164
Mason	220	0.75	Pere Marquette 138 kV	100	201	301
Osceola	270	0.75	Oscela 69 kV	123	246	369
Oceana	140	0.75	Donaldson Creek 138 kV	64	128	191
Muskegon	100	0.75	White Lake 138 kV	46	91	137
GR North	300	0.75	Kenowa 345 kV	191	383	574
Gratiot	300	0.75	Nelson Road 345 kV	137	274	410
Midland	320	0.75	Begole 138 kV	146	292	438
Hillsdale	300	0. 5	Dowling Junction 138 kV	91	182	274
Thumb	305	2.5	Wyatt 230/345 kV	547	1,094	1,641
Lower MI Total				**1,500**	**3,000**	**4,500**

In the proposed offshore sensitivity analysis, 1,000 MW of nameplate offshore wind generation was modeled in two groups of 500 MW each. One 500 MW wind farm in the southern end of Lake Michigan, far enough offshore to not be visible from the shore in Illinois, Indiana, or Michigan, and another 500 MW wind farm generally near the mouth of Saginaw Bay. The off-shore wind farm in Lake Michigan was modeled at the AEP Benton Harbor 345 kV bus in the models and the Saginaw Bay off-shore wind from was modeled at the Hampton 345 kV bus. 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 wind scenario (4,500 MW).

Future Generation Output Assumptions

For wind availability, the study assumed 15% wind output from all identified wind sites for the summer peak load scenarios. The shoulder or off-peak load scenarios (80% of peak load levels) assumed 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. It should be noted that because the wind was not dispatched to 100% of its nameplate capability in the peak load analysis, the transmission projects discussed herein would not be expected to be able to support 100% of the wind farms nameplate capability during peak load scenarios.

Both the wind and non-wind resources were dispatched by reducing generation both external and internal to Michigan. Three quarters of the new resources were dispatched against generation external to MECS (adjusting the area interchange) and one quarter of the new resources were dispatched against generators, in merit order, within the MECS footprint.

It should be noted that external systems were not monitored and it is most likely that when attempting to export the amount of power evaluated in this study there would most likely be limits on neighboring systems including but not limited to First Energy, AEP, NIPSCO, Detroit Edison, and Consumers Energy.

TABLE 4.2.4 -- CASES USED FOR FUTURE GENERATION SCENARIOS

Case Name	Case Description	ITC Area Interghange (MWs)	METC Area Interchange (MWs)	METC to ITC Flow (MWs)	Flow from Michigan into Ontario (MWs)	Future Fossil Units (MW)	Future On-Shore Wind Level (MW)	Future Off-Shore Wind Level (MW)	Ludington Status
gen_base_peak.sav	Future Generation Base Peak	-1575	500	1795	1,100	0	0	0	Generating
gen_peak.sav	Future Generation w/3 Peak	-1575	1900	2405	1,100	1900	0	0	Generating
gen_1500_peak.sav	Future Generation w/3 Peak 1500 Wind	-1100	2035	2210	1,100	1900	1500[1]	0	Generating
gen_3000_peak.sav	Future Generation w/3 Peak 3000 Wind	-1060	2355	2340	1,100	1900	3000[1]	0	Generating
gen_4500_peak.sav	Future Generation w/3 Peak 4500 Wind	-1000	2295	2235	1,100	1900	4500[1]	0	Generating
gen_4500_os_peak.sav	Future Generation w/3 Peak 5500 Wind	-1000	2365	2275	1,100	1900	4500[1]	1000[1]	Generating
wind_1500_peak.sav	Future Generation Peak 1500 Wind	-1100	635	1605	1,100	0	1500[1]	0	Generating
wind_3000_peak.sav	Future Generation Peak 3000 Wind	-1060	955	1660	1,100	0	3000[1]	0	Generating
wind_4500_peak.sav	Future Generation Peak 4500 Wind	-1000	895	1630	1,100	0	4500[1]	0	Generating
wind_4500_os_peak.sav	Future Generation Peak 5500 Wind	-995	965	1670	1,100	0	4500[1]	1000[1]	Generating
gen_base_80.sav	Future Generation Base 80% Peak	635	2370	1350	1,100	0	0	0	Generating
gen_80.sav	Future Generation w/3 80% Peak	635	3670	1885	1,100	1900	0	0	Generating
gen_1500_80.sav	Future Generation w/3 80% Peak 1500 Wind	1045	4370	1925	1,100	1900	1500	0	Generating
gen_3000_80.sav	Future Generation w/3 80% Peak 3000 Wind	1455	4970	1870	1,100	1900	3000	0	Generating
gen_4500_80.sav	Future Generation w/3 80% Peak 4500 Wind	1635	5670	2020	1,100	1900	4500	0	Generating
gen_4500_os_80.sav	Future Generation w/3 80% Peak 5500 Wind	1865	6420	2315	1,100	1900	4500	1000	Generating
wind_1500_80.sav	Future Generation 80% Peak 1500 Wind	1045	2970	1350	1,100	0	1500	0	Generating
wind_3000_80.sav	Future Generation 80% Peak 3000 Wind	1455	3570	1285	1,100	0	3000	0	Generating
wind_4500_80.sav	Future Generation 80% Peak 4500 Wind	1635	4270	1430	1,100	0	4500	0	Generating
wind_4500_os_80.sav	Future Generation 80% Peak 5500 Wind	1865	5020	1730	1,100	0	4500	1000	Generating
gen_base_lp.sav	Future Generation Base 80% Peak LP	640	1365	390	1,100	0	0	0	Pumping

[1] Wind dispatched at 15% of total plant capacity.

Case Name	Case Description	ITC Area Interghange (MWs)	METC Area Interchange (MWs)	METC to ITC Flow (MWs)	Flow from Michigan into Ontario (MWs)	Future Fossil Units (MW)	Future On-Shore Wind Level (MW)	Future Off-Shore Wind Level (MW)	Ludington Status
gen_lp.sav	Future Generation w/3 80% Peak LP	640	40	945	1,100	1900	0	0	Pumping
gen_1500_lp.sav	Future Generation w/3 80% Peak LP 1500 Wind	1050	670	950	1,100	1900	1500	0	Pumping
gen_3000_lp.sav	Future Generation w/3 80% Peak LP 3000 Wind	1440	1440	970	1,000	1900	3000	0	Pumping
gen_4500_lp.sav	Future Generation w/3 80% Peak LP 4500 Wind	1850	2040	920	1,100	1900	4500	0	Pumping
gen_4500_os_lp.sav	Future Generation w/3 80% Peak LP 5500 Wind	1850	2240	1105	1,100	1900	4500	1000	Pumping
wind_1500_lp.sav	Future Generation 80% Peak LP 1500 Wind	1050	-735	345	1,100	0	1500	0	Pumping
wind_3000_lp.sav	Future Generation 80% Peak LP 3000 Wind	1440	35	360	1,100	0	3000	0	Pumping
wind_4500_lp.sav	Future Generation 80% Peak LP 4500 Wind	1850	635	315	1,100	0	4500	0	Pumping
wind_4500_os_lp.sav	Future Generation 80% Peak LP 5500 Wind	1850	835	570	1,100	0	4500	1000	Pumping

FIGURE 4.3.1 – CURRENT MISO QUEUE WIND LOCATIONS

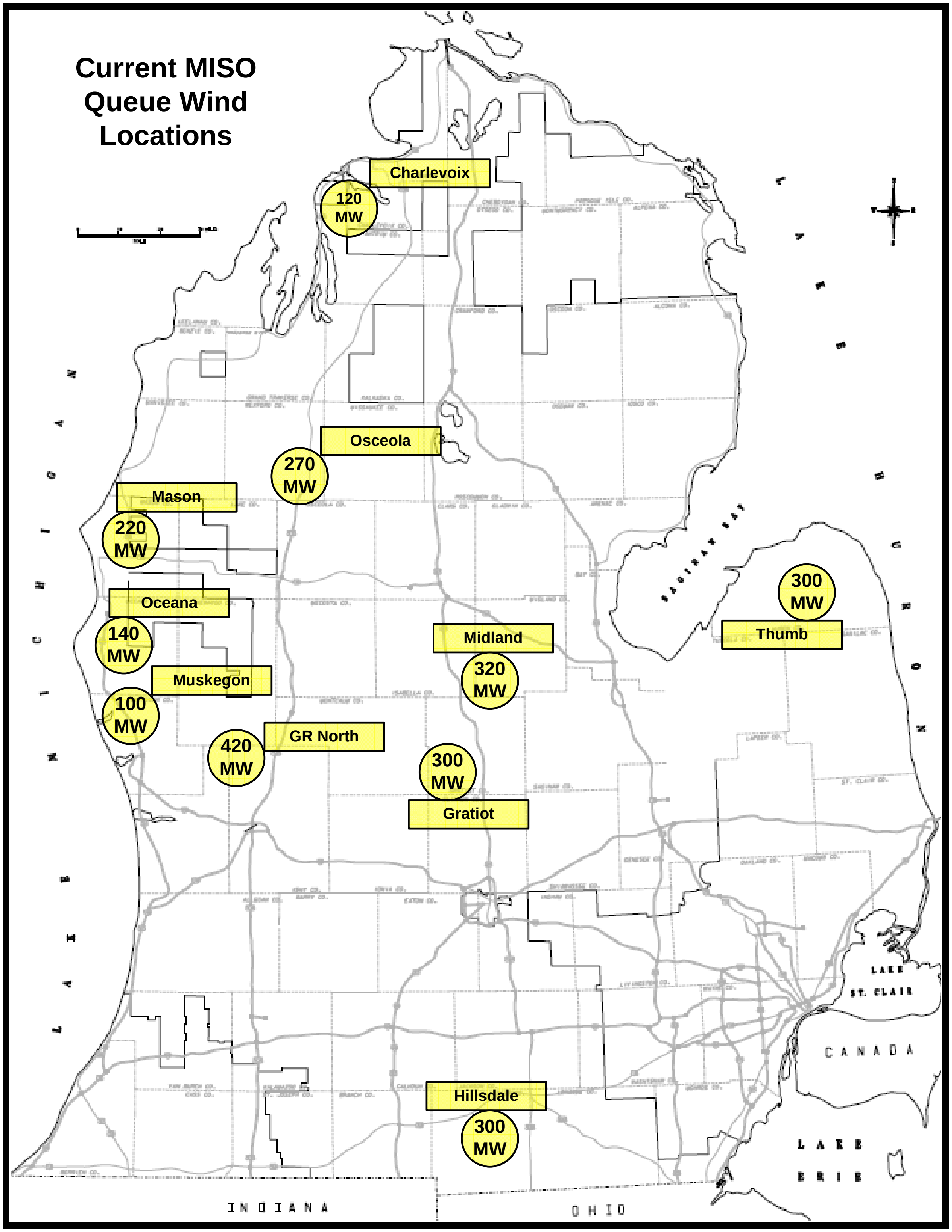


FIGURE 4.3.2 – 3 FOSSIL UNITS USED IN ALL FUTURE GENERATION SCENARIOS

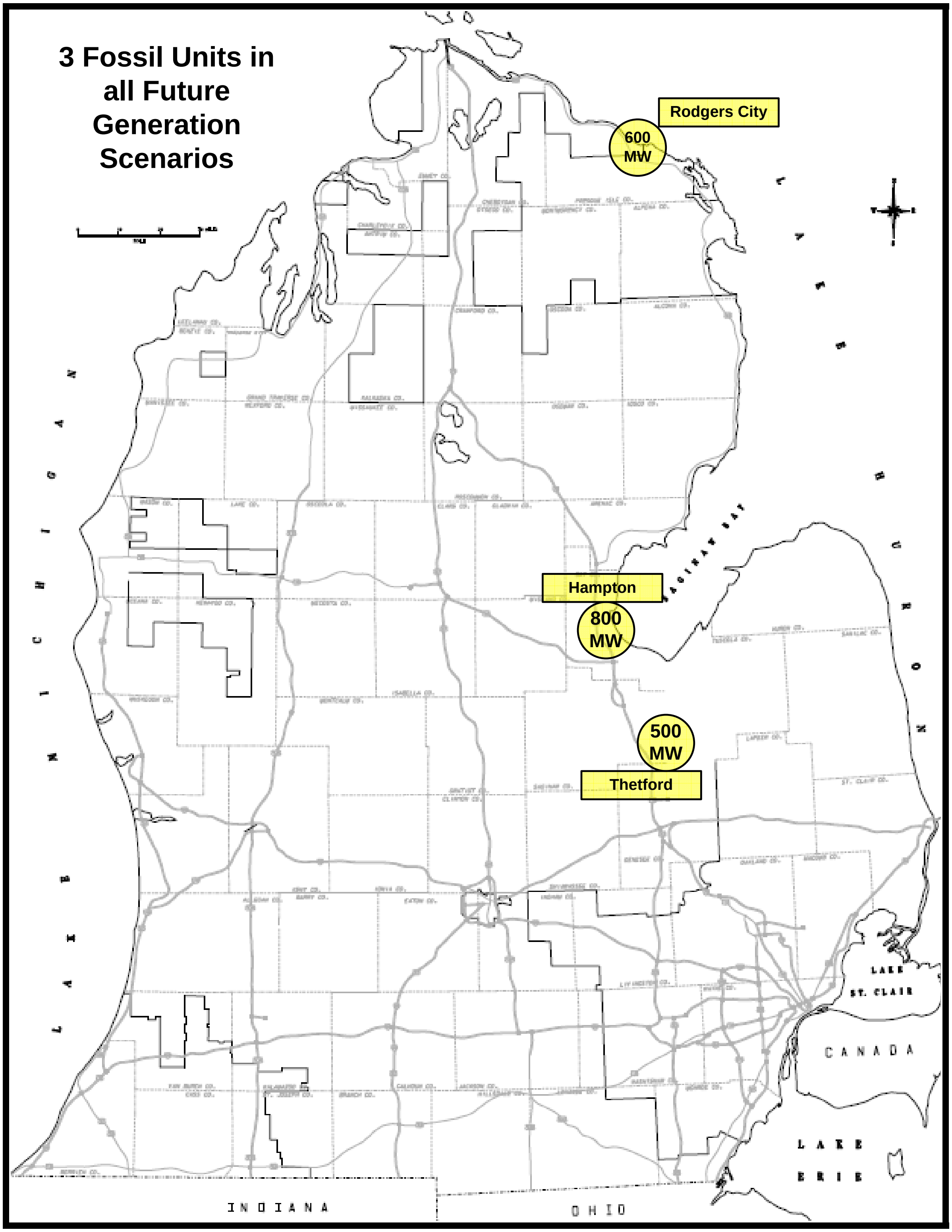


FIGURE 4.3.3 – LOCATIONS FOR 1500 MW WIND SCENARIO

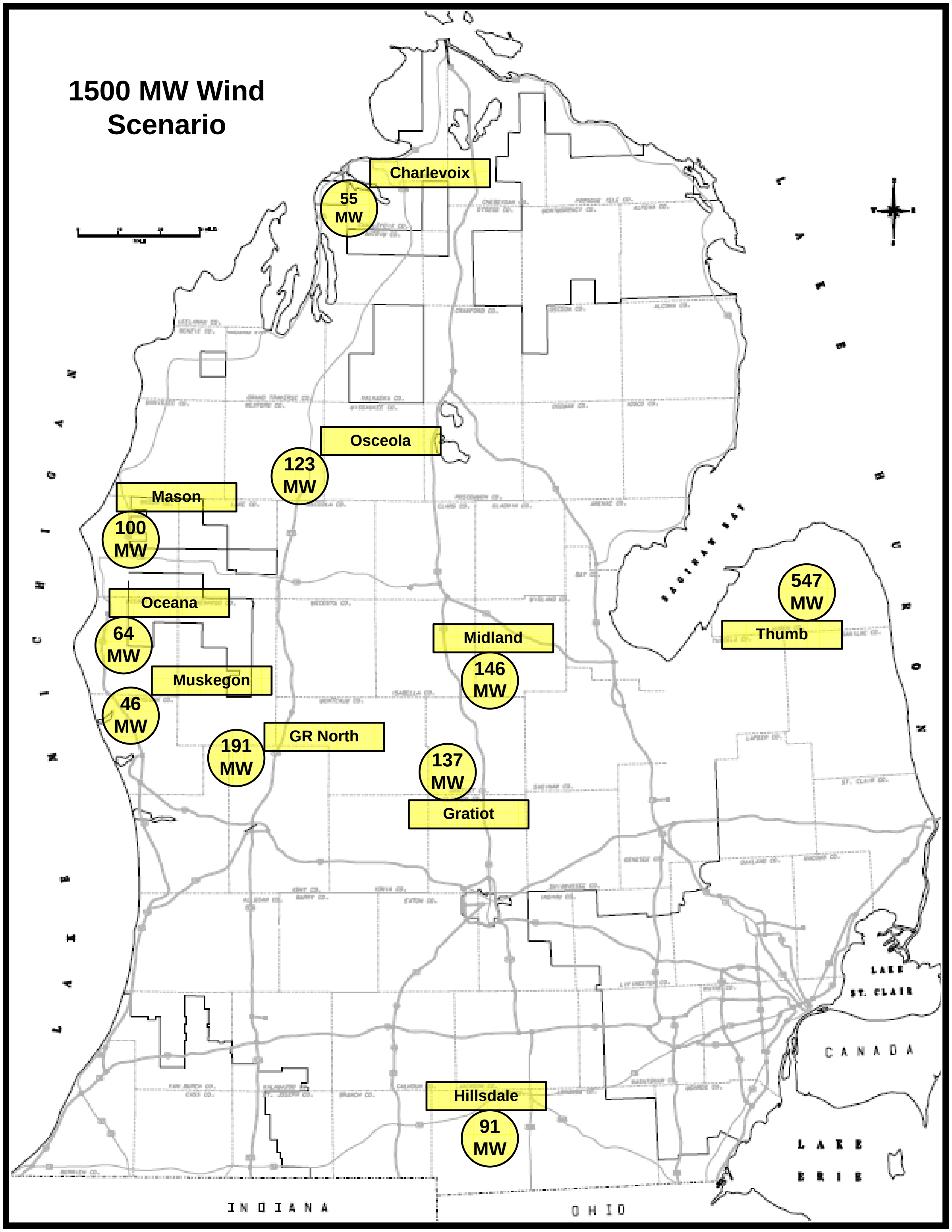


FIGURE 4.3.4 – LOCATIONS FOR 3000 MW WIND SCENARIO

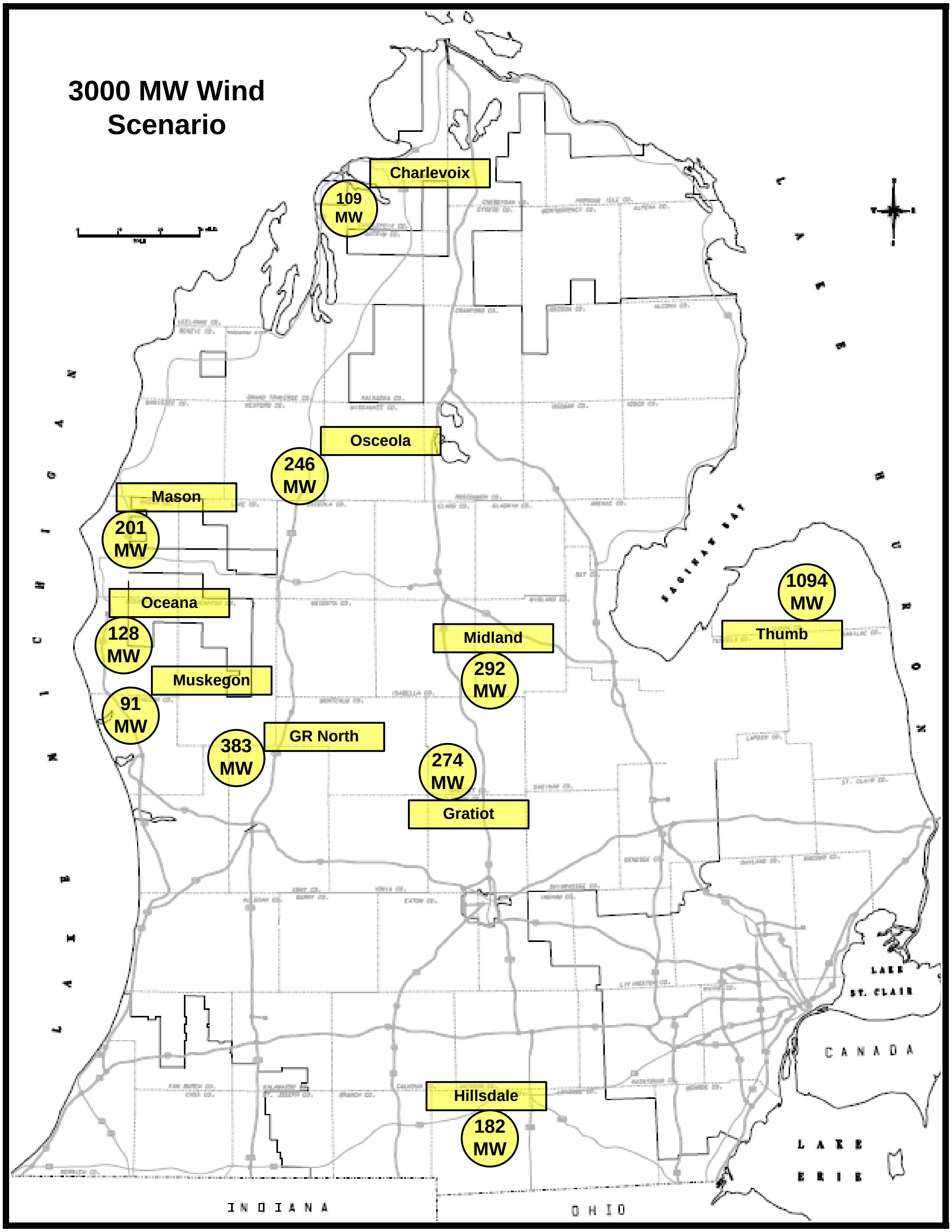


FIGURE 4.3.5 – LOCATIONS FOR 4500 MW WIND SCENARIO

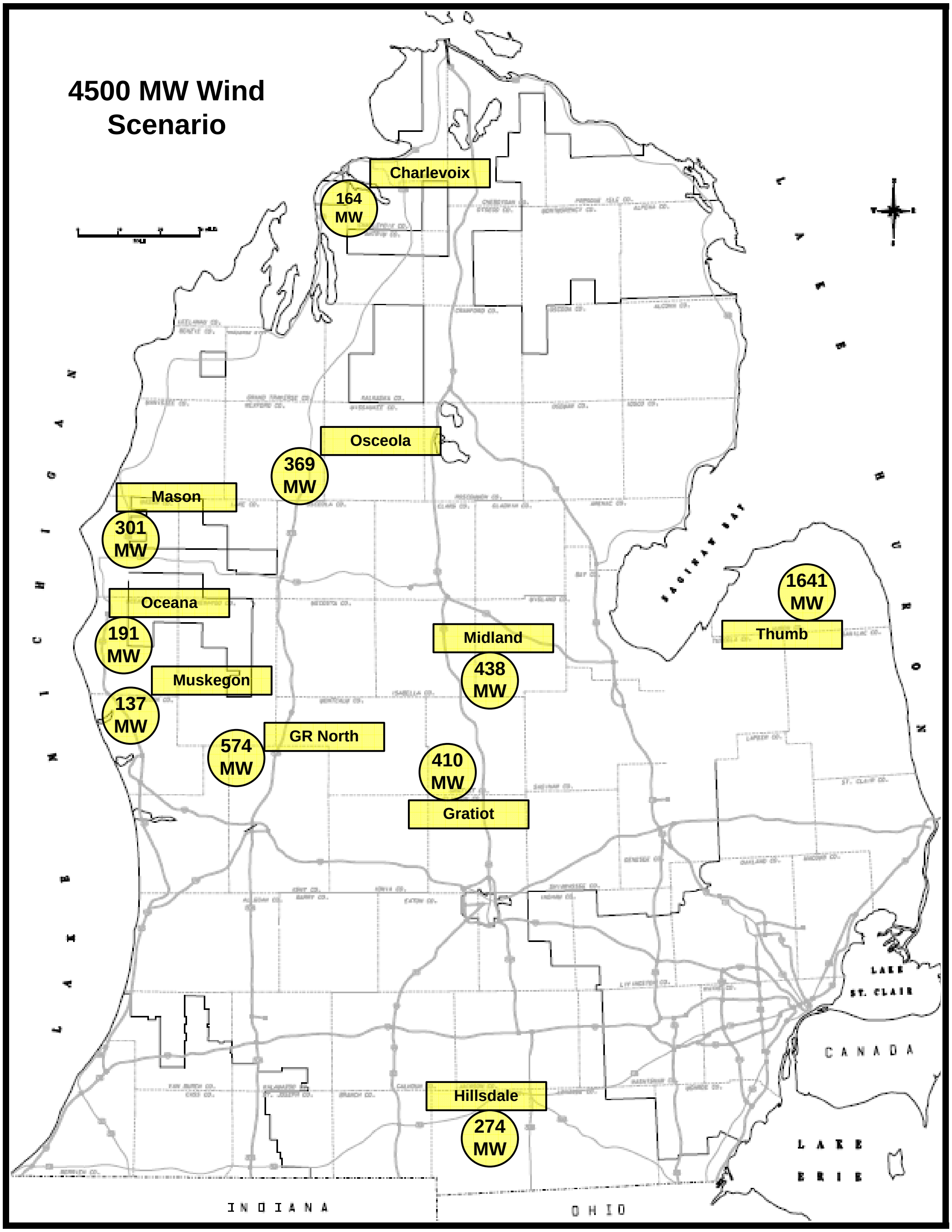
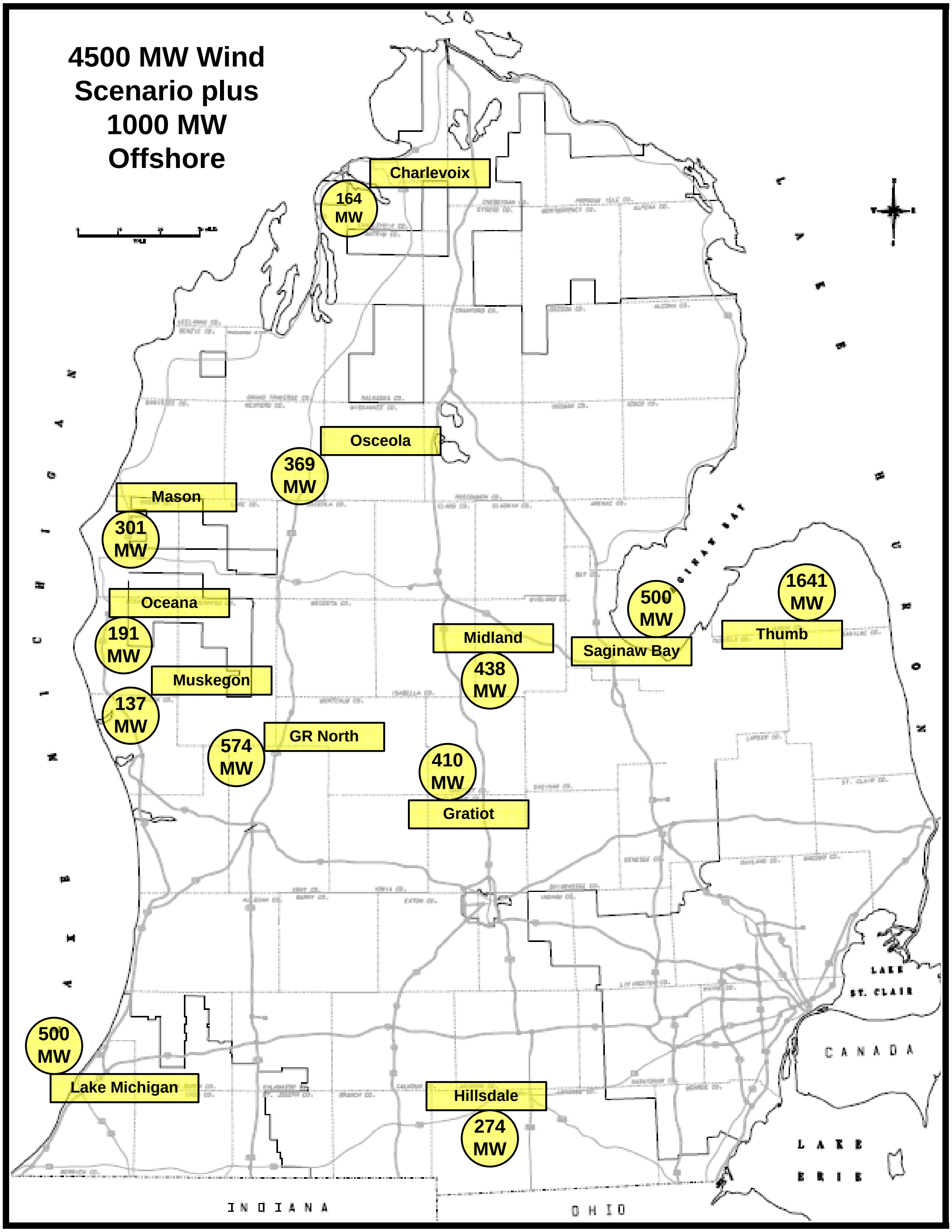


FIGURE 4.3.6– LOCATIONS FOR 4500 MW WIND SCENARIO PLUS 1000 MW OFFSHORE



5 STUDY METHODOLOGIES

5.1 CONTINGENCIES ANALYZED

A DC Thermal analysis was performed for all contingencies (see Table 5.1.1 below) in all of the models studied.

All single and double contingencies (transmission and generator) in the ITCT/METC area and selected contingencies involving the surrounding system were considered for this analysis. Thus, global single contingency and global double contingency analysis was performed. In some instances, a double contingency is specially classified as a double circuit tower, breaker fault/failure or bus section contingency. To reduce redundancy, an attempt was made to only analyze these specially classified double contingencies once. Thus, not all of the double contingencies appear as double ("T-2") transmission outages. For example, all double contingencies that are also double circuit tower contingencies would only be reported as double circuit tower contingencies.

Along with the single contingencies defined from operating device to operating device single branch contingencies were also analyzed in order to determine the impact of one end of a circuit opening. Double contingencies were not developed from the single branch contingencies.

Some generator contingencies involved the simultaneous outage of groups of some smaller units. In instances with several large generators connected to the same power flow bus, to eliminate redundancy, only the outage of the largest unit was considered. Pre-existing generator outages (dispatched off) were considered as generator contingency scenarios.

TABLE 5.1.1– CONTINGENCIES CONSIDERED

Contingency	Considers Elements beyond ITC and ITC Ties	Used in Peak Cont. Analysis.	Used in 80% Peak Cont. Analysis.
None	N/A	Y	Y
Single Generator	Y	Y	Y
Single Transmission	Y	Y	Y
Portion of a single transmission	N	Y	Y
Transformer	N	Y	Y
Breaker open/failure	Y	Y	Y
Transformer + Single Gen	N	Y	Y
Double Circuit Tower	N	Y	Y
Breaker Fault/Failure	N	Y	Y
Bus Section[5]	N	Y	Y
Single Trans + Single Gen	N	Y	Y
Double Transmission[2]	Y	Y	Y
Double Generator[3]	Y	Y	Y

[2] These included all combinations of single transmission contingencies (both inside ITCT/METC and selected contingencies in surrounding areas) not otherwise contained in another contingency list (bus section, double circuit tower, breaker fault/failure). The analysis preformed is more stringent than NERC category C because no manual intervention was considered between events.

[3] These included all combinations of single generator contingencies (both inside ITCT/METC and selected contingencies in surrounding areas). For this analysis, all combinations of the two largest generators at one station were considered. The analysis preformed was more stringent than NERC category C because no manual intervention was allowed between events.

TABLE 1 – REPORTING CRITERIA

Contingency	Thermal Loading Reporting Criteria[4]	
	ITC Facilities	non-ITC Facilities
None	100% SN	N/A
Single Generator	100% SN	N/A
Single Transmission	100% SN	N/A
Portion of a single transmission	100% SN	N/A
Transformer	100% SN	N/A
Breaker open/failure	100% SN	N/A
Transformer + Single Gen	100% SN	N/A
Double Circuit Tower	100% SN	N/A
Breaker Fault/Failure[2]	100% SN	N/A
Bus Section[5]	100% SN	N/A
Single Trans + Single Gen	100% SN	N/A
Double Transmission[3]	100% SN	N/A
Double Generator[4]	100% SN	N/A

5.2 MONITORED FACILITIES

In this thermal analysis all ITCT/METC facilities (including ITCT/METC tie lines) rated 100 kV and above were monitored. Neither ITCT nor METC have any transmission facilities or buses rated less than 100 kV. Thus all ITCT and METC facilities were monitored.

No facilities outside ITCT/METC area were monitored for this study, however, where applicable external facilities were discussed in specific sections of the results.

5.3 RATINGS USED

Analysis of the ITCT and METC systems under base conditions (no contingencies) and single generating out conditions were performed using summer normal ratings. All other analysis was performed using summer emergency ratings.

5.4 MAKE UP FOR OUTAGED GENERATION

The outage of generation results in the need to increase generation to keep the load and generation in balance. In this study, when generation was modeled as forced out as part of a contingency, the “make up” generation was assumed to come from the available generation in the ITCT/METC footprint.

5.5 LOAD THROWOVER

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 were considered in this analysis.

5.6 AC VS. DC ANALYSIS

Because reactive system loading and support is extremely hard to project out this far into the future and AC analysis takes considerably more time and effort than DC analysis, system voltages were not considered for this study. Shorter term studies will be used to determine reactive system needs.

[4] For brevity, only the highest impact contingencies may be reported. These values do not necessarily represent ITCT/METC planning criteria.