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December 4, 2024

Ms. Lisa Felice *Via E-File*
Michigan Public Service Commission
7109 W. Saginaw Hwy.
Lansing, MI 48909

RE: MPSC Case No. U-21471 & U-21472

Dear Ms. Felice:

Attached please find the enclosed documents for filing:

- Direct Testimony and Exhibits of Douglas B. Jester on behalf of Citizens Utility Board of Michigan and Sierra Club (CUB-1 through CUB-4); and
- Proof of Service.

Thank you for your assistance in this matter. If you have any questions, please feel free to contact me.

Sincerely,

Digitally signed by Christopher Bzdock
Date: 2024.12.04 12:52:50 -05'00'

Christopher M. Bzdok
chris@tropospherelegal.com

CC: Parties to Case No. U-21471 & U-21472

STATE OF MICHIGAN

BEFORE THE MICHIGAN PUBLIC SERVICE COMMISSION

In the matter of the application of MICHIGAN ELECTRIC TRANSMISSION COMPANY, LLC for an Act 30 certificate of public convenience and necessity for the construction of a major transmission line between Oneida Substation in Eaton County and Nelson Road Substation in Gratiot County, Michigan.	U-21471
In the matter of the application of MICHIGAN ELECTRIC TRANSMISSION COMPANY, LLC for an Act 30 certificate of public convenience and necessity for the construction of a major transmission line between the Indiana/Michigan state border at Gilead Township in Branch County and the new Helix Substation in Calhoun County, Michigan	U-21472

DIRECT TESTIMONY OF DOUGLAS B. JESTER

ON BEHALF OF

CITIZENS UTILITY BOARD OF MICHIGAN
AND SIERRA CLUB

December 4, 2024

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I. INTRODUCTION & QUALIFICATIONS

Q. Please state for the record your name, position, and business address.

A. My name is Douglas B. Jester. I am Managing Partner of 5 Lakes Energy, a Michigan limited liability corporation, located at PO Box 869, Northport, Michigan 49670.

Q. On whose behalf is this testimony being offered?

A. I am testifying on behalf of Citizens Utility Board of Michigan (CUB) and Sierra Club (SC), collectively identified as CUB-SC

Q. Please summarize your experience in the field of utility regulation.

A. I have worked for more than 30 years in utility industry regulation and related fields. My work experience is summarized in my resume, provided as Exhibit CUB-1.

Q. Have you testified before this Commission or as an expert in any other proceedings?

A. I have previously testified before the Michigan Public Service Commission ("Commission") in the following cases:

- Case U-17473 (Consumers Energy Company Plant Retirement Securitization);
- Case U-17096-R (Indiana Michigan 2013 PSCR Reconciliation);
- Case U-17301 (Consumers Energy Renewable Energy Plan 2013 Biennial Review);
- Case U-17302 (DTE Energy Renewable Energy Plan 2013 Biennial Review);
- Case U-17317 (Consumers Energy 2014 PSCR Plan);
- Case U-17319 (DTE Electric 2014 PSCR Plan);
- Case U-17671-R (UPPCO 2015 PSCR Reconciliation);
- Case U-17674 (WEPCO 2015 PSCR Plan);

- Case U-17674-R (WEPCO 2015 PSCR Reconciliation);
- Case U-17679 (Indiana-Michigan 2015 PSCR Plan);
- Case U-17688 (Consumers Energy Cost of Service and Rate Design);
- Case U-17689 (DTE Electric Cost of Service and Rate Design);
- Case U-17698 (Indiana-Michigan Cost of Service and Rate Design);
- Case U-17735 (Consumers Energy General Rates);
- Case U-17752 (Consumers Energy Community Solar);
- Case U-17762 (DTE Electric Energy Optimization Plan);
- Case U-17767 (DTE General Rates);
- Case U-17792 (Consumers Energy Renewable Energy Plan Revision);
- Case U-17895 (UPPCO General Rates);
- Case U-17911 (UPPCO 2016 PSCR Plan);
- Case U-17911-R (UPPCO 2016 PSCR Reconciliation);
- Case U-17990 (Consumers Energy General Rates);
- Case U-18014 (DTE General Rates);
- Case U-18089 (Alpena Power PURPA Avoided Costs);
- Case U-18090 (Consumers Energy PURPA Avoided Costs);
- Case U-17911-R (UPPCO 2016 PSCR Reconciliation);
- Case U-18091 (DTE PURPA Avoided Costs);
- Case U-18092 (Indiana Michigan Power Company PURPA Avoided Costs);
- Case U-18093 (Northern States Power PURPA Avoided Costs);
- Case U-18094 (Upper Peninsula Power Company PURPA Avoided Costs);
- Case U-18095 (Wisconsin Public Service Company PURPA Avoided Costs);

- Case U-18096 (Wisconsin Electric Power Company PURPA Avoided Costs);
- Case U-18224 (UMERC Certificate of Necessity);
- Case U-18232 (DTE Renewable Energy Plan);
- Case U-18255 (DTE Electric General Rates);
- Case U-18322 (Consumers Energy General Rates);
- Case U-18406 (UPPCO 2018 PSCR Plan);
- Case U-18408 (UMERC 2018 PSCR Plan);
- Case U-18419 (DTE Certificate of Necessity);
- Case U-20072 UPPCO 2017 PSCR Reconciliation);
- Case U-20111 (UPPCO Tax Cuts and Jobs Act of 2017 Adjustment);
- Case U-20134 (Consumers Energy General Rates);
- Case U-20150 (UPPCO Revenue Decoupling Mechanism Complaint);
- Case U-20162 (DTE General Rates);
- Case U-20165 (Consumers Energy Integrated Resource Plan);
- Case U-20229 (UPPCO 2019 PSCR Plan Case);
- Case U-20276 (UPPCO General Rates);
- Case U-20350 (UPPCO Integrated Resource Plan);
- Case U-20359 (I&M 2019 General Rate Case);
- Case U-20471 (DTE Integrated Resource Plan);
- Case U-20479 (SEMCO 2019 General Rate Case);
- Case U-20561 (DTE 2019 General Rate Case).;
- Case U-20591 (Indian Michigan Power Company IRP);
- Case U-20642 (DTE Gas 2020 General Rate Case).;

- Case U-20649 (Consumers Electric Voluntary Green Pricing).;
- Case U-20650 (Consumers Gas 2020 General Rate Case);
- Case U-20697 (Consumers Electric 2020 General Rate Case);
- Case U-20713 (DTE 2020 Voluntary Green Pricing);
- Case U-20836 (DTE Electric 2022 General Rate Case);
- Case U-20874 (Alpena Power 2022-23 EWR Plan Case);
- Case U-20875 (Consumers Energy 2022-23 EWR Plan Case);
- Case U-20876 (DTE Electric 2022-23 EWR Plan Case);
- Case U-20877 (Indiana Michigan 2022-23 EWR Plan Case);
- Case U-20878 (NSP 2022-23 EWR Plan Case);
- Case U-20879 (UPPCO 2022-23 EWR Plan Case);
- Case U-20880 (UMERC 2022-23 EWR Plan Case);
- Case U-20881 (DTE Gas 2022-23 EWR Plan Case);
- Case U-20882 (MGU Gas 2022-23 EWR Plan Case);
- Case U-20883 (SEMCO Gas 2022-23 EWR Plan Case);
- Case U-20889 (Consumers Karn Retirement Securitization);
- Case U-20963 (Consumers Energy Electric Rate Case);
- Case U-21015 (DTE Securitization Case);
- Case U-21048 (Consumers Energy 2022 PSCR Plan);
- Case U-21081 (UMERC 2021 IRP);
- Case U-21090 (Consumers Energy 2021 IRP);
- Case U-21189 (Indiana Michigan 2022 IRP);
- Case U-21193 (DTE Electric 2022 IRP);

- Case U-21224 (Consumers Energy 2022 Electric Rate Case);
- Case U-21297 (DTE Electric 2023 Rate Case);
- Case U-21377 (IM Renewable Acquisition);
- Case U-21389 (Consumers Energy 2023 Electric Rate Case);
- Case U-21540 (MGU 2024 Gas Rate Case);
- Case U-21555 (UPPCO 2024 Rate Case);
- Case U-21534 (DTE 2024 Electric Rate Case);
- Case U-21585 (Consumers 2024 Electric Rate Case);
- Case U-21654 (EWR Alternative Compliance Plan); and
- Case U-21662 (DTE 2024 Renewable Energy Plan Amendment)

Additionally, I have testified as an expert witness before the Public Utilities Commission of Nevada in Case No. 16-07001 concerning the 2017-2036 integrated resource Plan of NV Energy; and before the Missouri Public Service Commission in Case Nos. ER-2016-0179, ER-2016-0285, and ET-2016-0246 concerning residential rate design and electric vehicle ("EV") policy, revenue requirements, cost of service, and rate design. I testified before the Kentucky Public Service Commission in Case No. 2016-00370 concerning municipal street lighting rates and technologies. I testified before the Massachusetts Department of Public Utilities in Case Nos. DPU 17-05 and DPU 17-13 concerning EV charging infrastructure program design and cost recovery. Before the Rhode Island Public Utilities Commission, in case 4780, I testified concerning Advanced Metering Infrastructure and EV charging infrastructure. Before the Delaware Public Service Commission, I testified regarding EV charging infrastructure in case 17-1094. I testified before the Georgia Public Service Commission in Case No. 4822 concerning PURPA avoided cost. I testified before the Colorado Public Utilities Commission in Cases No. 20A-0204E and 20A-195E concerning cost recovery for EV charging infrastructure. I also testified before the Minnesota Public Utilities Commission in Case No. 22-432 regarding EV charging rate design. I prepared comments concerning medium-duty and heavy-duty vehicle charging infrastructure filed in Connecticut Public Utilities Regulatory Authority in Case No. DN 21-09-17.

I have also testified as an expert witness on behalf of the State of Michigan before the Federal Energy Regulatory Commission ("FERC") in cases relating to the relicensing of hydro-electric generation and have participated in state and federal court cases on behalf of the State of Michigan, concerning electricity generation matters, which were settled before trial.

Q. Are you sponsoring any exhibits?

A. Yes, I am sponsoring the following exhibit:

Exhibit CUB-1:	Resume of Douglas B. Jester
Exhibit CUB-2:	GridLab Transmission Needs Study Main Report
Exhibit CUB-3:	GridLab Transmission Needs Study Appendix
Exhibit CUB-4:	MISO Detailed Business Case for LRTP Tranche 1

II. <u>SUMMARY</u>

Q. What topics are you addressing in your testimony?

A. My testimony will address the public benefits and benefit-cost analysis of both the Proposed Major Transmission Line between Oneida Substation in Eaton County and Nelson Road Substation in Gratiot County, Michigan and the Proposed Major

Transmission Line between the Indiana/Michigan state border at Gilead Township in Branch County and the new Helix Substation in Calhoun County, Michigan (hereafter, the "proposed transmission lines"). I do not address the particular routes of the proposed transmission lines.

Q. Which testimony do you discuss in your testimony?

A. I am addressing aspects of the testimony of METC witness Charles L. Marshall. I also discuss the Revised Comments of the Midcontinent Independent System Operator ("MISO") in support of the Applications for an Act 30 certificate of public convenience and necessity for the proposed transmission lines.[1]

Q. Do you have specific relevant background for this testimony?

A. I do. I have long closely monitored and selectively participated in MISO's stakeholder processes,[2] including the processes leading to the development of Exhibits METC-1A, METC-2A, METC-3A, METC-7A, METC-8A, and METC-9A and as a result of closely following those processes I am familiar with Exhibits METC-4A and METC-10A. I co-chaired the work group on Energy Production, Transmission, Distribution, and Storage of the Michigan Council on Climate Solutions, whose recommendations were the basis of major portions of the MI Healthy Climate Plan presented in Exhibit METC-5A. I participated in the development and drafting of 2023 PA 235, which recently increased Michigan's renewable energy standards and established clean energy standards applicable to Michigan electricity providers. I was a witness in the Integrated Resource Plan ("IRP")

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[1] Consolidated Cases U-21471/U-21472 Errata to Comments of Midcontinent Independent System Operator, Inc. dated October 28, 2024.

[2] These processes are well described in the direct testimony of Charles L. Marshall, 9:12 through 10:11

cases whose outcomes are summarized in Exhibit METC-6A.[3] I also co-authored a report concerning Michigan's transmission needs that I submitted to the Commission in Case No. U-21099, which is provided as Exhibits CUB-2 and CUB-3.

III. OVERVIEW OF CASE

Q. What is the purpose of this case?

A. In consolidated cases U-21471 and U-21472, METC asks the Commission to grant certificates of public necessity and convenience 1995 PA 30, MCL 460.561 et seq., the Electric Transmission Line Certification Act for the construction of a Major Transmission Line between Oneida Substation in Eaton County and Nelson Road Substation in Gratiot County, Michigan and a Major Transmission Line between the Indiana/Michigan state border at Gilead Township in Branch County and the new Helix Substation in Calhoun County, Michigan. Grants of these certificates will enable METC to construct these lines along specified routes, notwithstanding conflicts with local zoning ordinances, and to exercise eminent domain in order to obtain conveyance of property rights from land owners along these routes, as necessary to construct the proposed transmission lines.

Q. What is your overall evaluation of METC's proposed transmission lines?

A. Testimony presented by METC, including various Exhibits consisting of work published by MISO, and comments submitted by MISO in the present cases[4] are persuasive as to the public necessity and convenience of these proposed transmission lines. If anything, those

[3] These are summarized in the direct testimony of Charles L. Marshall, Table 1, 23:1

[4] Consolidated Cases U-21471/U-21472 Errata to Comments of Midcontinent Independent System Operator, Inc. dated October 28, 2024.

submissions in these cases understate the importance of the proposed transmission lines. However, I have not evaluated and am not testifying as to the particular routes selected by METC and proposed in these cases. The Commission should grant certificates for some route for each of the proposed transmission lines.

IV. <u>BENEFITS OF THE PROPOSED TRANSMISSION LINES, ACCORDING TO METC AND MISO</u>

Q. Please summarize the benefits of the proposed transmission lines, as presented by METC and MISO.

A. The proposed transmission lines are included in a portfolio of transmission projects across the Midwest developed and approved by MISO. This portfolio is known as the Long Range Transmission Planning ("LRTP") Tranche 1 "LRTP Tranche 1") and was approved by MISO's Board of Directors as part of MISO Transmission Expansion Plan ("MTEP"). [5] This portfolio was crafted by MISO through an extensive planning process involving numerous analyses and an extensive stakeholder process[6], which I monitored and sometimes participated in on behalf of CUB throughout the process.

The MISO transmission system is a network in which requirements and performance of each component depends on the rest of the network. Thus, MISO rightly developed its analysis and presentation of the benefits of the portfolio primarily for the consolidated portfolio, rather than for individual projects within the portfolio. However, based on my

[5] Consolidated Cases U-21471/U-21472 Errata to Comments of Midcontinent Independent System Operator, Inc. dated October 28, 2024, p 4

[6] Consolidated Cases U-21471/U-21472 Errata to Comments of Midcontinent Independent System Operator, Inc. dated October 28, 2024, pp 5-10

observations, MISO's planning process was designed and executed to discover a portfolio in which every project contributed positively to the benefits and benefit-cost ratio of the portfolio. Further, in MISO's planning process, every project in the portfolio must satisfy Criterion 3:

> A Multi-Value Project must address at least one Transmission Issue associated with a projected violation of a NERC or Regional Entity standard and at least one economic-based Transmission Issue that provides economic value across multiple pricing zones. The project must generate total financially quantifiable benefits, including quantifiable reliability benefits, in excess of the total project costs based on the definition of financial benefits and Project Costs provided in Section II.C.7 of Attachment FF. [7]

Thus, while I primarily discuss the aggregate benefits of the LRTP Tranche 1 portfolio, each of the proposed transmission lines also has been demonstrated to provide net benefits to the MISO system.

Q. What are the benefits of LRTP Tranche 1?

A. MISO's projections of the benefits of LRTP Tranche 1 are included in Exhibit METC-3B. Based on my monitoring of MISO's LRTP process, including careful review of nearly every document prepared by MISO during that process, I accept that MISO's benefit projections are reasonable. Those benefits are summarized in Figure 2 of Exhibit METC 3B, reproduced below.[8]

[7] Consolidated Cases U-21471/U-21472 Errata to Comments of Midcontinent Independent System Operator, Inc. dated October 28, 2024, p 8.

[8] Exhibit METC 3B, p 3

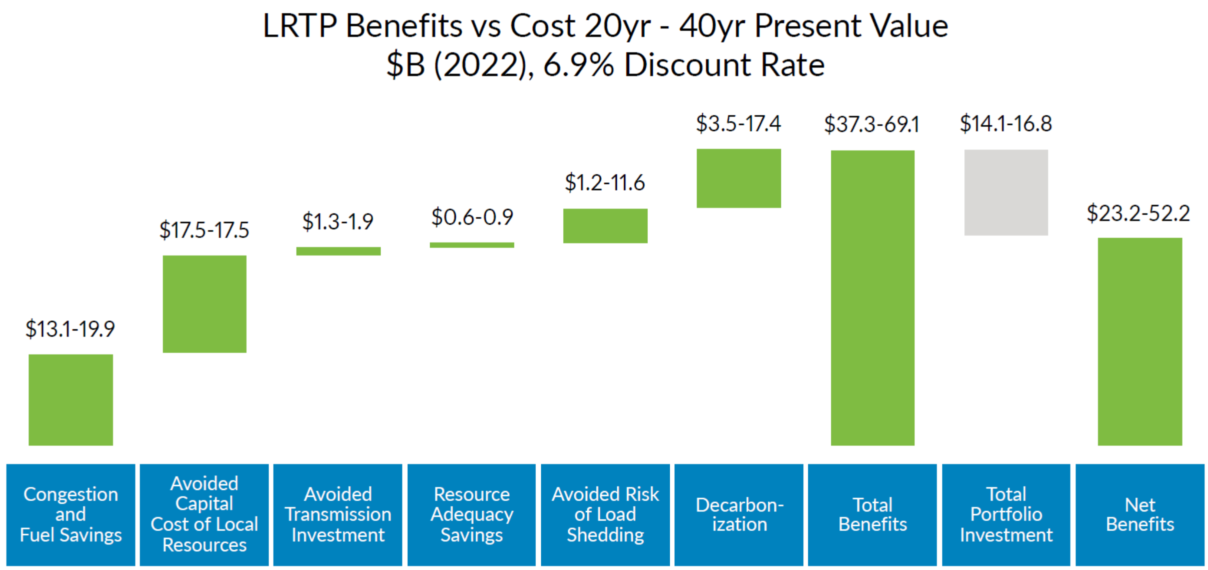

Figure 2: LRTP Tranche 1 Portfolio benefits far outweigh costs (Values as of 6/1/22)*

*Note: This implies benefit-to-cost (B/C) ratio ranges of 20-yr PV B/C = 2.6 and 40-yr PV B/C = 4.0

Q. What is the benefit-cost ratio of LRTP Tranche 1 for Michigan utility customers?

A. Most of the Lower Peninsula of Michigan is located in MISO Resource Zone 7. MISO produced estimates of the benefits and costs of LRTP Tranche 1 for each MISO Resource Zone, which were also identified as Cost Zones for LRTP Tranche 1, in Figure 3 of METC Exhibit 3B,[9] shown below:

[9] Exhibit METC-3B, p 4

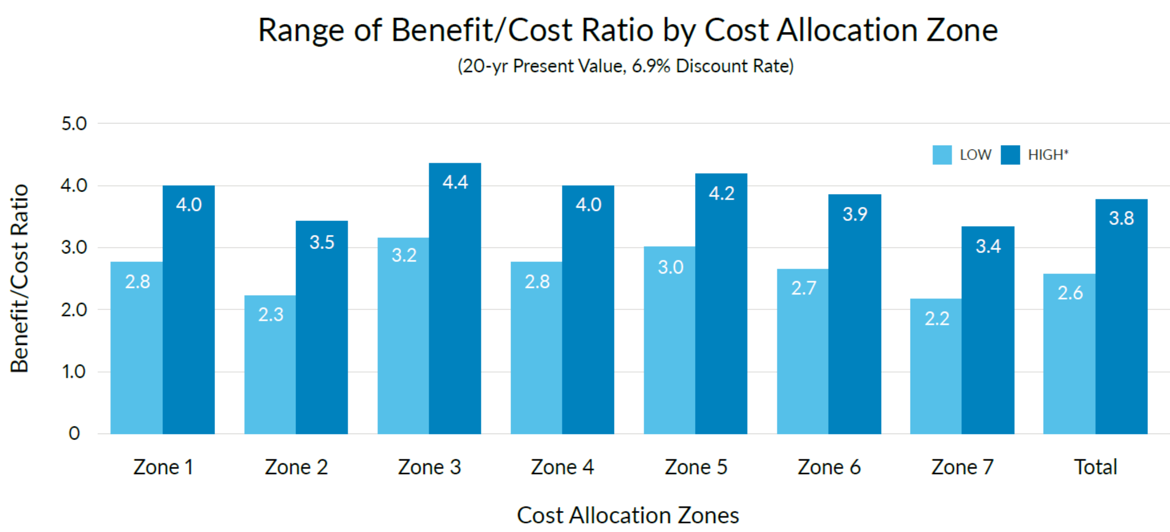

Figure 3: Benefits from the LRTP Tranche 1 portfolio exceed costs in every Midwest Subregion cost allocation zone

* The low and high range of benefit/cost ratios by Cost Allocation Zone are driven by changing two assumptions in the 20-year present value analysis: 1) increasing the Value of Lost Load (VOLL) from $3,500/MWh (low) to $23,000/MWh (high); and 2) increasing the price of carbon from $12.55/ton (low) to $47.80/ton (high).

In this analysis, the costs allocated to a zone are the projected incremental payments to MISO through its transmission tariffs by utilities, hence customers, located in the zone; this is not the same as the cost of the LRPT Tranche 1 projects that are located in the zone.

As is shown in the figure above, MISO projects that the benefit-cost ratio for Zone 7 is between 2.2 and 3.4.

Although MISO presented some elements of its benefit-cost analysis by Zone in Exhibit METC 3B, MISO made a somewhat more detailed presentation in a stakeholder presentation on June 25, 2022 that is consistent with Exhibit METC-3B.[10] I provide that presentation as Exhibit CUB-4. For a zonal summary of benefits, see slides 57-58.

[10] Ex CUB-4, MISO LRTP Tranche 1 Portfolio Detailed Business Case, presented on June 25, 2022.

Q. According to MISO, what are the congestion and fuel savings to Zone 7?

A. Congestion and fuel savings are two different perspectives on the same underlying phenomenon, so are not additive. In its normal market operations, MISO operates real-time and day-ahead energy markets based on Locational Marginal Prices ("LMPs") in which each market participant's offer to supply energy is matched to demand and is cleared based on a security-constrained economic dispatch process.[11] LMPs incorporate both the marginal cost of supply to match demand, and also the cost of congestion in the transmission system. Congestion measures the extra production (supply) cost incurred to satisfy constraints in the transmission system as calculated in the security-constrained economic dispatch process. When the capacity of the transmission system is increased, and transmission constraints are relaxed, MISO is able to match supply to demand using power supplies that are less expensive to operate, primarily through reduced fuel usage or fuel costs. Because the congestion charges are locational, reflecting transmission constraints between potentially cheaper supply and load in a particular place, avoided congestion charges allow cost savings to be attributed to a particular load zone. MISO projects that congestion and fuel savings to Zone 7 have a 20-year net present value ("NPV") of $1,006 million at a discount rate of 6.9%.[12]

[11] Consolidated Cases U-21471/U-21472 Errata to Comments of Midcontinent Independent System Operator, Inc. dated October 28, 2024, p 3.

[12] Ex CUB-4, MISO LRTP Tranche 1 Portfolio Detailed Business Case, presented on June 25, 2022,, slides 57-58

Q. According to MISO, what are the avoided cost of local resource investment to Zone 7?

A. MISO evaluates avoided cost of local resource investments by comparing the costs of supply if new supply resources are built in the optimal locations with and without the new transmission portfolio. This analysis takes advantage of better locations and reduced interconnection costs when the overall transmission network has greater capacity. MISO attributes these savings to zones based on the load share of each zone, reflecting that MISO dispatches overall resources throughout MISO as a pool serving all load. MISO projects that the avoided cost of local resource investment for Zone 7 has 20-year NPV of $3,460 million. [13]

Q. According to MISO, what are the avoided transmission investments for Zone 7?

A. MISO has determined that the projects included in LRTP Tranche 1 will reduce usage and avoid or delay local replacements or upgrades in the transmission system. Zonal savings are based on the zone in which those costs are avoided, since tariff allocations of these costs are generally to the local zone. MISO projects that avoided transmission investments for Zone 7 have 20-year NPV of $74 million. [14]

Q. According to MISO, what are the resource adequacy savings for Zone 7?

A. One of the benefits of a regional market is that supply resource reserves can be shared across the region by way of the transmission network rather being supplied locally, with a net reduction in total supply resource requirements. To ensure that each zone has adequate

[13] Ex CUB-4, MISO LRTP Tranche 1 Portfolio Detailed Business Case, presented on June 25, 2022, slides 57-58

[14] Ex CUB-4, MISO LRTP Tranche 1 Portfolio Detailed Business Case, presented on June 25, 2022, slides 57-58

resources, MISO requires that resources within a zone include an appropriate reserve margin for the portion of demand within the zone that cannot be served by importing capacity from the rest of MISO. According to MISO's analysis, in the absence of the LRTP Tranche 1 portfolio, Zone 7 is the only zone that is projected to have insufficient local resources, falling 465 MW short of requirements.[15] After implementation of LRTP Tranche 1, MISO projects that Zone 7 will have an excess of capacity at 827 MW over minimum requirements.[16] Consequently, MISO attributes resource adequacy savings only to Zone 7, with a 20-year NPV of $624 million. [17]

Q. According to MISO, what are the benefits of avoided risk of load shedding for Zone 7?

A. To the extent that MISO has resources exceeding its minimum resource adequacy requirements, the probability that it will be unable to meet load at all times is reduced. MISO values this avoided risk as the product of the probability of lost load and the value of lost load, on a regional basis. MISO attributes the benefits of avoided risk of load shedding as proportional to load share. The Zone 7 share of the benefits of avoided risk of load shedding is projected to have 20-yr NPV of $264 million to $1,618 million. [18]

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[15] Exhibit METC-3B, p 57, Table 7-4.

[16] When a zone exceeds minimum capacity requirements, this increases the probability that the zone will have adequate resources at all times so has value. MISO includes the value of that excess capacity above minimum requirements under the heading of avoided risk of load shedding, not as avoided cost of resource adequacy.

[17] Ex CUB-4, MISO LRTP Tranche 1 Portfolio Detailed Business Case, presented on June 25, 2022, slides 57-58.

[18] Ex CUB-4, MISO LRTP Tranche 1 Portfolio Detailed Business Case, presented on June 25, 2022, slides 57-58.

Q. According to MISO, what are the benefits of decarbonization for Zone 7?

A. MISO has assessed that LRTP Tranche 1 will enable increased use of renewable resources and dispatch of more efficient plants due to relaxed transmission constraints, resulting in reduced greenhouse gas emissions. MISO values this "decarbonization" based on various estimates of the social cost of carbon[19] and attributes those values to each zone based on load share. The Zone 7 share of decarbonization benefits is projected to have 20-yr NPV of $687 million to $2,656 million. [20]

Q. According to MISO, what are the total benefits of LRTP Tranche 1 for Zone 7?

A. Summing the benefits itemized above, MISO attributes benefits of LRTP Tranche 1 for Zone 7 as having a 20-yr NPV of $6,096 million to $9,438 million.

Q. According to MISO, what are the total costs of LRTP Tranche 1 for Zone 7?

A. MISO projects that the tariff-based allocations of the total costs of LRTP Tranche 1 to Zone 7 total $2,789 million.

Q. On the basis of the values you summarized above, does MISO conclude that LRTP Tranche 1 is beneficial to Zone 7?

A. Yes. MISO calculates a zonal benefit-cost ratio of 2.2 to 3.4, indicating that this is a worthwhile investment. The net benefits are projected to have 20-yr NPV of $3,307 million to $6,649 million. Out of the benefits projected by MISO, the categories that are folded into utility customer bills are congestion and fuel savings, avoided capital cost of local

[19] Exhibit METC-3B, pp 64-67

[20] Ex CUB-4, MISO LRTP Tranche 1 Portfolio Detailed Business Case, presented on June 25, 2022, slides 57-58.

resource investment, avoided transmission investment, and resource adequacy savings; these have total 20-yr NPV of $5,164 million for net on-bill benefits of $2,375 million.

V. UPDATES TO MISO BENEFIT PROJECTIONS

Q. Do you assess that MISO has accurately projected the benefits of LRTP Tranche 1 for Zone 7?

A. MISO's analysis was largely completed in 2022. Events and additional information since then suggest that MISO's projection of benefits may be low.

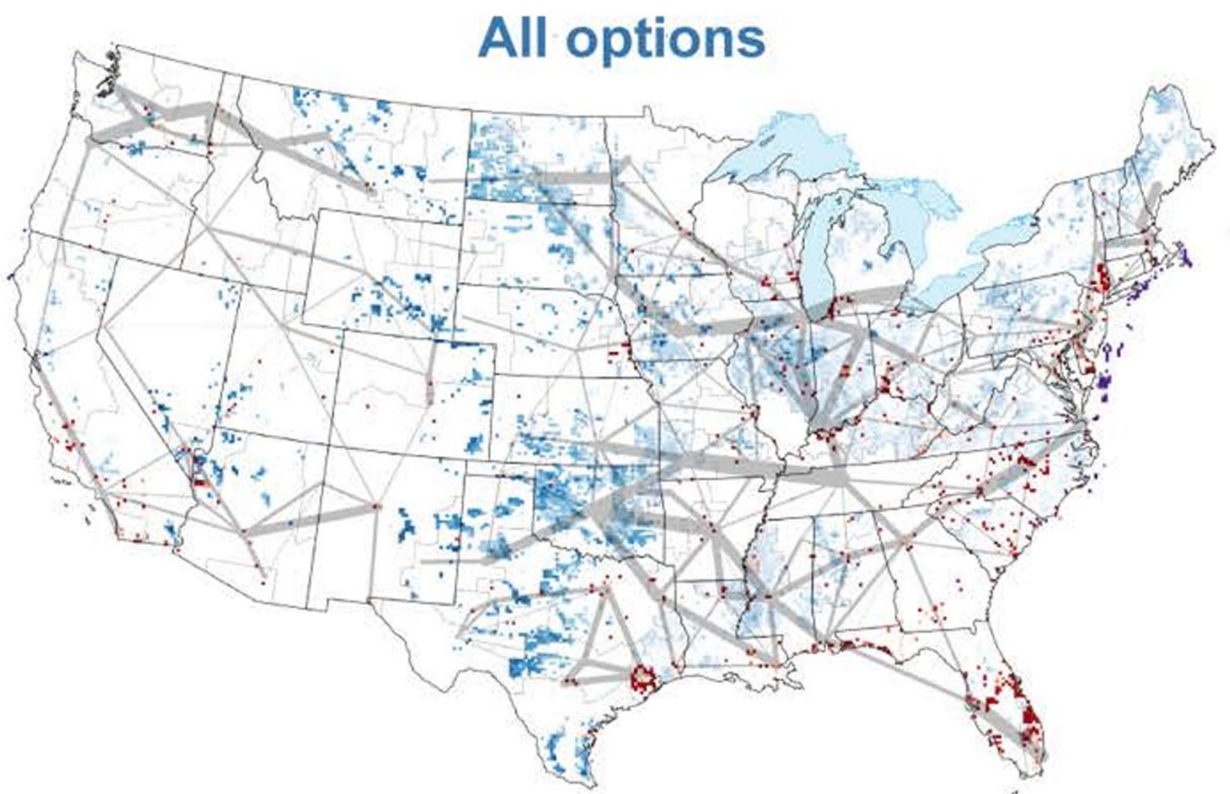
Q. What events have occurred since MISO projected the benefits of LRTP Tranche 1?

A. Principally that the Inflation Reduction Act of 2022 ("IRA") was adopted and signed into law on August 16, 2022 and that Michigan enacted 2023 PA 235 on November 28, 2023.

Q. What is the significance of these events for the projected benefits and costs of LRTP Tranche 1?

A. The IRA provided substantial future production or investment tax credits for generation of electricity using renewable resources. 2023 PA 235 adopted increased renewable energy standards for Michigan utilities of 50% by 2030 and 60% by 2035, and allowed increased use of renewable energy from MISO outside of Michigan to meet those standards. 2023 PA 235 also adopted clean energy standards for Michigan utilities of 80% by 2035 and 100% by 2040.

It is not possible to quantify the effects of these events on MISO's benefit estimates without re-doing most of their analyses, which is a very considerable undertaking that cannot be done in the context of the present case. However, there has been considerable work demonstrating that high renewable or clean energy standards require increased transmission capacity. For example, a recent National Renewable Energy Laboratory (NREL) report[21] found that in a national scenario where clean energy resource options are similar to those allowed by 2023 PA 235, the optimum level of transmission capacity is about twice the current level. The following portion of their Figure ES-2 shows in gray the transmission additions that NREL's analysis would recommend, as point-to-point lines that do not reflect actual routes:



[21] Denholm, Paul, Patrick Brown, Wesley Cole, et al. 2022. Examining Supply-Side Options to Achieve 100% Clean Electricity by 2035. Golden, CO: National Renewable Energy Laboratory. NREL/TP 6A40-81644. https://www.nrel.gov/docs/fy22osti/81644.pdf

The width of a gray line in the above map indicates the relative recommended transmission capacity. It is notable that the line from the rest of MISO into Zone 7 is amongst the widest of the lines shown.

Q. What additional information should the Commission consider?

A. Exhibits CUB-2 and CUB-3 are, respectively, the main report and technical appendix of a report that I co-authored with colleagues assembled by GridLab that was previously submitted to the Commission in Case No. U-21099. Our analysis of Michigan's transmission needs considered transmission routes and options between Zone 7 and other transmission regions in addition to transmission between the rest of MISO and Zone 7. Our analysis produced results similar to those produced by MISO, with a notable finding that LRTP Tranche 2 not only increases the capacity import limit of Zone 7 for imports from the rest of MISO, by approximately the same quantity as assessed by MISO, but also increases the ability of Zone 7 to import from other transmission regions by approximately 300 MW. I do not believe that this benefit was considered by MISO and would have the effect of adding to both the congestion and fuel cost savings projected by MISO and to the avoided risk of lost load.

Q. Has the relationship between expanding capacity import limits and the clean energy transition been assessed in other MPSC proceedings?

A. Yes. This subject has come up regularly in IRP cases in which I have been a witness – especially cases concerning Consumers Energy and DTE Electric. These cases show that increasing import capability by expanding transmission capacity is an important component of the pathway to retire legacy fossil generation and replace it with clean energy.

For example, in DTE Electric's 2018 Certificate of Necessity (CON) / IRP proceeding under MCL 460.6s for what became the Blue Water Energy Center, DTE's evidence for its identified capacity need included testimony that import capability to Zone 7 was constrained. The Michigan Environmental Council, Natural Resources Defense Council, and Sierra Club (MEC/NRDC/SC or MNS) countered that evidence. The Commission, while approving the CON, found DTE's transmission evidence to be outdated and lacking. The Commission found that "DTE Electric could have conducted a more in-depth investigation of transmission system constraints as well as transmission options to enable delivery of energy resources from outside of the MISO region by further engaging transmission owners and other entities in a stakeholder process."[22]

This issue came up again in DTE's 2019-2020 IRP case under MCL 460.6t. Again based on evidence from MEC/NRDC/SC, the Commission found:

> The Commission finds that DTE Electric failed to support its decision to ignore resources available from outside of Zone 7. As with the starting point discussion, the Commission observes that an IRP that is burdened with predetermined constraints and outcomes cannot comply with the dictates of Section 6t(5), the MIRPP, or the IRP Filing Requirements, because the point of the exercise is to identify the optimal way forward. Failure to consider all resource options, including those that exist outside Zone 7, violates the dictates of Section 6t(5)(h), (j), and (k). However, the Commission finds that this failure cannot be remedied in the instant docket. The Attorney

[22] Case No. U-18419, Order dated April 27, 2018, p. 112.

> General has correctly described the situation – the company has complied with the letter of the law in that it has provided an "analysis of potential new or upgraded electric transmission options," but has failed to comply with the spirit of that language or the language of the CON order, both of which contemplate a much more robust analysis than the one provided here. As such, DTE Electric's cursory review of transmission options may be adequate to ensure minimal compliance with the statute's requirement to consider transmission options in this case. The Commission further finds that information included in the record herein indicates that, in the very near future, an examination of potential ways to increase the CIL will become a necessary component of any IRP, and the Commission directs DTE Electric to include such an examination in its next IRP filing. The company will be required to work with transmission owner(s) in a way which produces "potential transmission options that could impact the utility's IRP by: (1) increasing import or export capability; (2) facilitating power purchase agreements or sales of energy and capacity both within or outside the planning zone from neighboring RTOs," and "up-to-date information about current and expected transmission system conditions and import/export capabilities." The next transmission analysis shall provide the Commission with an examination of the full suite of options, including renewable energy imports, transmission limits and transmission growth opportunities, and ways to optimize the utility's portfolio to reduce risk and improve cost-effectiveness.[23]

Finally, this issue arose in Consumers Energy's 2021-2022 IRP case. The parties ultimately settled that case, but the Proposal for Decision explained that Consumers' analysis of

[23] Case No. U-20471, Order dated February 20, 2020, pp. 82-83 (citations omitted).

transmission and imports was insufficient to meet the Company's obligations under a settlement and the Commission's Order in U-20471:

> The central problem with the company's transmission analysis, or lack thereof, appears to be Consumers' starting point assumption that, given the company's intention to retire significant capacity, it faced a binary choice to acquire new capacity in Zone 7, or it could import capacity from elsewhere in MISO or other regions. Of course, the MISO and NERC reliability requirements mandate that a significant amount of capacity be located in Zone 7, but the remainder of the company's capacity needs could have, and should have, been optimized as part of the company's modeling, evaluating the costs of transmission expansion or upgrades as well as the benefits of the additional flexibility and potential access to lower-cost capacity. To be fair, the company's PCA might still have been the most economical choice, but the Commission will never know because the analysis was never performed.
>
> Consistent with the discussion above, the Commission should find that Consumers' transmission analysis did not comply with the settlement agreement. In addition, the Commission should require Consumers, consistent with the Commission's directions set forth in the February 20, 2020 order in Case No. U-20471, pp. 82-83, to "provide the Commission with an examination of the full suite of options, including renewable energy imports, transmission limits and transmission growth opportunities, and ways to optimize the utility's portfolio to reduce risk and improve cost effectiveness[,]" in the company's next IRP.[24]

Based on the extensive history of this issue, it is my opinion that new transmission projects such as the ones in this case have significant public benefits as an important component of

[24] Case No. U-21090, PFD dated March 7, 2022, pp. 122-23.

Michigan's pathway to decarbonization. Relatedly, MEC, NRDC, and Sierra Club have also introduced testimony in IRP cases that speeding the retirement of legacy fossil generation will have important public health benefits by reducing the load of other harmful pollutants in the ambient air.[25]

VI. RECOMMENDATIONS

Q. Please summarize your conclusions and recommendations to the Commission.

A. In my opinion, the facts and evidence I have discussed overwhelmingly demonstrate that the quantifiable and nonquantifiable public benefits of the transmission lines proposed in these consolidated cases justify their construction. On behalf of CUB-SC, I recommend that the Commission grant certificates of public convenience and necessity for the proposed transmission lines in this case, adopting whatever routes the Commission determines most appropriate.

Q. Does that complete your testimony?

A. Yes, it does.

[25] See Case No. U-20471, Direct Testimony of George Thurston, 7 Tr 2879-2918, and Direct Testimony of Kindra Weid, 7 Tr 2920-2946.

Douglas B. Jester

Personal Information

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Professional experience

January 2011 – present 5 Lakes Energy

Managing Partner

Co-owner of a consulting firm working to advance the clean energy economy in Michigan and beyond. Consulting engagements with foundations, startups, and large mature businesses have included work on public policy, business strategy, market development, technology collaboration, project finance, and export development concerning energy efficiency, smart grid, renewable generation, electric vehicle infrastructure, and utility regulation and rate design. Policy director for renewable energy ballot initiative and Michigan energy legislation advocacy. Supported startup of the Energy Innovation Business Council, a trade association of clean energy businesses. Developed integrated resource planning models for use in ten states' compliance with the Clean Power Plan. Expert witness in more than 70 electric utility regulation cases in Michigan and approximately 15 cases in other states.

February 2010 - December 2010 Michigan Department of Energy, Labor and Economic Growth

Senior Energy Policy Advisor

Advisor to the Chief Energy Officer of the State of Michigan with primary focus on institutionalizing energy efficiency and renewable energy strategies and policies and developing clean energy businesses in Michigan. Provided several policy analyses concerning utility regulation, grid-integrated storage, performance contracting, feed-in tariffs, and low-income energy efficiency and assistance. Participated in Pluggable Electric Vehicle Task Force, Smart Grid Collaborative, Michigan Prosperity Initiative, and Green Partnership Team. Managed development of social-media-based community for energy practitioners. Organized conference on Biomass Waste to Energy.

August 2008 - February 2010 Rose International

Business Development Consultant - Smart Grid

- Employed by Verizon Business' exclusive external staffing agency for the purpose of providing business and solution development consultation services to Verizon Business in the areas of Smart Grid services and transportation management services.

December 2007 - March 2010 Efficient Printers Inc

President/Co-Owner

- Co-founder and co-owner with Keith Carlson of a corporation formed for the purpose of acquiring J A Thomas Company, a sole proprietorship owned by Keith Carlson. Recognized as Sacramento County (California) 2008 Supplier of the Year and Washoe County (Nevada) Association for Retarded Citizens 2008 Employer of the Year. Business operations discontinued by asset sale to focus on associated printing software services of IT Services Corporation.

August 2007 - 2015 IT Services Corporation

President/Owner

- Founder, co-owner, and President of a startup business intended to provide advanced IT consulting services and to acquire or develop managed services in selected niches, currently focused on developing e-commerce solutions for commercial printing with software-as-a-service.

2004 – August 2007 Automated License Systems

Chief Technology Officer

- Member of four-person executive team and member of board of directors of a privately-held corporation specializing in automated systems for the sale of hunting and fishing licenses, park campground reservations, and in automated background check systems. Executive responsible for project management, network and data center operations, software and product development. Brought company through mezzanine financing and sold it to Active Networks.

2000 - 2004 WorldCom/MCI

Director, Government Application Solutions

- Executive responsible in various combinations for line of business sales, state and local government product marketing, project management, network and data center operations, software and product development, and contact center operations for specialized government process outsourcing business. Principal lines of business were vehicle emissions testing, firearm background checks, automated hunting and fishing license systems, automated appointment scheduling, and managed application hosting services. Also responsible for managing order entry, tracking, and service support systems for numerous large federal telecommunications contracts such as the US Post Office, Federal Aviation Administration, and Navy-Marine Corps Intranet.
- Increased annual line-of-business revenue from $64 million to $93 million, improved EBITDA from approximately 2% to 27%, and retained all customers, in context of corporate scandal and bankruptcy.
- Repeatedly evaluated in top 10% of company executive management on annual performance evaluations.

1999-2000 Compuware Corporation

Senior Project Manager

- Senior project manager, on customer site with five project managers and team of approximately 80, to migrate a major dental insurer from a mainframe environment to internet-enabled client-server environment.

1995 - 1999 City of East Lansing, Michigan

Mayor and Councilmember

- Elected chief executive of the City of East Lansing, a sophisticated city of 52,000 residents with a council-manager government employing about 350 staff and with an annual budget of about $47 million. Major accomplishments included incorporation of public asset depreciation into budgets with consequent improvements in public facilities and services, complete rewrite and modernization of city charter, greatly intensified cooperation between the City of East Lansing and the East Lansing Public Schools, significant increases in recreational facilities and services, major revisions to housing code, initiation of revision of the City Master Plan, facilitation of the merger of the Capital Area Transportation Authority and Michigan State University bus systems, initiation of a major downtown redevelopment project, City government efficiency improvements, and numerous other policy initiatives. Member of Michigan Municipal League policy committee on Transportation and Environment and principal writer of league policy on these subjects (still substantially unchanged as of 2022).

1995-1999 Michigan Department of Natural Resources

Chief Information Officer

- Executive responsibility for end-user computing, data center operations, wide area network, local area network, telephony, public safety radio, videoconferencing, application development and support, Y2K readiness for Departments of Natural Resources and Environmental Quality. Directed staff of about 110. Member of MERIT Affiliates Board and of the Great Lakes Commission's Great Lakes Information Network (GLIN) Board.

1990-1995 Michigan Department of Natural Resources

Senior Fisheries Manager

- Responsible for coordinating management of Michigan's Great Lakes fisheries worth about $4 billion per year including fish stocking and sport and commercial fishing regulation decisions, fishery monitoring and research programs, information systems development, market and economic analyses, litigation, legislative analysis and negotiation. University relations. Extensive involvement in regulation of steam electric and hydroelectric power plants.
- Served as agency expert on natural resource damage assessment, for all resources and causes.
- Considerable involvement with Great Lakes Fishery Commission, including:

- Co-chair of Strategic Great Lakes Fishery Management Plan working group
- Member of Lake Erie and Lake St. Clair Committees
- Chair, Council of Lake Committees
- Member, Sea Lamprey Control Advisory Committee
- St Clair and Detroit River Areas of Concern Planning Committees

1989-1990 American Fisheries Society

Editor, North American Journal of Fisheries Management

- Full responsibility for publication of one of the premier academic journals in natural resource management.

1984 - 1989 Michigan Department of Natural Resources

Fisheries Administrator

- Assistant to Chief of Fisheries, responsible for strategic planning, budgets, personnel management, public relations, market and economic analysis, and information systems. Department of Natural Resources representative to Governor's Cabinet Council on Economic Development. Extensive involvement in regulation of steam electric and hydroelectric power plants.

1983-present Michigan State University

Adjunct Instructor

- Irregular lecturer in various undergraduate and graduate fisheries and wildlife courses and informal graduate student research advisor in fisheries and wildlife and in parks and recreation marketing.

1977 – 1984 Michigan Department of Natural Resources

Fisheries Research Biologist

- Simulation modeling & policy analysis of Great Lakes ecosystems. Development of problem-oriented management records system and "epidemiological" approaches to managing inland fisheries.
- Modeling and valuation of impacts of power plants on natural resources and recreation.

Education

1991-1995 Michigan State University

PhD Candidate, Environmental Economics

Coursework completed, dissertation not pursued due to decision to pursue different career direction.

1980-1981 University of British Columbia

Non-degree Program, Institute of Animal Resource Ecology

1974-1977 Virginia Polytechnic Institute & State University

MS Fisheries and Wildlife Sciences

MS Statistics and Operations Research

1971-1974 New Mexico State University

BIS Mathematics, Computer Science, Biology, and Fine Arts

Citizenship and Community Involvement

Youth Soccer Coach, East Lansing Soccer League, 1987-89

Co-organizer, East Lansing Community Unity, 1992-1993

Bailey Community Association Board, 1993-1995

East Lansing Commission on the Environment, 1993-1995

East Lansing Street Lighting Advisory Committee, 1994

Councilmember, City of East Lansing, 1995-1999

Mayor, City of East Lansing, 1995-1997

East Lansing Downtown Development Authority Board Member, 1995-1999

East Lansing Transportation Commission, 1999-2004

East Lansing Non-Profit Housing and Neighborhood Services Corporation Board Member, 2001-2004

Lansing – East Lansing Smart Zone Board of Directors, 2007-2017

Council on Labor and Economic Growth, State of Michigan, by appointment of the Governor, May 2009 – May 2012

East Lansing Downtown Development Authority Board Member and Vice-Chair, 2010 – 2018.

East Lansing Brownfield Authority Board Member and Vice-Chair, 2010 – 2018.

East Lansing Downtown Management Board and Chair, 2010 – 2016

East Lansing City Center Condominium Association Board Member, 2015 – present.

City of East Lansing Advisory Commissioner to the Lansing Board of Water and Light, 2017 – present.

State of Michigan UP Energy Task Force, 2019-present, appointed by Governor Whitmer.

State of Michigan Dam Safety Committee, 2020-2021

State of Michigan Council on Climate Solutions, Energy Production, Transmission, Distribution, and Storage Workgroup Co-Chair, 2021-present.

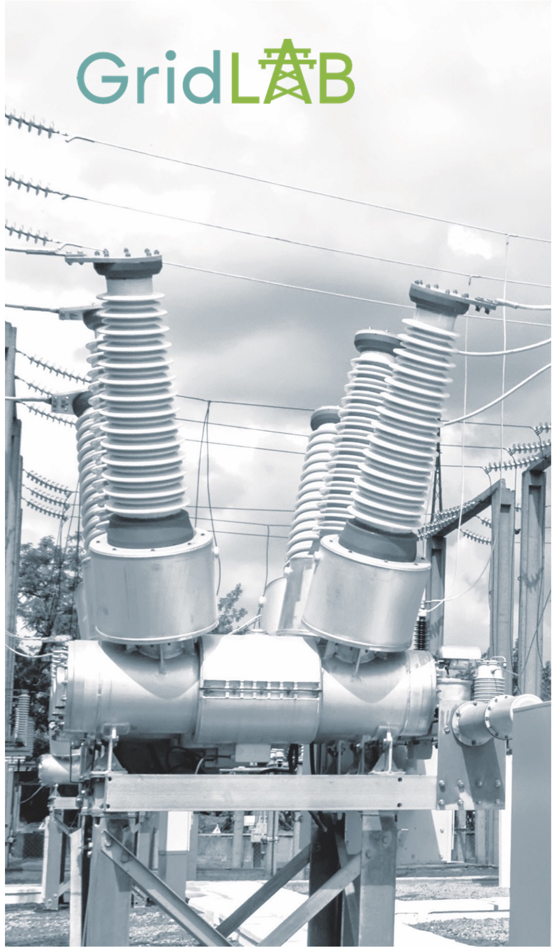
Board and Executive Committee Member, For Love of Water (FLOW), 2019 - present

Understanding Michigan's Transmission Needs

Project team: 5 Lakes Energy, GridLab, Warren Lasher, Potomac Law Group, Telos Energy

June 2023

GridLAB



Background

- Project purpose and background
  - Responsive to MPSC Jun 23 2022 order in docket #U-21099
  - Commission sought comment on actions / policies that might maximize benefits to the reliability of Michigan's transmission connections to MISO, PJM, IESO and how to boost those connections
- Core work contributions:
  - Assessment of regulatory documents and timeline
  - Power system analysis
  - Discussion on opportunities for Michigan

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Team description

Multi-disciplinary team with deep regulatory and analytical expertise

GridLAB

5lakes energy

Lasher Energy Consulting

Warren Lasher, independent consultant

Potomac LAW GROUP

TELOS ENERGY

GridLAB

Timeline of the Growth of Michigan's Grid and Regulatory Assessment

Potomac Law Group

GridLAB

Timeline summary

First 50 years
Michigan-centered organic growth then consolidation into national holding companies with out-of-state ownership

Middle 50 Years
Michigan Utilities Serving Regional Interests within Michigan

New Millennium
Consolidation and Dawn of Meaningful Regional Transmission Planning

Unique features of Michigan transmission system post-1975 and post-2000s
Controlled interconnections with Ontario transmission system

(See appendix for more details on the timeline)

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Overview of regulatory documents

- relevant regulatory approaches and interregional coordination agreements were originally developed in historical context of individual franchised transmission companies and to address specific problems
- did not anticipate rise of Regional Transmission Organizations (RTOs)
- coordination agreements in RTO era originally emphasized avoidance of harm rather than promotion of regional benefits
- MISO's capacity auction has location requirements for generation
- new development is the MISO Transmission Expansion Planning (MTEP) regional planning approach, promotion of Multi-Value Projects (MVPs) and Long Range Transmission Project Initiative. MVPs are:
  - intended to reliably and economically enable regional public policy needs (for example state renewable portfolio standards)
  - provide multiple types of regional economic value
  - or provide a combination of regional reliability and economic value

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Michigan-Ontario Phase Angle Regulators

US DOE Presidential Permits; ITC-Hydro One Interconnection Facilities Agreement (8/8/2011) and MISO and IESO Operating Instruction entitled "Operation of the Michigan-Ontario Tie Lines and Associated Facilities" (8/8/2011)

There are four international electric transmission lines that interconnect the electrical systems of The Detroit Edison Company (Detroit Edison) and Hydro One Networks, Inc. (Hydro One; formerly Ontario Hydro), the provincial utility of Canada's Province of Ontario. In Presidential Permit PP-221, the US Department of Energy (DOE) authorized Detroit Edison to construct, operate, maintain, and connect these international transmission facilities:

- B3N Facility: A 230,000-volt (230-kV) transmission line connecting Detroit Edison's Bunce Creek Station, located in Marysville, Michigan, with Hydro One's Scott Transformer Station located in Sarnia, Ontario (previously authorized in Presidential Permit PP-21)
- J5D Facility: A 230-kV transmission line connecting Detroit Edison's Waterman Station, located in Detroit, Michigan, with Hydro One's J. Clark Keith Generating Station, located in Windsor, Ontario (previously authorized in Presidential Permit PP-21)
- L4D facility: A 345-kV transmission line connecting Detroit Edison's St. Clair Generating Station, located in East China Township, Michigan, with Hydro One's Lambton Generating Station, located in Moore Township, Ontario (previously authorized in Presidential Permit PP-38)
- L51D facility: A 230-kV transmission line connecting Detroit Edison's St. Clair Generating Station, located in East China Township, Michigan, with Hydro One's Lambton Generating Station, located in Moore Township, Ontario (previously authorized in Presidential Permit PP-58)

In Order PP-221, DOE consolidated all of Detroit Edison's existing Presidential permits into one permit and authorized Detroit Edison to place in service the voltage-regulating autotransformer on the L51D facility. See Order 230-2 and PP230-4. plus Comments and Supplemental Documents detailing highly contested proceedings at DOE and FERC regarding operation and cost allocation applicable to the PARs.

By formal agreement among ITC, MISO, and PJM, and conditional support from IESO, NYISO, and other parties, the PARs are operated on a flow to schedule basis since 2012.

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Key regulatory documents

MISO Tariff: limitation of MISO's capacity mechanism (Planning Resource Auction)

MISO maintains an annual capacity requirement for all load-serving entities (LSEs) based on the load forecast plus reserves.

- LSEs are required to specify to MISO what physical capacity, including demand resources, they have designated to meet their load forecast
- Location-specific approach
- requirement for presence of generation resource within Zone 7 (Michigan)

MISO Joint Operating Agreements: Affected System Study Standards in MISO-PJM and MISO-SPP JOAs

- **Issue:** Affected System study standard that will be applied to a generator interconnecting within MISO (direct connecting system) evaluating the effect on neighboring RTOs (i.e., Energy Resource Interconnection Service (ERIS)/Network Resource Interconnection Service (NRIS) modeling standards)
  - **ERIS:** connect a generating facility in a manner that allows it to deliver electric output using the existing firm or nonfirm capacity of the Transmission Provider's Transmission System on an as-available basis
  - **NRIS:** connect a generating facility in a manner that integrates with the Transmission Provider's Transmission System (1) in a manner comparable to that in which the Transmission Provider integrates its generating facilities to serve native load customers; or (2) in an RTO or ISO with market based congestion management, in the same manner as Network Resources

- MISO applies the ERIS modeling standard for its Affected System analysis of proposed generation located within and sinking in another RTO, regardless of whether the generator requests ERIS or NRIS in the host RTO (i.e., PJM or SPP)
- SPP and PJM evaluate the impacts to their respective systems using the thresholds associated with the same level of service that is requested on the host RTO.
- **Potential Effect:** more robust transmission infrastructure built in neighboring RTOs related to Affected System study approach for generator interconnection

See: Order on Complaint and Technical Conference, EDF Renewable Energy, Inc. v. MISO, PJM, SPP, 168 FERC ¶ 61,173 (2019)

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Power system analysis

Telos Energy Group

GridLAB

Transmission Analysis

Purpose

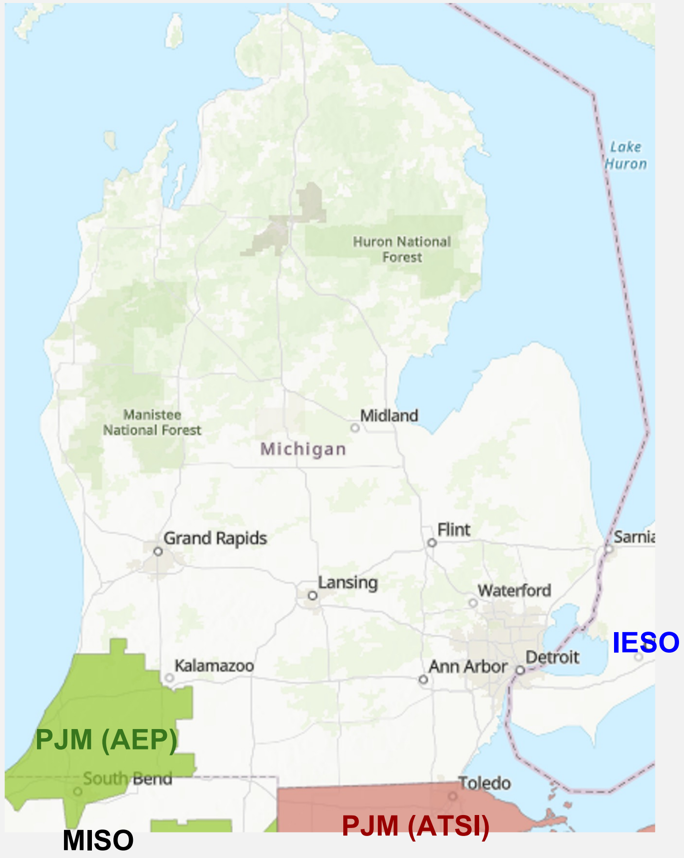
Assess the grid's physical capabilities and constraints for moving power into the lower peninsula

Basis

The MISO MTEP20 model, accessed enabled by Michigan PSC

Outlook

2025 and similar near-term scenarios with new renewables



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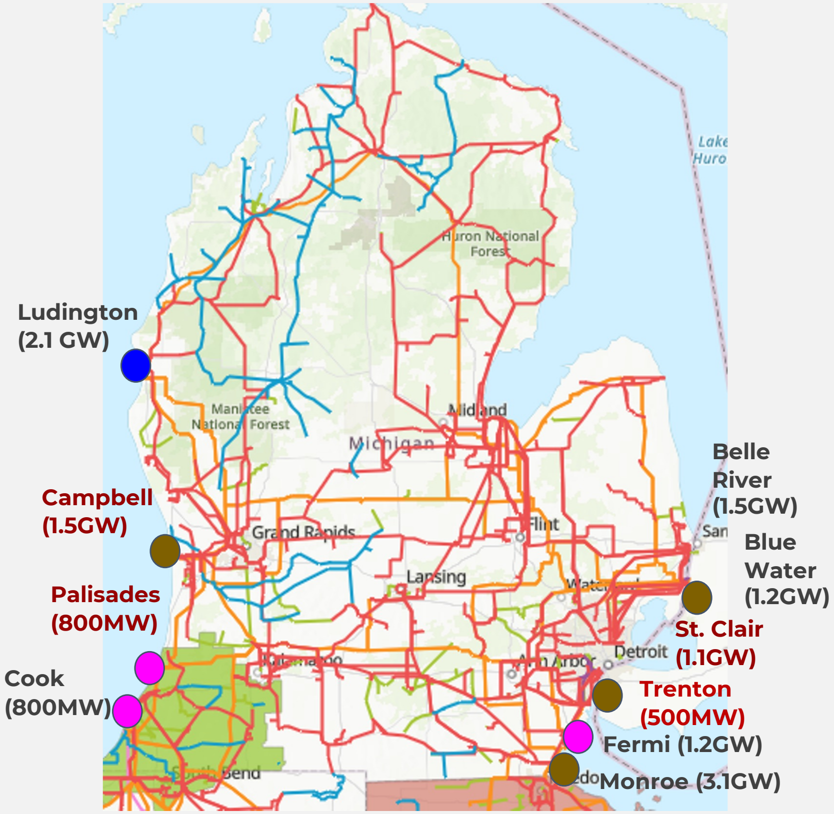
Transmission Analysis Assumptions

- Assumed Retirements: St. Clair, Trenton Channel, Palisades, Campbell (3.9GW)
- Assumed New Resources: 8.6GW solar, storage & wind, dispatched to 3.9GW, spread according to MISO Generator Interconnection Queue
- Analysis Conducted: AC Contingency Analysis (thermal and voltage violations) (method similar to MISO CIL/CEL Study)
- Study Scenarios of increasing imports for:
  - MISO Imports (like MISO CIL/CEL Study)
  - MISO, PJM, and IESO Imports
- Sensitivities: Tranche 1, Shoulder Case, Ludington Operations



Source: arcgis (HIFLD Public Database)

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Major Transmission Analysis Findings

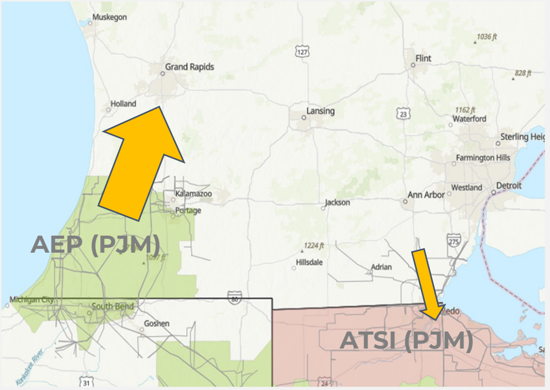
Power Flows to Michigan (Lower Peninsula)

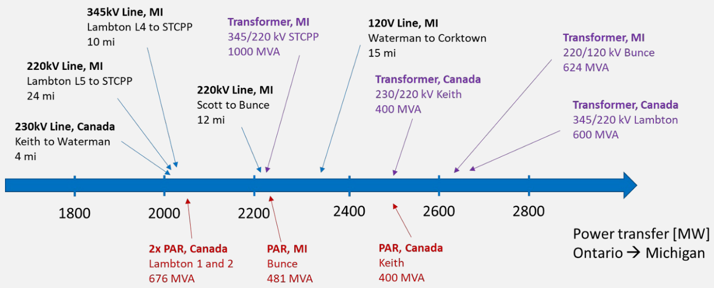
- Very little flow directly from MISO (without Tranche 1)
- Most imports (~4GW) would flow from PJM (AEP, SW Michigan)
- ~2 GW imports available from IESO
- 0.2 GW imports available from Upper Peninsula

When Pressing Imports Higher

- MI-IESO PARs and nearby lines reach thermal limits around 2GW
- Lake Erie loop flow (LEC) does not appear to be a constraint
- The first thermal violations that appear are mild (central Michigan, NW Ohio 138kV)
- Voltage violations are few and relatively small

Note: This is in-part due to the assumption of many new resources spread across the Lower Peninsula





Michigan - Ontario Interface, Incremental Overloads

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Findings from Sensitivities

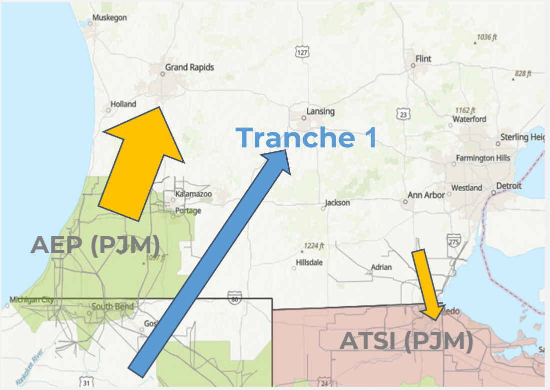
Tranche 1 Addition

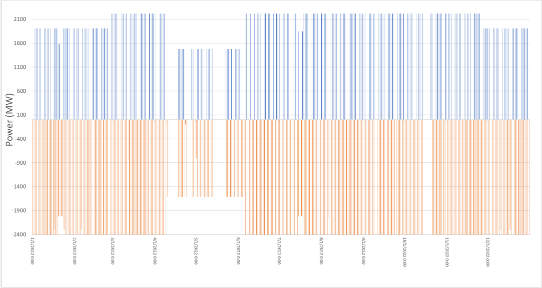
- Relieves central Michigan & NW Ohio thermal violations
- Enables ~1.7 GW of transfer from MISO territory and 2+ GW total increased imports

Ludington Operations

- MTEP Summer and shoulder cases assume full discharging (2.3GW)
- Full discharging cases show few transmission violations
- Full charging cases show moderate thermal violations near Grand Rapids

Shoulder Case - Findings are relatively similar to summer peak case





Ludington Operations, 2022

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Opportunities for Michigan

Lasher Energy Consulting

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Issues for Discussion

This analysis has indicated four areas that warrant further discussion.

1. Energy transfers across the border with Ontario
2. Energy transfers across the southern border with Ohio and Indiana
3. Resource Additions and Retirements
4. Other transmission considerations (Ludington, HVDC)

Overall, the availability of adequate transmission, both within lower Michigan and connecting lower Michigan with its neighbors, will be a major determining factor in how well Michigan achieves its clean energy goals.

And the challenge is not just to plan for the future. As technologies on the grid change, it is increasingly apparent that the established regulatory policies and market design procedures that were developed during an era characterized by large baseload thermal generation and inelastic customer demand may not be well-suited to the grid of the future. Planning for the future will need to include some reconsideration of past decisions and agreements.

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Energy Transfers Across the Border with Ontario

The border between Michigan and Ontario presents near-term and long-term opportunities for economic energy transactions

Near term Opportunities

- Based on this analysis, imports and exports up to ~2,000 MW appear to be achievable given current infrastructure
- Impacts on other regions at these transfer levels appear to be mitigated through the operations of the Phase-angle regulators located on the border
- It does not appear that this import capacity is part of the MISO Capacity Import Limit calculations. As such, Michigan utilities are not able to utilize this import capacity in their resource planning to meet MISO Zone 7 capacity requirements.
- Inclusion of scheduled imports to meet MISO capacity requirements also may be limited due to a lack of a formal capacity sharing agreement between IESO and MISO.

Recommendation

- Initiate discussions with MISO and IESO to identify options to better utilize this import capacity
- Specifically, ask MISO for credit for the non-firm power flows between IESO and Michigan for calculating Michigan's local resource adequacy requirements

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Energy Transfers Across the Border with Ontario

Long-term Opportunities

- Ontario represents a significantly diverse energy trading partner with increasing needs for energy and similar clean energy goals to Michigan.
- It will be easier for Michigan to achieve its clean energy goals if it has trading partners with renewable energy sources that have a certain amount of diversity from resources in Michigan, i.e, partners that can provide excess renewable energy when resources in Michigan are at low output, and who can purchase excess renewable energy when resources in Michigan are producing abundantly.

Recommendation

Establish a process with IESO and MISO - that considers long term decarbonization goals and implications for load and resource planning - to identify mutually beneficial projects to increase transmission capacity across the Michigan Ontario border. To the extent increased transfers have an impact on flows between Ontario and and other states, engage with these other regions to find appropriate solutions.

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Energy Transfers Across the Southern Michigan Border

A majority of the transmission capacity for imports and exports across the southern border of Michigan involves circuits operated in the PJM market. Geographically, there is actually only a small portion of the southern border that connects into a portion of the MISO market.

Near-Term Opportunities

- Given the dependence on PJM circuits for imports across the southern border, Michigan will benefit by increased coordination between MISO and PJM
- It is likely that new resources interconnecting within Michigan face interconnection study delays because of the transmission capacity impacts in both market regions
- It is not clear what impact parallel flows on PJM circuits have on the determination of import capacity limits into Michigan across the southern border

Recommendation

- Michigan PSC should coordinate with MISO and PJM to determine the impacts that established joint operating agreements have on opportunities for Michigan utilities to incorporate out-of-state resources into integrated resource plans and MISO capacity requirements
- Ask MISO for credit for the non-firm power flows between PJM and Michigan for calculating Michigan's local resource adequacy requirements

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Energy Transfers Across the Southern Michigan Border

Long-Term Opportunities

As the amount of renewable generation within and around Michigan grows, the value of transmission capacity for importing and exporting energy will increase. Joint operating agreements between MISO and PJM that limit availability of transmission will become increasingly burdensome.

Recommendations

- Review any MISO restrictions on capacity imports from regions outside MISO (these limitations are especially problematic for Michigan given its location on the edge of the MISO region and prevalence of transmission connections with PJM)
- Identify neighboring states with similar clean energy goals and diversity of renewable resources, and advocate in transmission planning processes for increased transmission capacity between these states and Michigan
- Engage in proactive discussions with MISO and PJM to identify opportunities for improving established joint operating procedures to better meet future challenges
  - Market design disparities between MISO and PJM may impact resource development decisions in Michigan and options for power imports
  - Long-term it may be warranted to explore the benefits of participating in the PJM market

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Resource Additions and Retirements

Future resource decisions will have an impact on the availability of transmission capacity. Resource retirements could lead to limitations on system import and export capacity, while resource additions could require lengthy transmission development projects to be fully integrated. Resource changes should be studied holistically to quantify all of the expected future impacts.

Recommendation: Develop an action plan for holistic and integrated energy system planning as called for in the Michigan Healthy Climate Plan developed by EGLE.

- Require consideration of imported resources in IRPs
- Require the consideration of HVDC and other transmission assets proactively as resources in IRPs
- Require LSEs in their IRPs to do a calculation of the effects of resource additions/retirements on capacity import limits

This action plan should include stakeholders, Consumers Energy, DTE, ITC, MISO and PJM.

Transmission planning within the lower Michigan region should include a proactive assessment of future needs given additional increased integration of renewable resources and retirement of thermal generation.

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Other Transmission Considerations

Ludington Pumped Storage: The Ludington facility will be increasingly valuable as the capacity of renewable resources in Michigan grows. This analysis indicates that insufficient transmission capacity may limit the operational capability of the facility under some conditions.

It's not clear how the operation of this unit is scheduled. In the future, a large storage resource can provide significant value by being operated to minimize operational risk and maximize utilization of clean energy resources.

Recommendations

- Transmission limitations affecting the operational capability of the Ludington pumped storage unit should be identified and addressed as appropriate.
- Operational scheduling procedures of the Ludington unit should be reviewed.

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Other Transmission Considerations

Michigan has limited capability to import or export power. This study assessed import capability from the Ontario region and from the MISO and PJM regions along the southern border. The ability to export renewable energy when internal resources are abundant and to import renewable energy when internal resources are low will become increasingly valuable as renewable resource capacity grows as will the ability to trade power with a diversity of regions.

Recommendation

Advocate for transmission projects that will allow import and export of power with other regions, such as the proposed transmission line connecting the western part of Michigan with Wisconsin.

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Appendix Slides

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Brief History of the Growth of Michigan's Transmission Grid (first 120 years)

First 50 years: Michigan-centered organic growth then consolidation into national holding companies with out-of-state ownership

- In 1883, the first incandescent light bulb in Detroit was installed at Metcalf Brothers dry goods store in Detroit.
- By 1900, the Edison Illuminating Co. and the Peninsular Electric Light Co. (which owned the electric distribution franchise in the area) provided all commercial electric lighting and power in the city of Detroit.
- In 1904, William Foote consolidated several power companies across Michigan under the name Commonwealth Power Co.
- In 1905, holding company American Light & Traction Co. acquired a majority of the Detroit City Gas Co.
  - American Light & Traction controlled utility and transportation interests across the Upper Midwest from Grand Rapids to Milwaukee. American Light and Traction had been founded in 1900 for the purpose for consolidating the utility industry's small, local power suppliers. By 1901, American Light and Traction owned and controlled over 40 gas producing plants, electric light, and traction (streetcar) companies.
- In 1920, the Michigan utilities owned by the Foote family were consolidated in new publicly traded company Consumers Power.
- In 1922 Consumers Power and the Michigan Light Company merged under the name Consumers Power.
- In 1929, Consumers Power became one of a myriad of companies owned by the New York City-based utility holding company conglomerate The Commonwealth and Southern Corporation. (Parts of Commonwealth & Southern became the forerunners of modern-day Consumers Energy, Southern Company, and Ohio Edison.)
- The 1930s-40s were marked by consolidation among gas and electric utility interests and infrastructure growth driven by support the WWII War effort and the expansion of America's dominant automotive industry.
- in 1949, Consumers Power became an independent company again upon separating from Commonwealth and Southern.

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Middle 50 Years Michigan Utilities Serving Regional Interests

- Expansion of Michigan economy to support US and allies in WWII and beyond
- Michigan's leadership in the US automotive industry
- In 1968, Consumers Power reincorporated as a Michigan corporation (was initially incorporated in Maine in 1910).
- In 1987, holding company CMS Energy was founded with subsidiary Consumers Power owning utility assets and CMS Enterprises owning non-utility and international assets.
- In January 1996, Detroit Edison established a holding company: DTE Energy.
- In 1997, Consumers Power changed its name to Consumers Energy Company.

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New Millennium: Consolidation and Dawn of Meaningful Regional Transmission Planning

- In 2000, Michigan's electric restructuring law required the state's major electric utilities to either divest their electric transmission systems or turn over operating control to an independent entity by Dec. 31, 2001.
- On May 31, 2001 DTE Energy and MCN Energy Group completed a merger which created Michigan’s largest energy company and a premier regional energy provider.
- Also in 2001, Consumers Energy sold its transmission assets to a partnership led by Trans-Elect (developer of electric and gas transmission systems focusing on the ownership and management of electric transmission systems through purchase and expansion of transmission assets).
- On December 20, 2001, Midcontinent Independent Transmission System Operator, Inc. (MISO) became the nation's first FERC-approved Regional Transmission Organization (RTO).
- In 2003, ITCTransmission was formed and acquired DTE’s transmission assets.
- In 2005, ITCTransmission acquired Michigan Electric Transmission Company (METC) (i.e., Consumers Energy’s former transmission assets previously sold to Trans-Elect). This marked the first time the Federal Energy Regulatory Commission authorized the acquisition of a stand-alone transmission company (“Transco”) by another Transco.
- In 2011, MISO launched its Multi-Value Projects (MVP) portfolio of regionally planned transmission projects.
- In 2016, Canadian holding company Fortis, Inc. acquired ITC Holdings Corp.; its ITC Michigan subsidiary holds transmission assets of former ITC and METC
- In 2020, MISO launched its Reliability Imperative.
- In 2021, MISO approved Long-Range Transmission Project (Tranche 1: first tranche of transmission solutions developed as part of effort to provide reliable and economic energy delivery to address future reliability needs resulting from transformational changes in generation resource fleet).

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Michigan-Ontario Phase Angle Regulators (PARs) Timeline

1975–Ontario Hydro's Keith PAR in Ontario enters service (first of the PARs on the Michigan-Ontario interface, originally installed to control local flows between Michigan and Ontario

Early 1990s–Unscheduled power flows on the transmission lines in Ontario, known as the Lake Erie Loop Flow (LELF), increase significantly, taking up transmission capacity and impacting power transfers between Ontario, New York and Michigan including transmission curtailments

1998–Detroit Edison, the former parent of ITC, and the former Ontario Hydro develop plans for Detroit Edison to install a PAR at BunceCreek in Michigan and Ontario Hydro to install two PARs at Lambton in Ontario. The Lambton PARs are for two separate lines that connect the Ontario and Michigan grids. Detroit Edison applies to U.S. Department of Energy (DOE) to modify a presidential permit to allow for installation of the Bunce Creek PAR

2000–Swiss-Swedish multinational manufacturer ABB delivers first PAR to Lambton; DOE grants presidential permit to ITC for Bunce Creek PAR

2001–First PAR at Lambton fails and is returned to ABB for rebuild

2002–ABB delivers second PAR to Lambton

2003–Original Bunce Creek PAR fails while in service in March 2003; the tower supporting the Canadian side of the Bunce Creek-Scott transmission line collapses in bad weather

2005–ABB delivers repaired first PAR back to Lambton

2006–Tower and line for the Bunce Creek-Scott line are replaced. ITC orders two new PARs from Smit Transformer (Netherlands) to replace the failed Bunce Creek PAR

2008–New York Independent System Operator alleges that LELF costs state's market almost $100 million in first seven months of the year and identifies operational PARs as a solution to reducing transmission congestion.

2009–ITC applies with DOE to amend presidential permit to replace the failed Bunce Creek PAR with two PARs; ITC completes installation of new Bunce Creek PARs in 2010

2011–ITC and MISO complete operatingagreements with Ontario power grid operator IESO and Hydro One; ITC and MISO seek cost-allocation agreements with New York ISO and PJM power grid operators before FERC, achieve agreement on operating protocols and settlement of presidential permit before DOE

2012–DOE approves presidential permit; PARs enter service

Ongoing monitoring and coordination shows LELF largely controlled and transmission "flow to schedule" over the Michigan-Ontario PARs since 2012

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The Need for Holistic Planning

Holistic and integrated energy system planning

Improve energy system planning by fully integrating traditional resources, transmission, distribution, new and emerging resources, and considerations related to the interdependency of electric and natural gas systems. Elevate community health impacts and equitable access to infrastructure in energy planning and investment decisions. Continue to develop and refine innovative rate designs to incent behaviors that advance clean energy goals.

From Michigan Healthy Climate Plan (EGLE, April 2022)
Who is responsible for establishing this holistic planning process?

Availability of adequate transmission, both within lower Michigan, and connecting lower Michigan with its neighbors, will be a major determining factor in how well Michigan achieves its stated clean energy goals.

The challenge is not just to plan for the future. As technologies on the grid change, it is becoming increasingly apparent that the established regulatory, market and operational policies and procedures that were developed during and for another era, one characterized by large baseload thermal generation and inelastic customer demand, may not be well-suited to the grid of the future. Many of the accepted (and ingrained) ways of doing business do not serve customers well and need to be reconsidered in light of the changing grid.

Understanding Michigan's Transmission Needs: Technical Appendix

June 2023

TELOS ENERGY

GridLAB

Introduction

Purpose: Assess the grid's physical capabilities and constraints for moving power into the lower peninsula

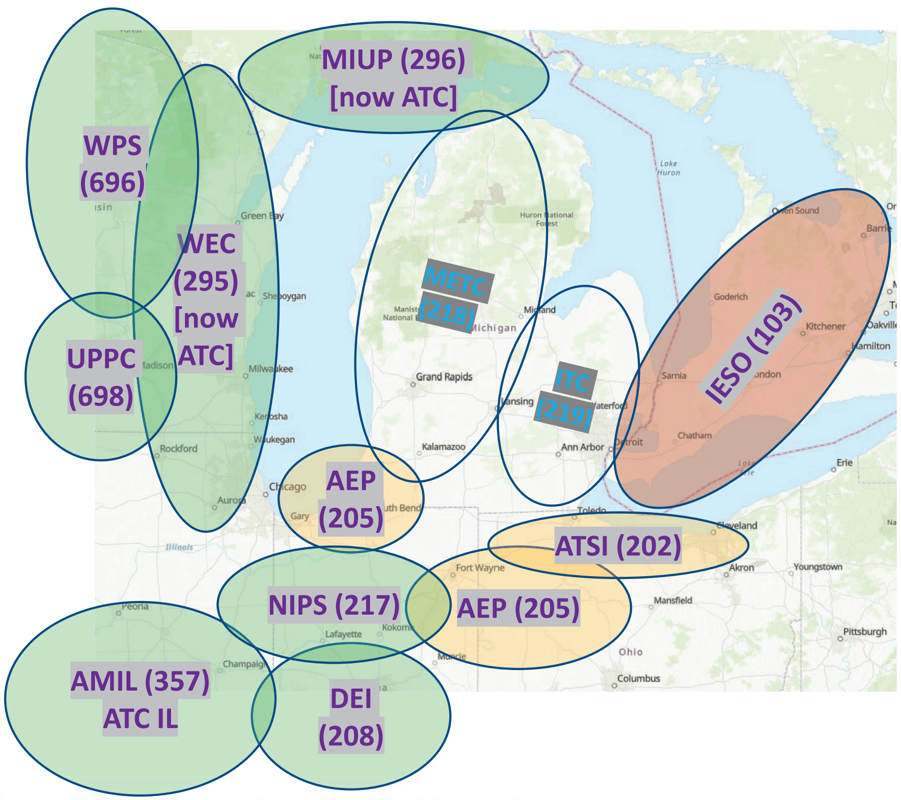
Outline:

- Analysis Approach
- Base Case Development
- PJM and IESO Import Findings
- All Imports and Regional Power Flow Considerations
- Tranche 1 Findings
- Ludington Findings

Note: All transmission maps shown are from publicly available databases found here:
https://www.arcgis.com/apps/mapviewer/index.html

Transmission Analysis

First-Contingent Incremental Transfer Capability (FCITC) analysis to the Lower Peninsula from surrounding areas



Focus is primarily on the summer peak snapshot

MISO Imports (area #)

- 217, 296, 208, 357, 295, 696, 698, 207, 210, 216, 314, 360, 361, 356, 357

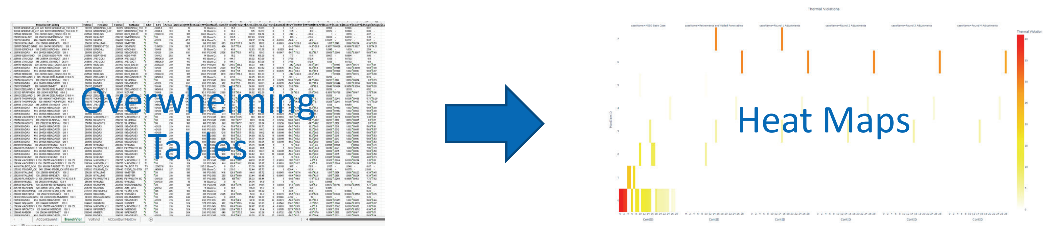
Ontario Imports (area #)

- 103

PJM Imports (area #)

- 202 and 205

Results Visualizations

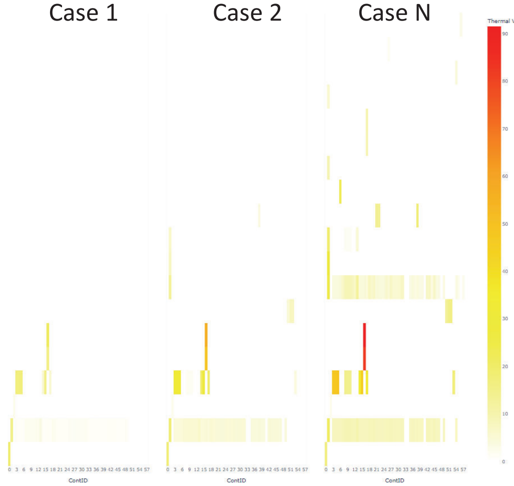


Visualizing Thermal Violations
(MW Overloads of Lines & Transformers)

Increasing Levels of Power Transfer →

Case 1 Case 2 Case N

Elements (Lines & Transformers)



Severity of Violation (MW)

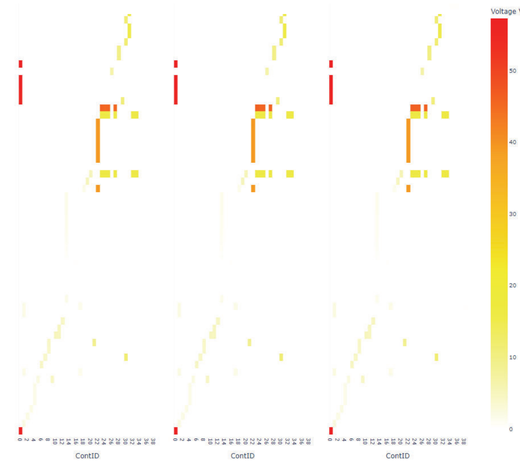
Contingencies

Visualizing Voltage Violations
(Buses / Substations with low voltage)

Increasing Levels of Power Transfer →

Case 1 Case 2 Case N

Violated Buses



Severity of Voltage Overload (kV)

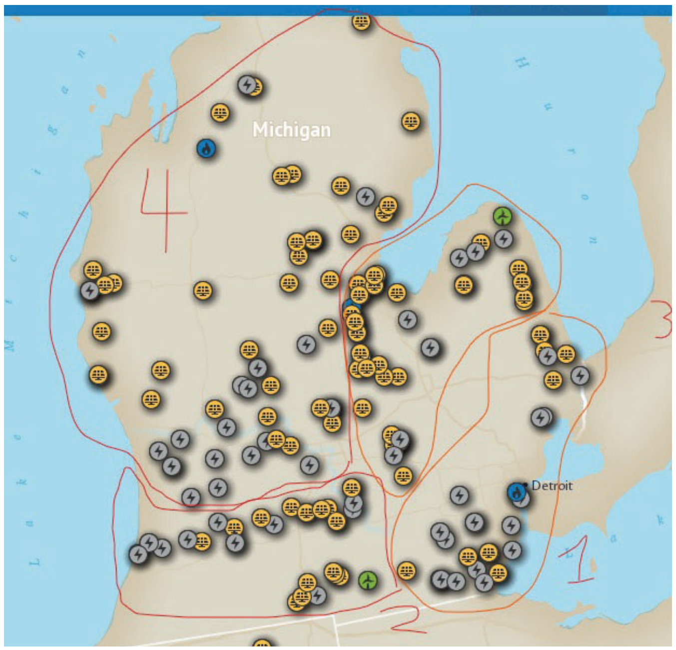
Contingencies

Note: Data for contingencies and overloaded elements are anonymized in the following slides (shown and “ContID” and “MonElemID”)

Base Case Development

A 2025 Future Scenario

Base Case



MISO Generator Interconnection Queue Map

2025 MISO cases modified

Retirements (3.9 GW)

- St. Clair (4 units, 1.1GW)
- Trenton Channel (unit 9, 500MW)
- Campbell (4 units, 1.5 GW)
- Palisades (1 unit, 800 MW)

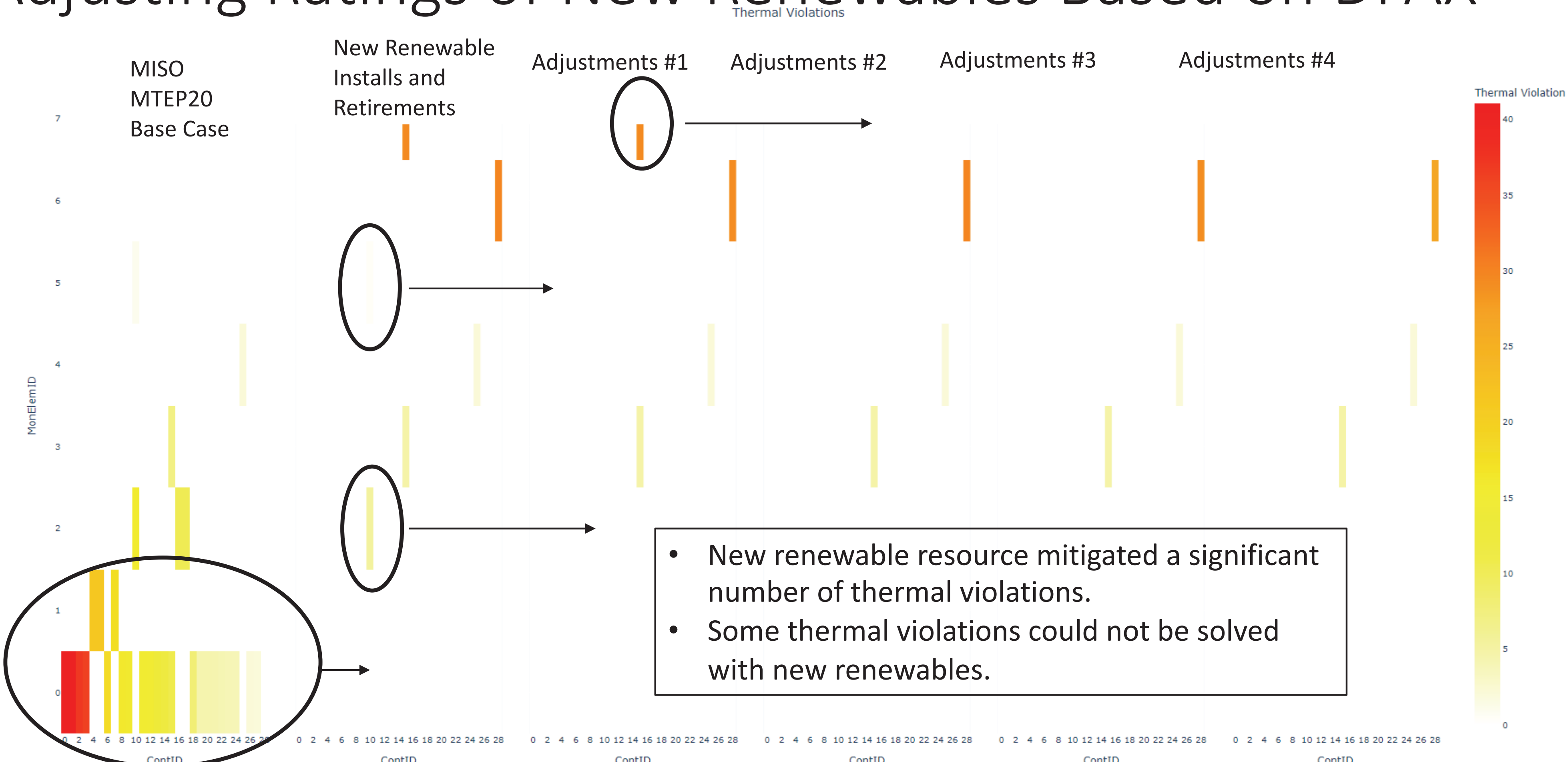
New Generation (3.9 GW dispatched)

- Solar, Wind, Battery (8.6GW installed, 3.9 GW dispatched)
- Locations based on MISO Queue – 12/31/2024
- Dispatch levels for Summer and Shoulder

Our Resource Dispatch Assumptions:

Dispatch level - Verified From MTEP22, 2024 Models							
Case/	Summer		Shoulder		Spring Light		Winter
Type	AA	TA	Average	High	AA	TA	
Solar	48%	48%	33%	0	0	0	0
Wind	16%	17%	28%	83%	0	0	67%

Adjusting Ratings of New Renewables Based on DFAX



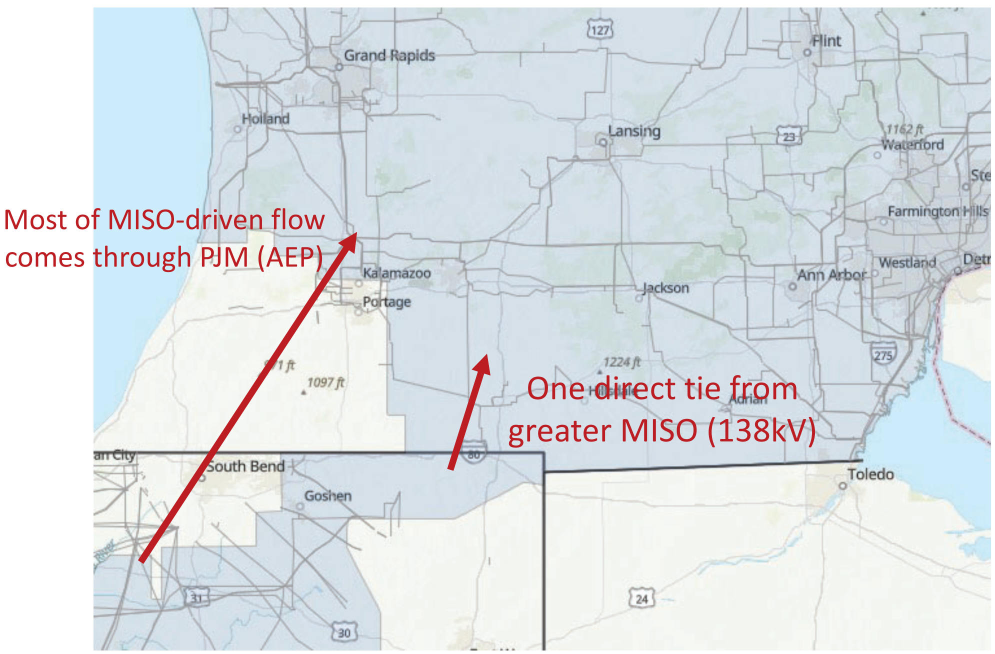
- New renewable resource mitigated a significant number of thermal violations.
- Some thermal violations could not be solved with new renewables.

Imports from MISO, PJM

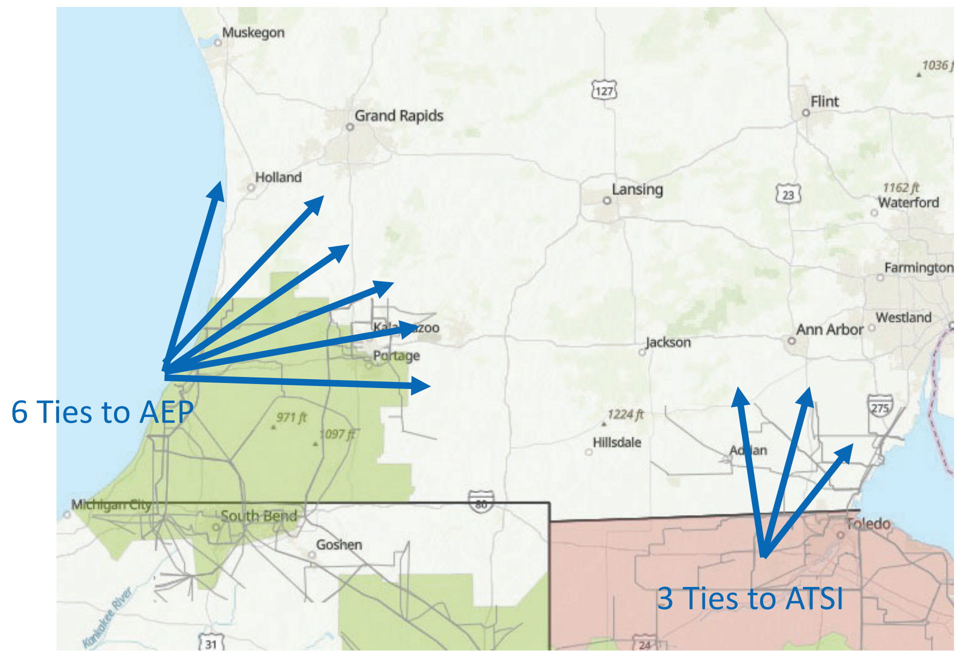
Transmission Import Capability

MISO v. PJM Import Flows

MISO Flow Paths



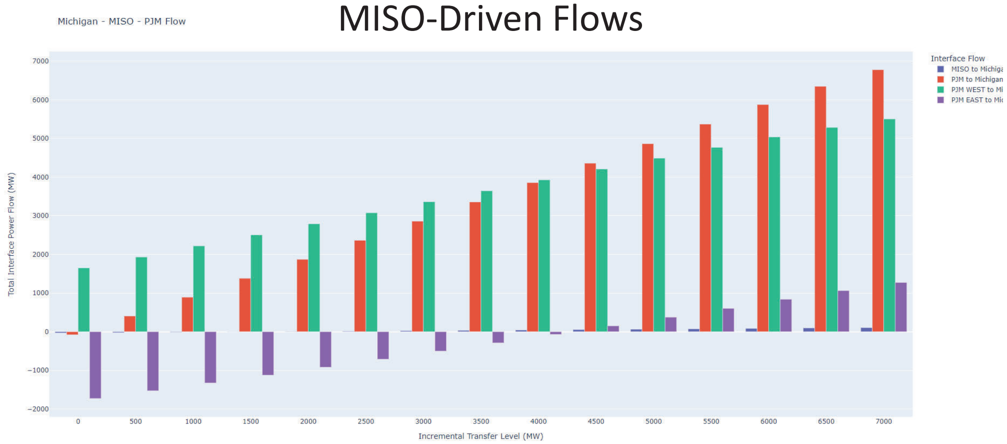
PJM Flow Paths



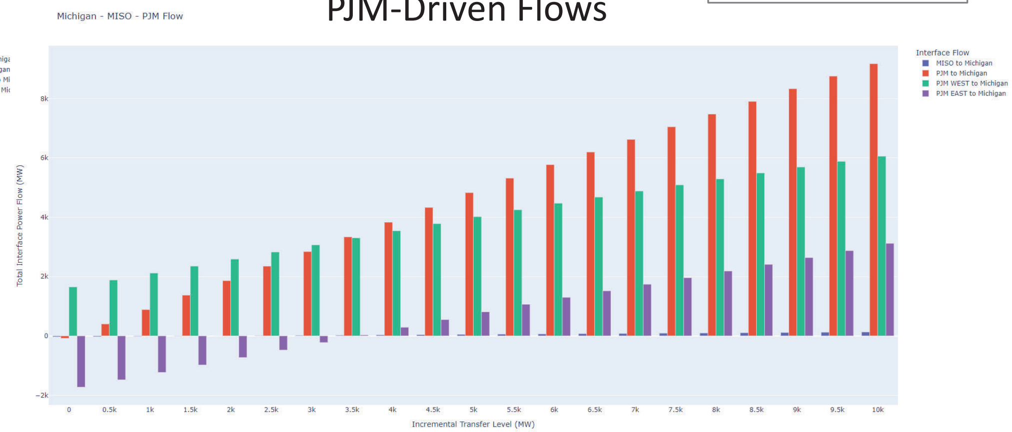
Flows to Michigan Driven from PJM, MISO

Legend
MISO
PJM Total
PJM West
PJM East

MISO-Driven Flows

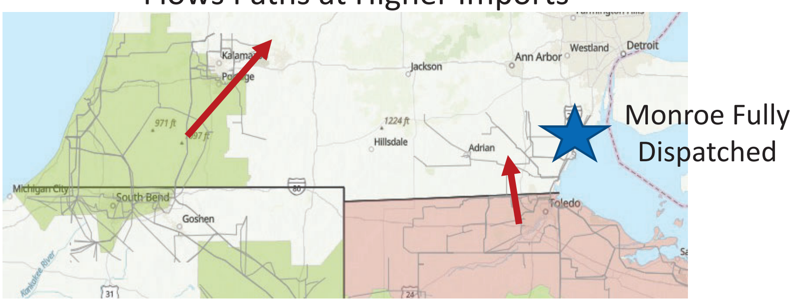


PJM-Driven Flows



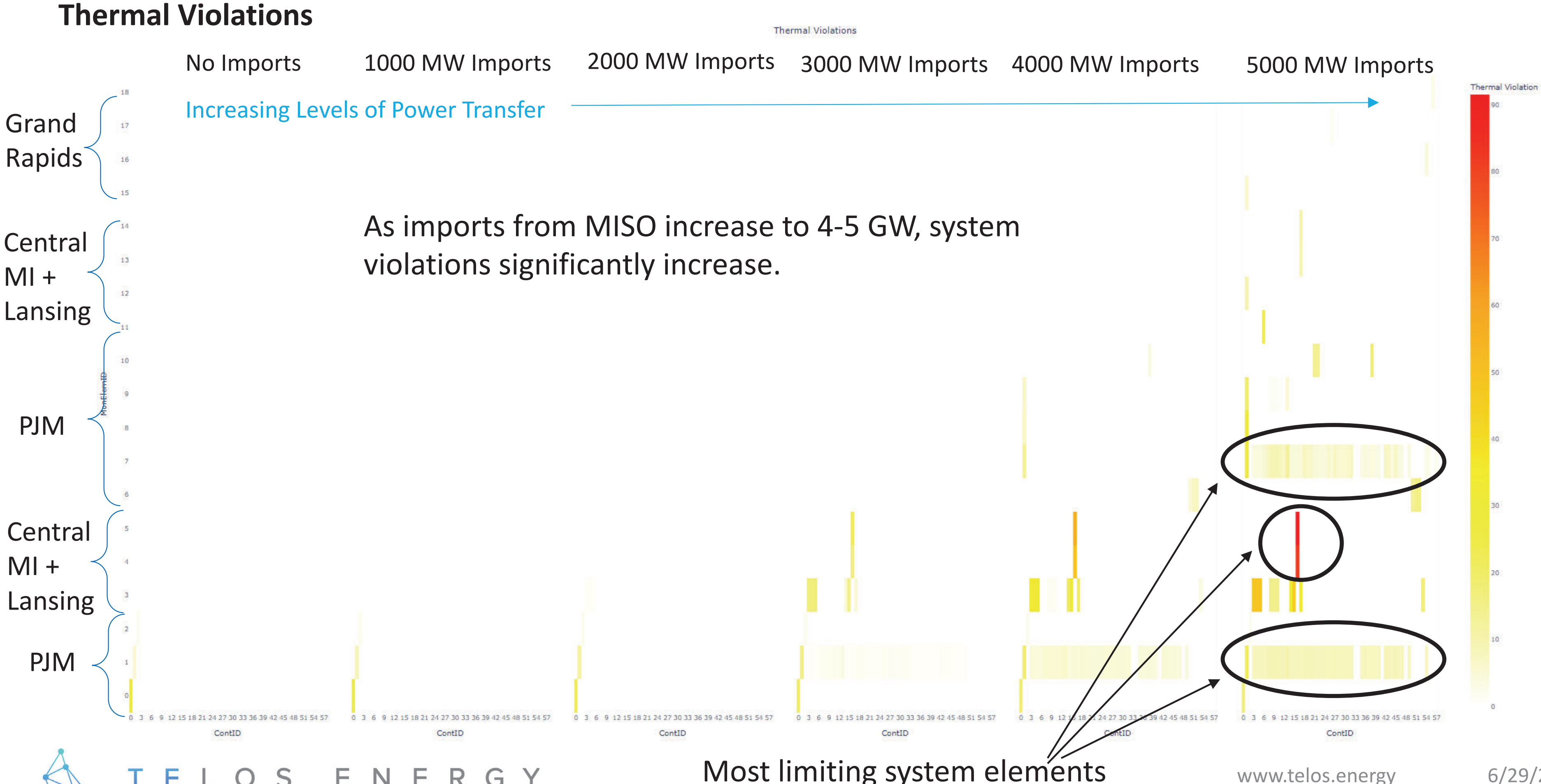
Flows Paths at Lower Imports (near MISO Base Case)

Flows Paths at Higher Imports

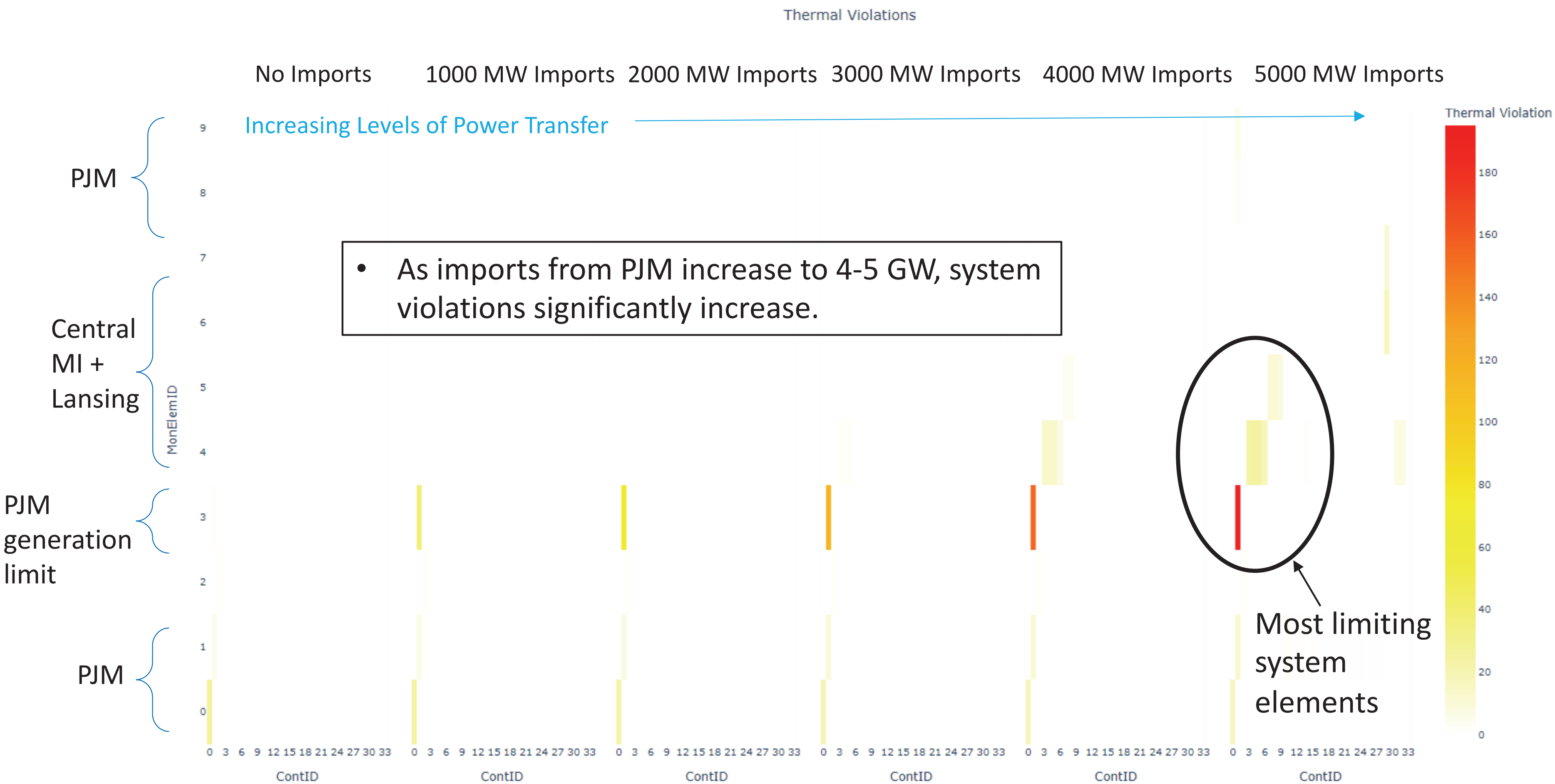


MISO-Driven Transfers, Thermal Violations

Thermal Violations



PJM-Driven Transfers, Thermal Violations



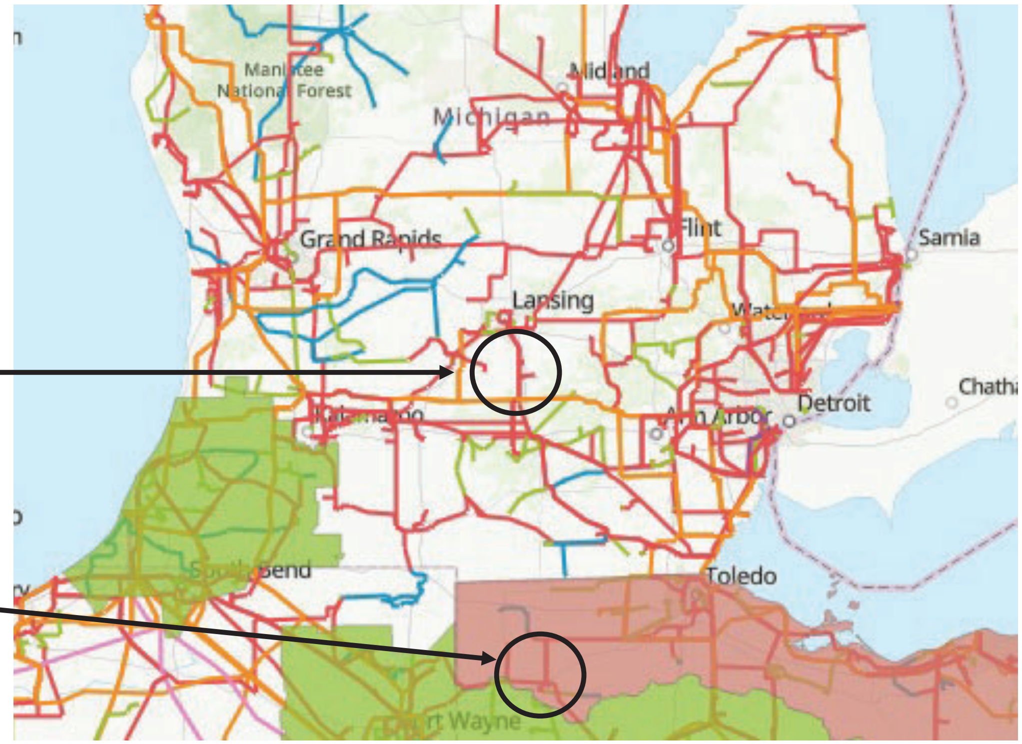
- As imports from PJM increase to 4-5 GW, system violations significantly increase.

Southern Import Thermal Violations

Summary:
- 4-5 GW of transfer prior to violations (consistent with 202 MISO CEL/CIL study)
- These are relatively minor violations

In Michigan:
- Bus violations south of Lansing
- Violated elements have already been identified for Appendix A projects

In Ohio:
- Defiance area in OH is impacted by scaling generation (redispatch would resolve violations)
- The most affected elements are three 138kV lines (6, 7, and 16 miles)

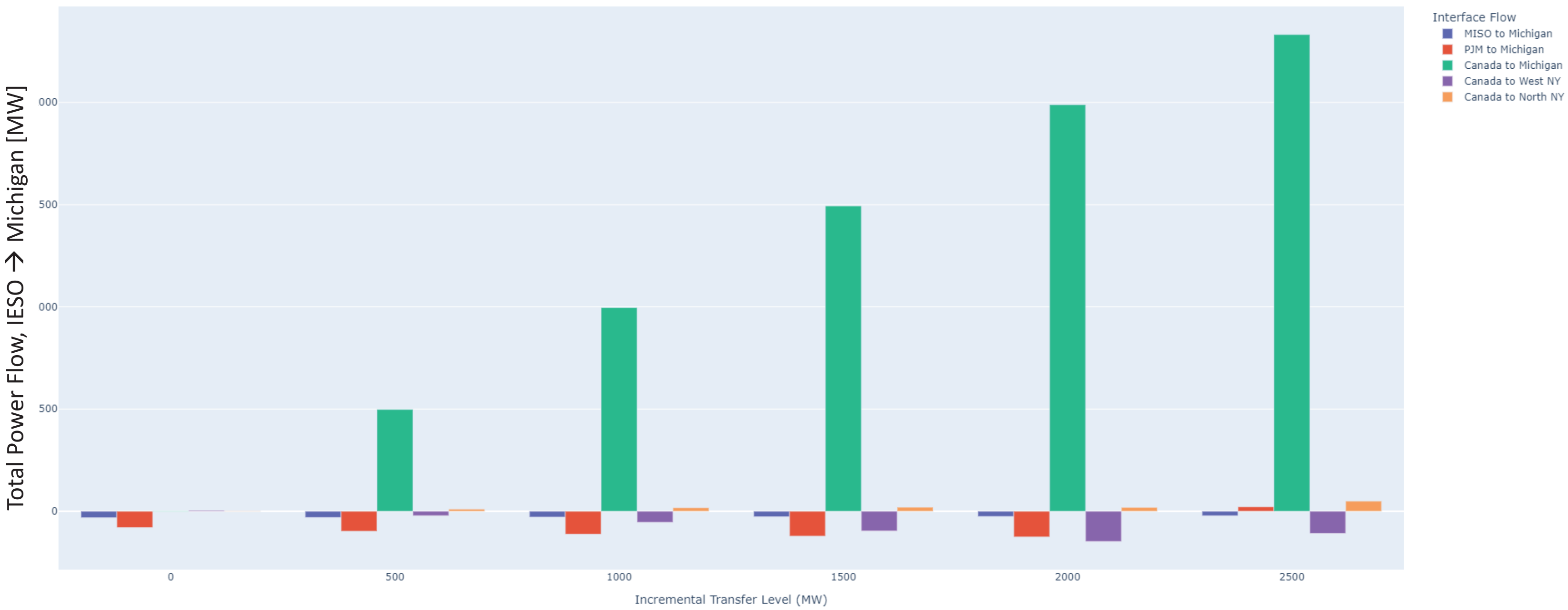


Imports from IESO

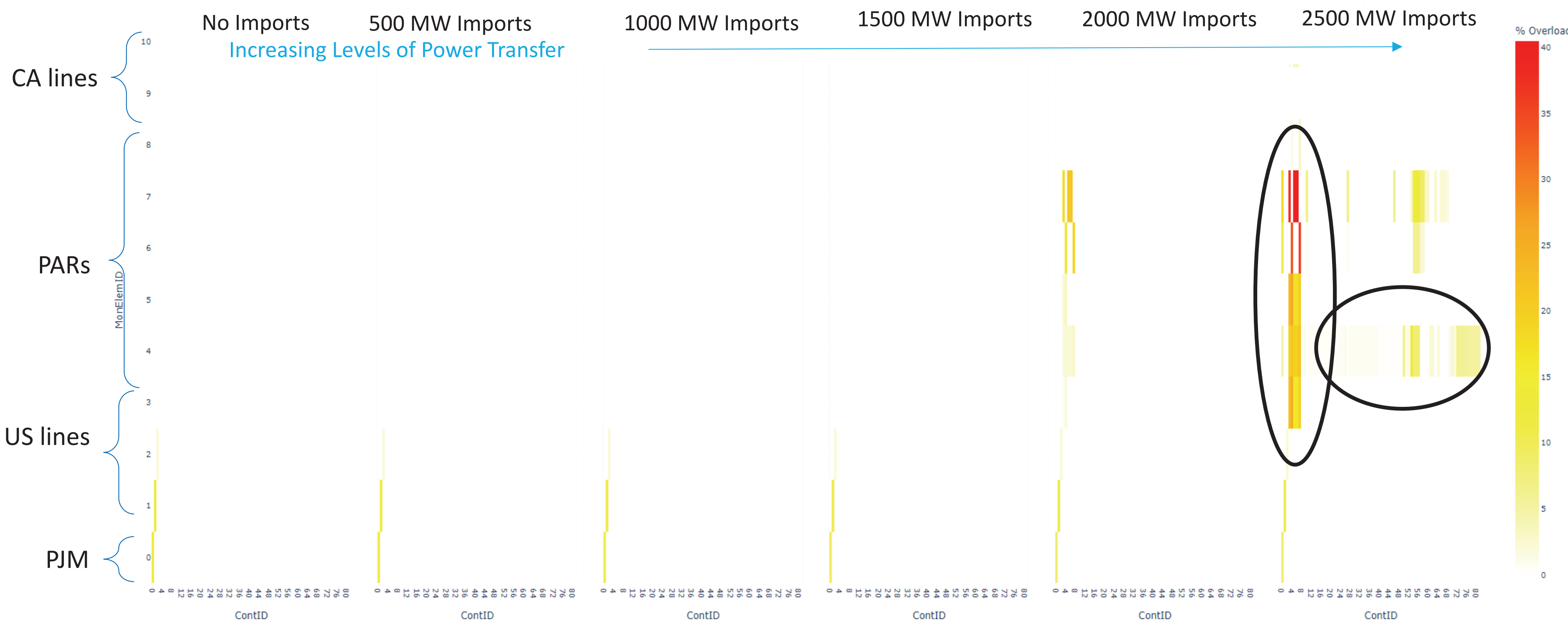
Steady-State Contingency Analysis

Canada Import Results

- Power is driven from Ontario to Michigan by Increasing Generation in Ontario and Modifying PAR Transfers
- Other interfaces are not significantly impacted because the PAR flows are coordinated with the change in Ontario generation

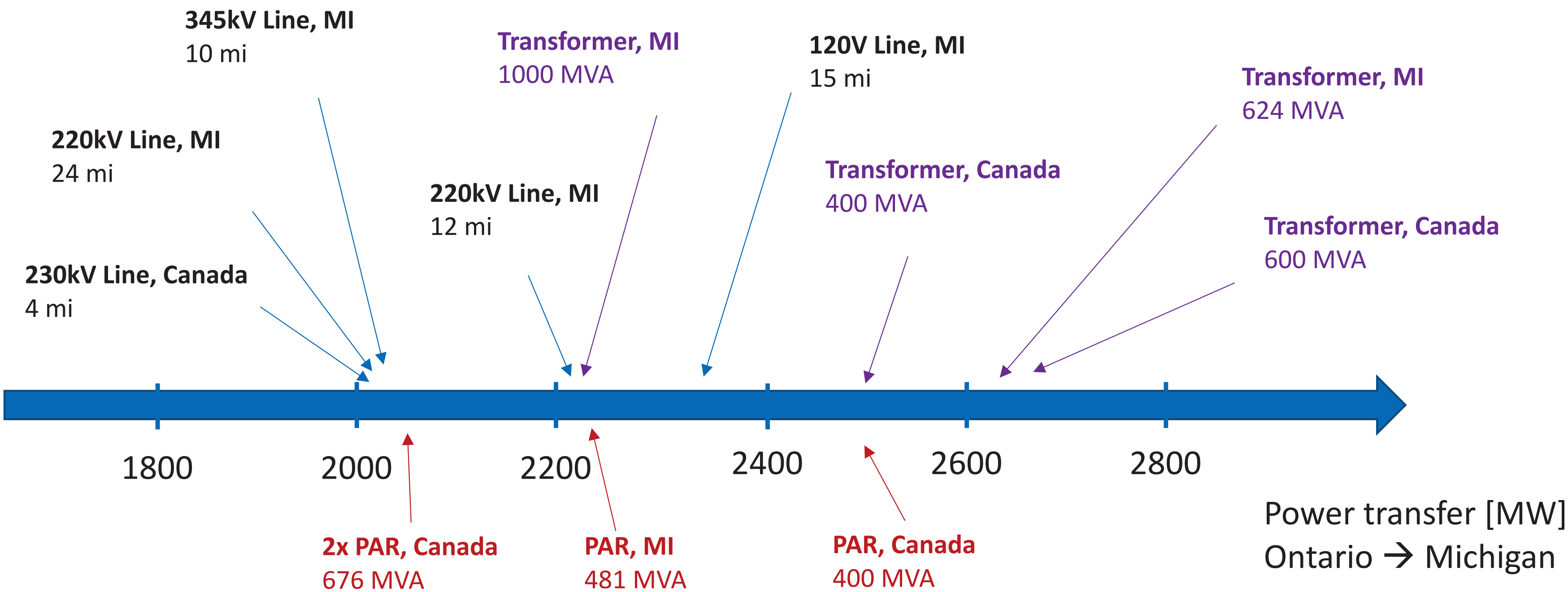


Ontario Export Results, Thermal



PARs themselves, nearby power transformers and lines interconnecting to the PARs become thermally overloaded for at least one contingency beyond 2GW of transfer (IESO → MI)

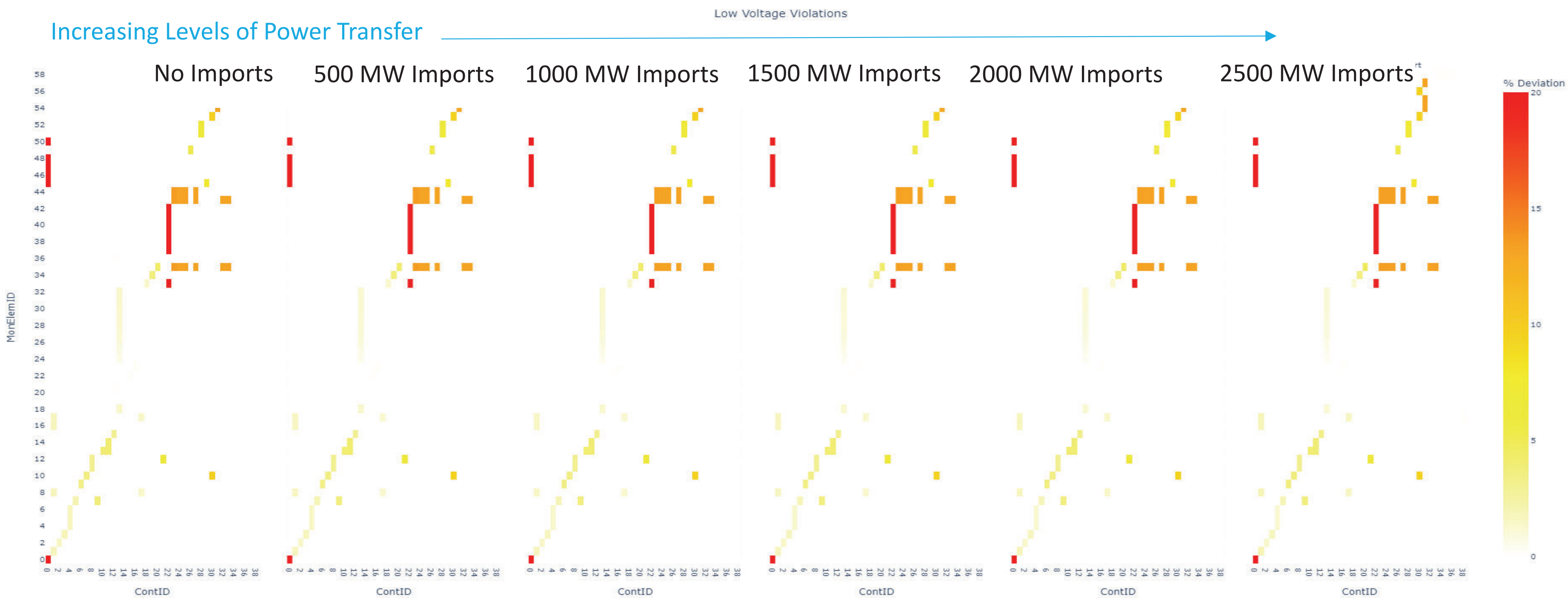
Beyond the PAR limits – MI and Canada Overloads



Ontario Export Results, Voltage

Voltage violations are essentially unchanged as power transfer increases. This is an expected result because:

- Major resources in Detroit remaining online in these scenarios, and
- the addition of voltage-regulating new renewable resources spread throughout the system

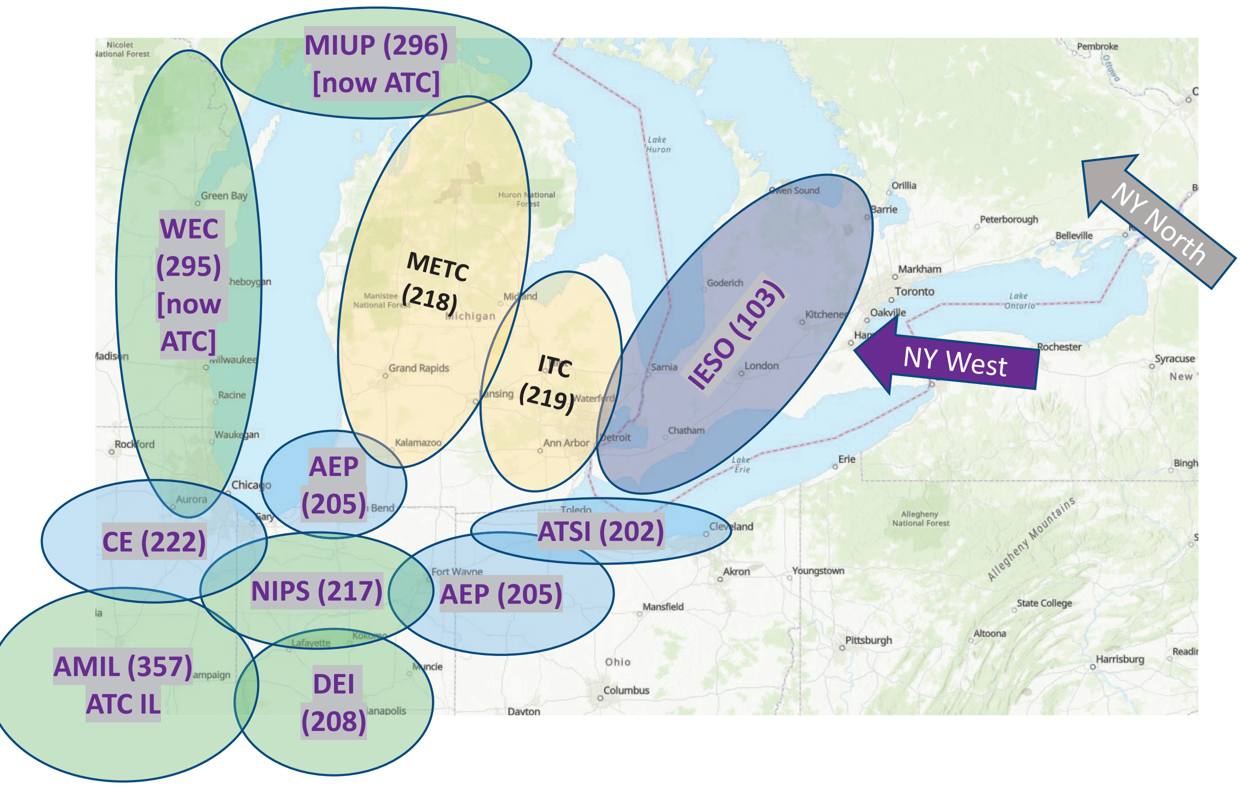


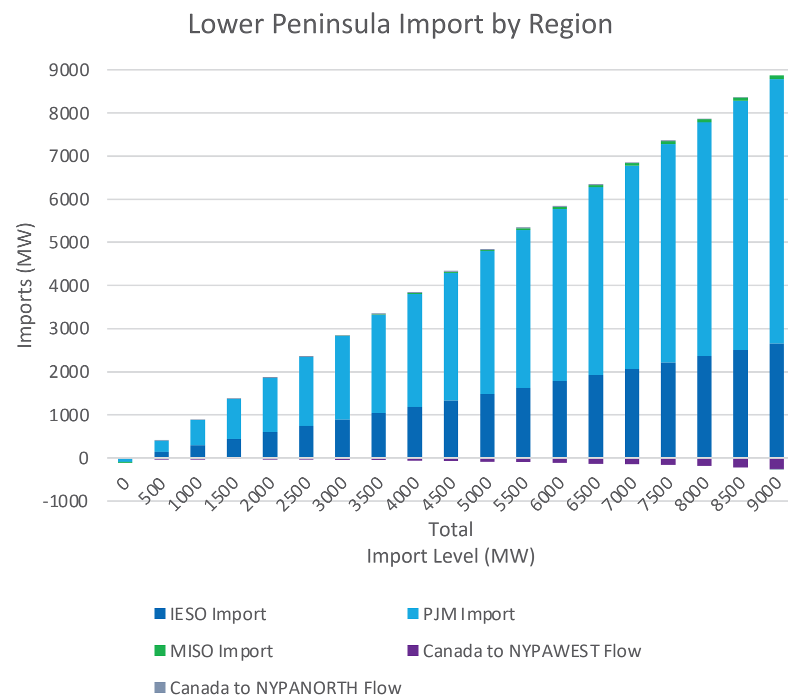
Imports from IESO, PJM, MISO

Regional Power Flow Considerations

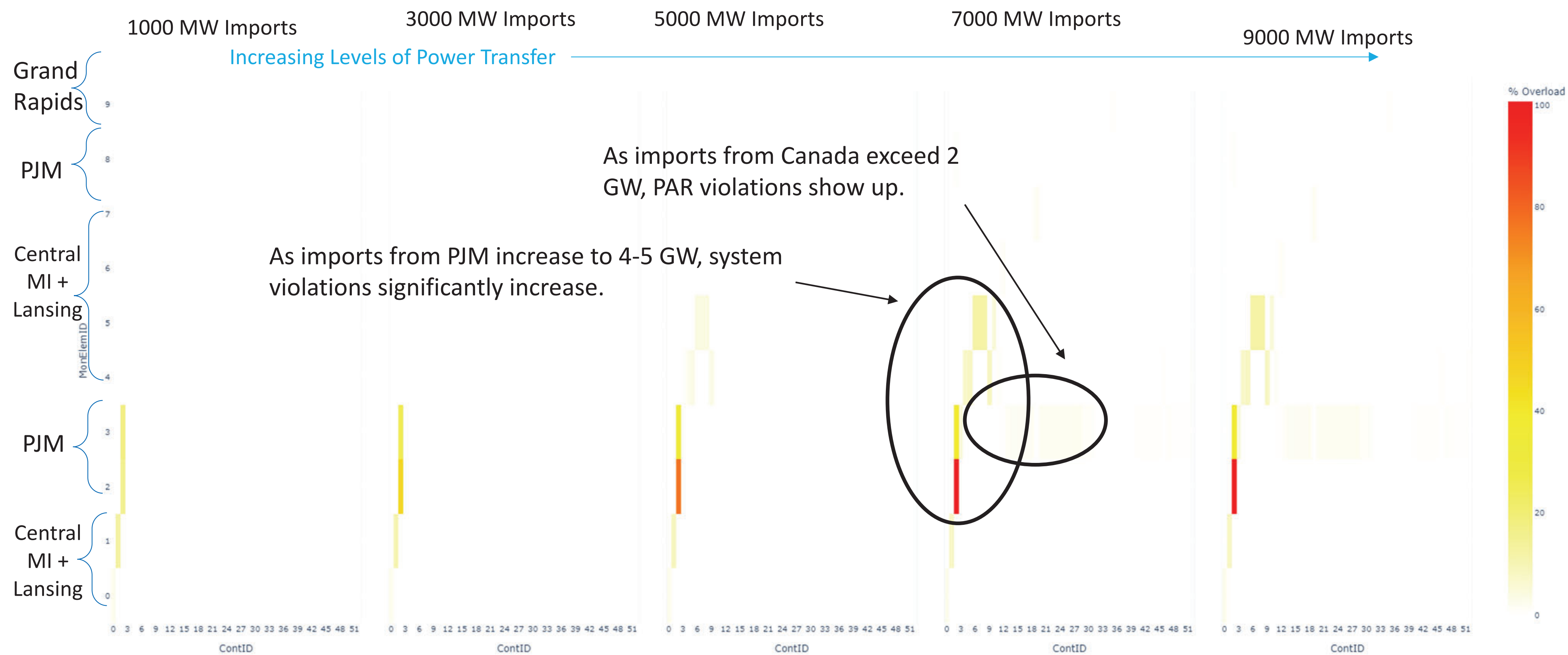
Michigan Imports – All Ties

Power Transfer Proportioning (Initial case: 30% IESO, 70% PJM + MISO)

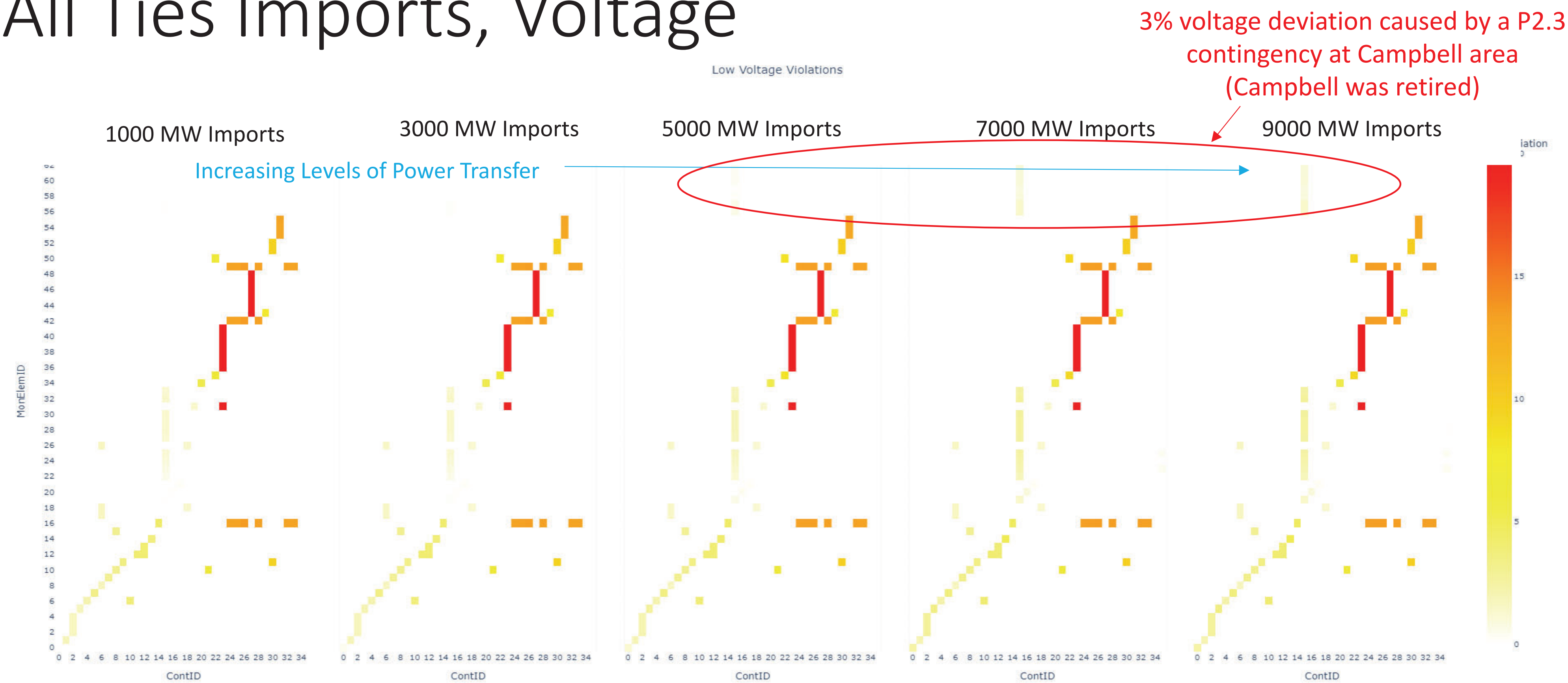




All Ties Imports, Thermal



All Ties Imports, Voltage



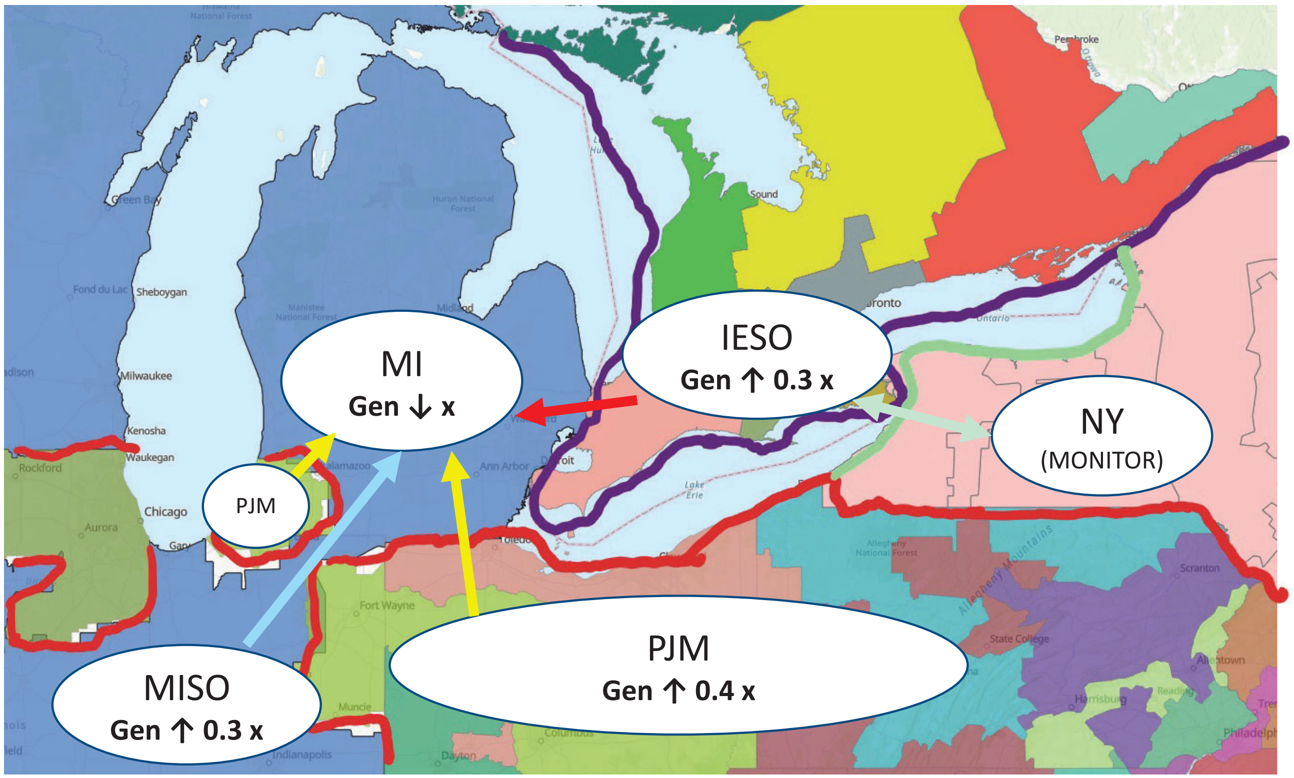
Voltage violations are not a significant constraint in these scenarios

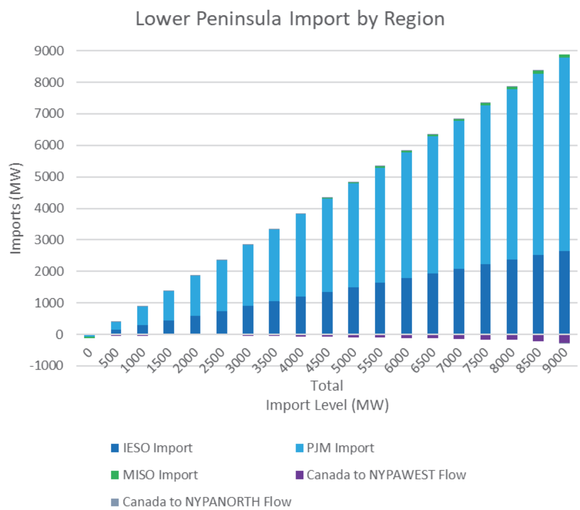
PAR Control Capability

A Closer Look at PAR Tapping

Power Import Balancing Sensitivity

Our Base Case for Driving Power into Michigan

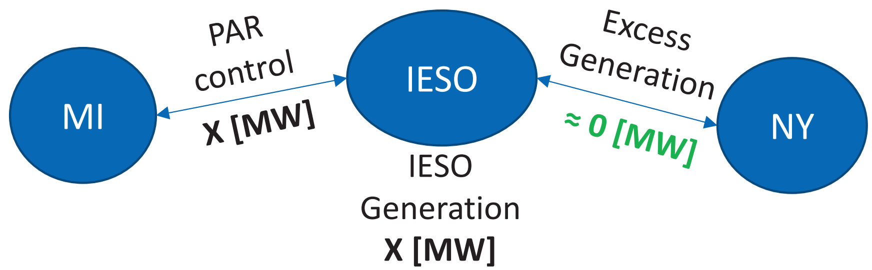




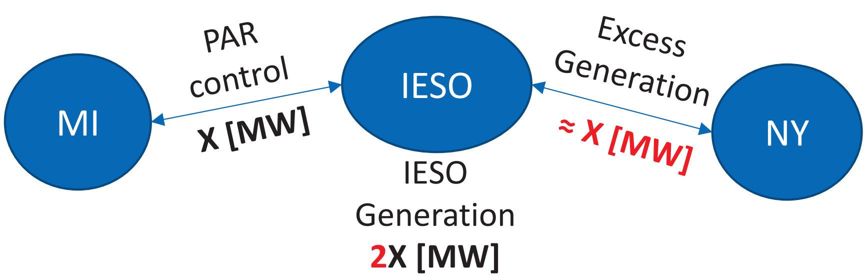
PAR Controllability & Lake Erie Circulation

To assess the impact on the PARs' tapping (controllability) for different regional transfer levels, we looked at 2 sensitivities to the base case:

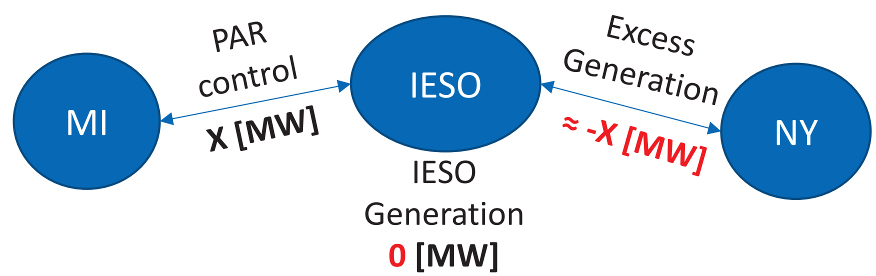
Base Case: Coordinated IESO Generation & PAR Flows



Sensitivity 1: High IESO Exports

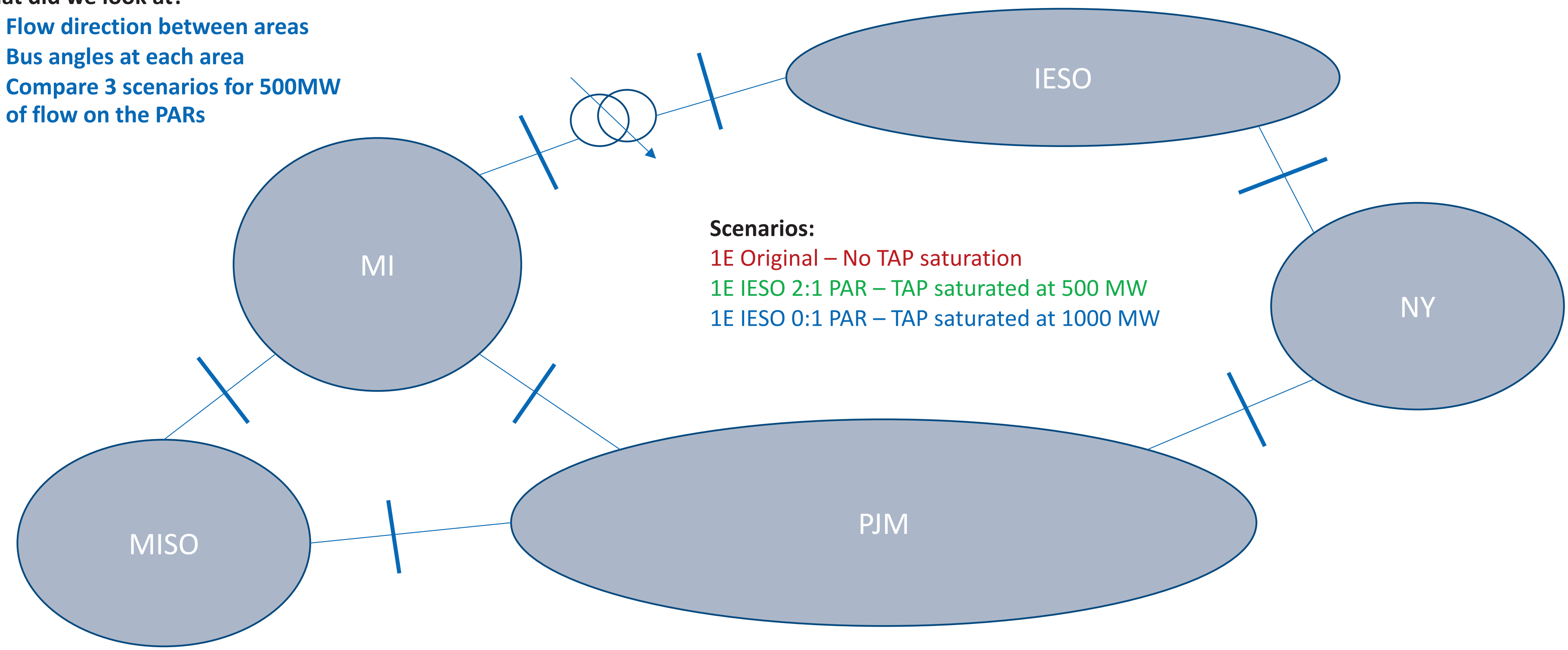


Sensitivity 2: NY Wheeling Power Through IESO



Lake Erie Circulation Findings

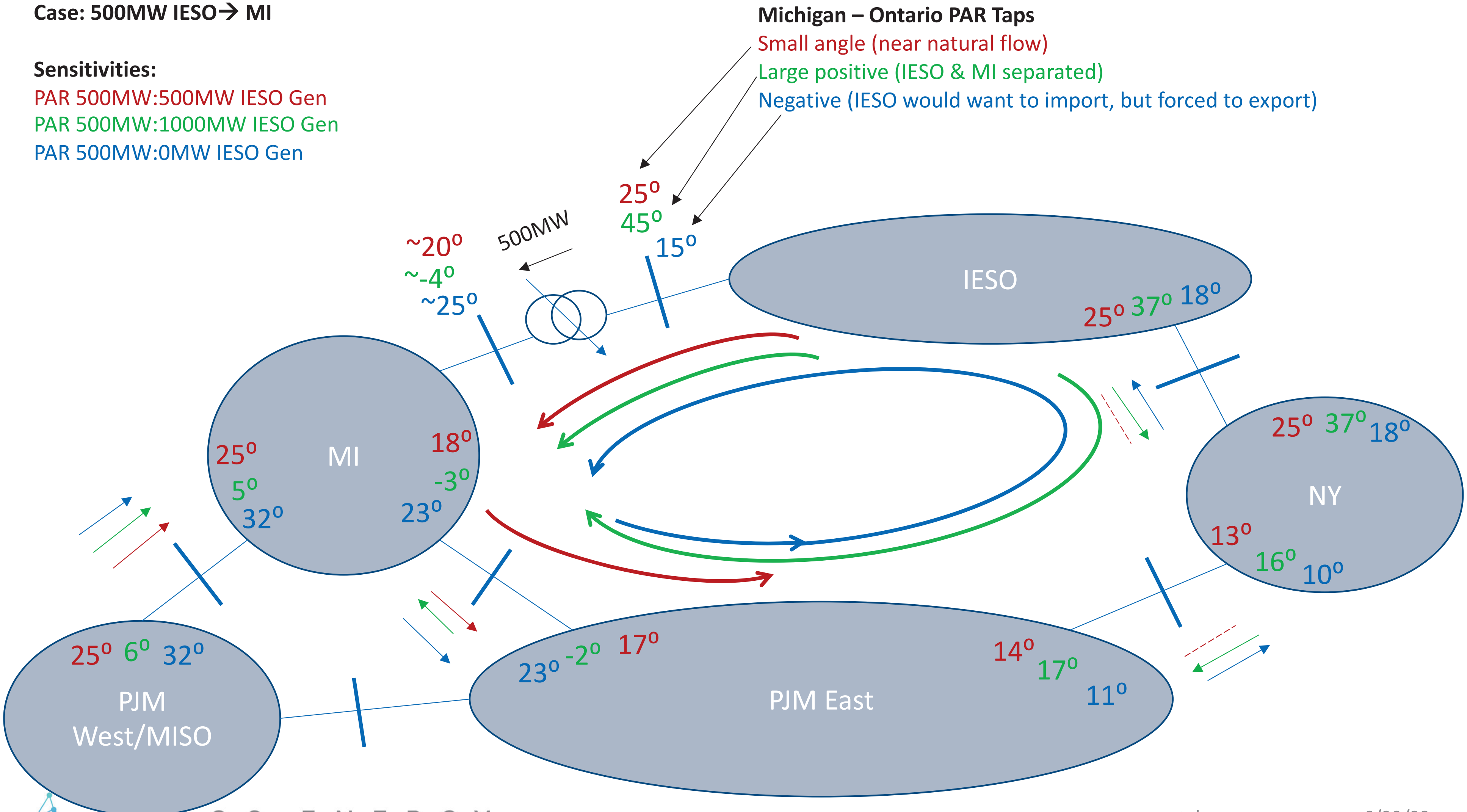
What did we look at?
- **Flow direction between areas**
- **Bus angles at each area**
- **Compare 3 scenarios for 500MW of flow on the PARs**



Scenarios:
1E Original – No TAP saturation
1E IESO 2:1 PAR – TAP saturated at 500 MW
1E IESO 0:1 PAR – TAP saturated at 1000 MW

Case: 500MW IESO→ MI

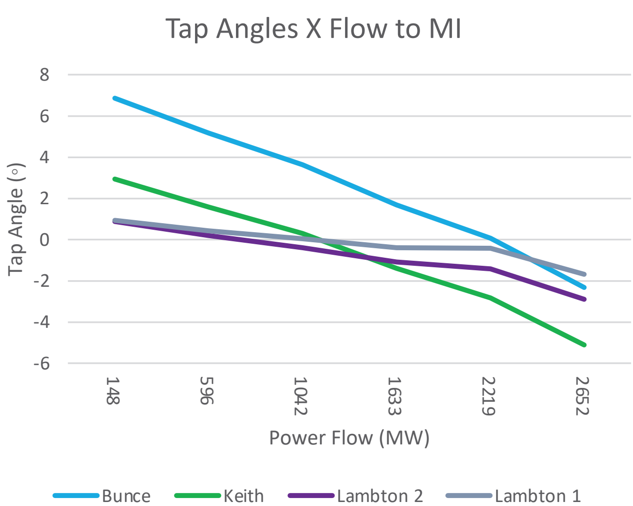
Sensitivities:
PAR 500MW:500MW IESO Gen
PAR 500MW:1000MW IESO Gen
PAR 500MW:0MW IESO Gen



PAR Tap Angle Findings

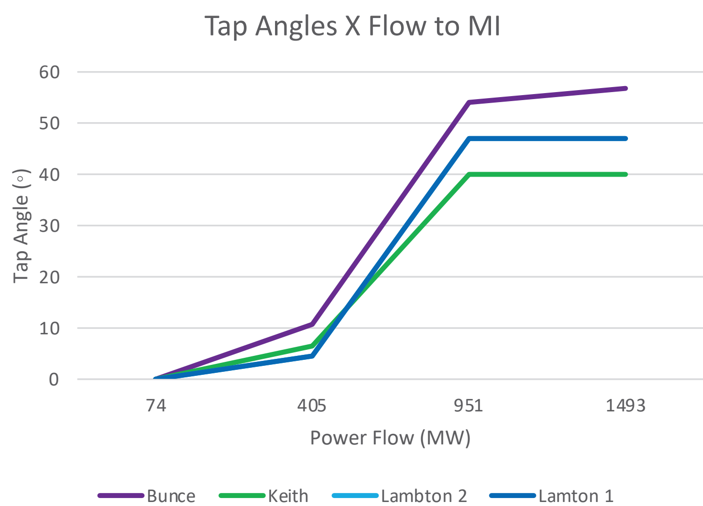
Original Case 1E

- 1:1 balance of PAR flows and change in IESO generation



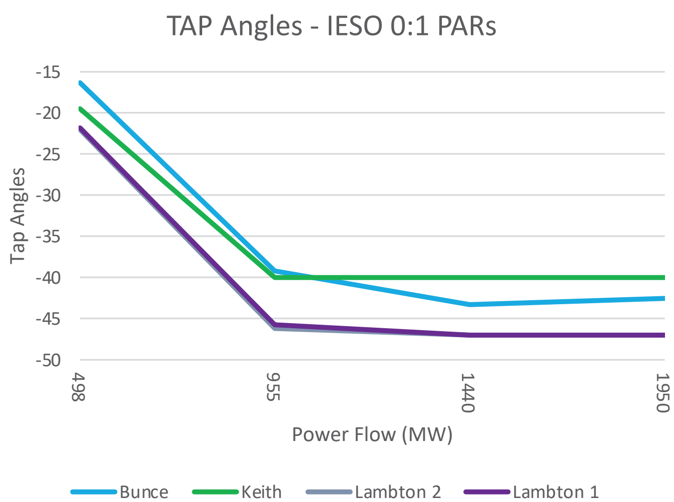
High IESO Generation

- 2:1 change in IESO generation to PAR flows



Low IESO Generation

- 0:1 change in IESO generation to PAR flows



PARs tap (exert control) more when the desired power transfer is farther from the "natural" power transfer level
Therefore, tap control effort is dependent on IESO's net generation/demand

Findings – PARs & LEC

Southwest Ontario is electrically far from Michigan

- Except for the PAR link
- Ontario is quite peninsular on the EI (only a few weak connections back to MISO)

Therefore, the generation in IESO relative to MISO, PJM, NY impacts how the PARs are used (taps needed to reach desired power flow)

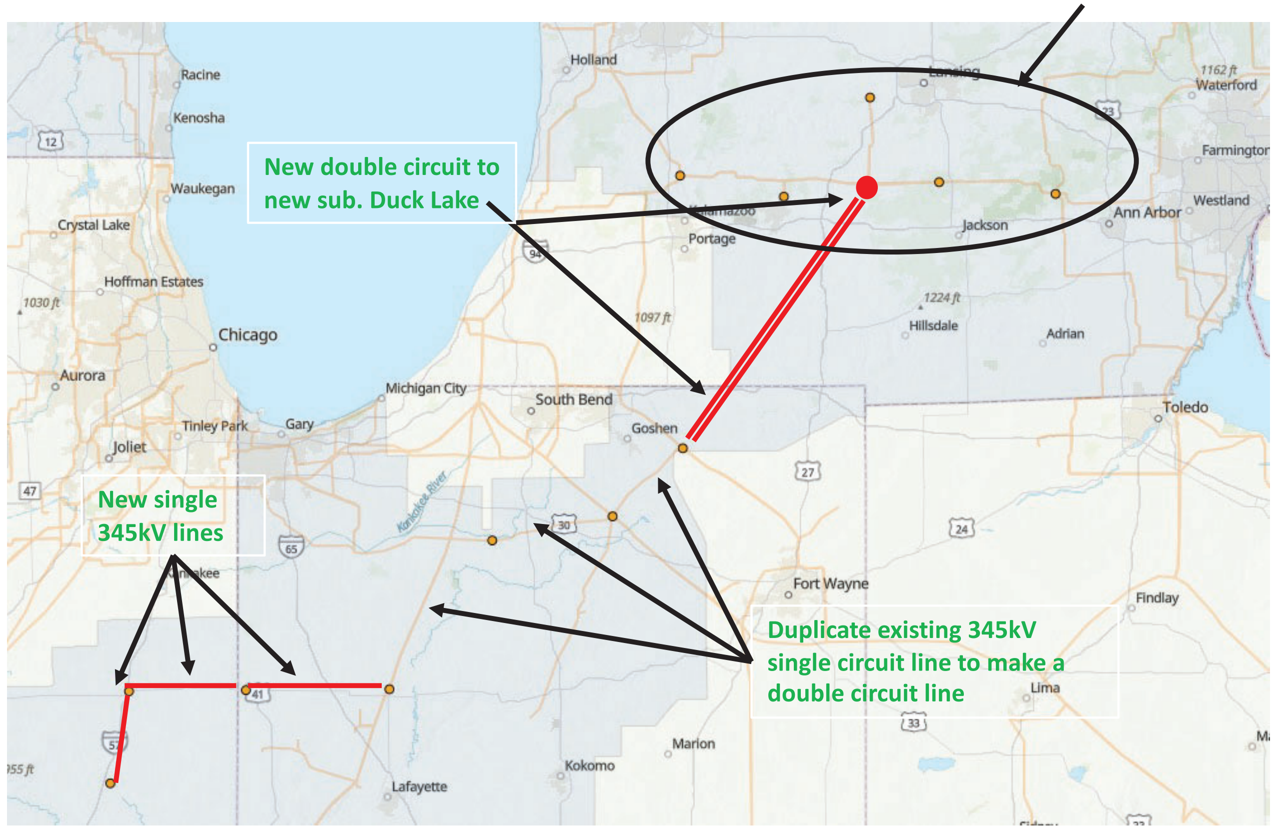
- When IESO is a net gen, the PARs are used to restrain flow
- When IESO is a net load, the PARs can be used for force flow to MI (reverse of the natural flow)

Tranche 1 Sensitivity

Tranche 1 Added, All Regions Importing

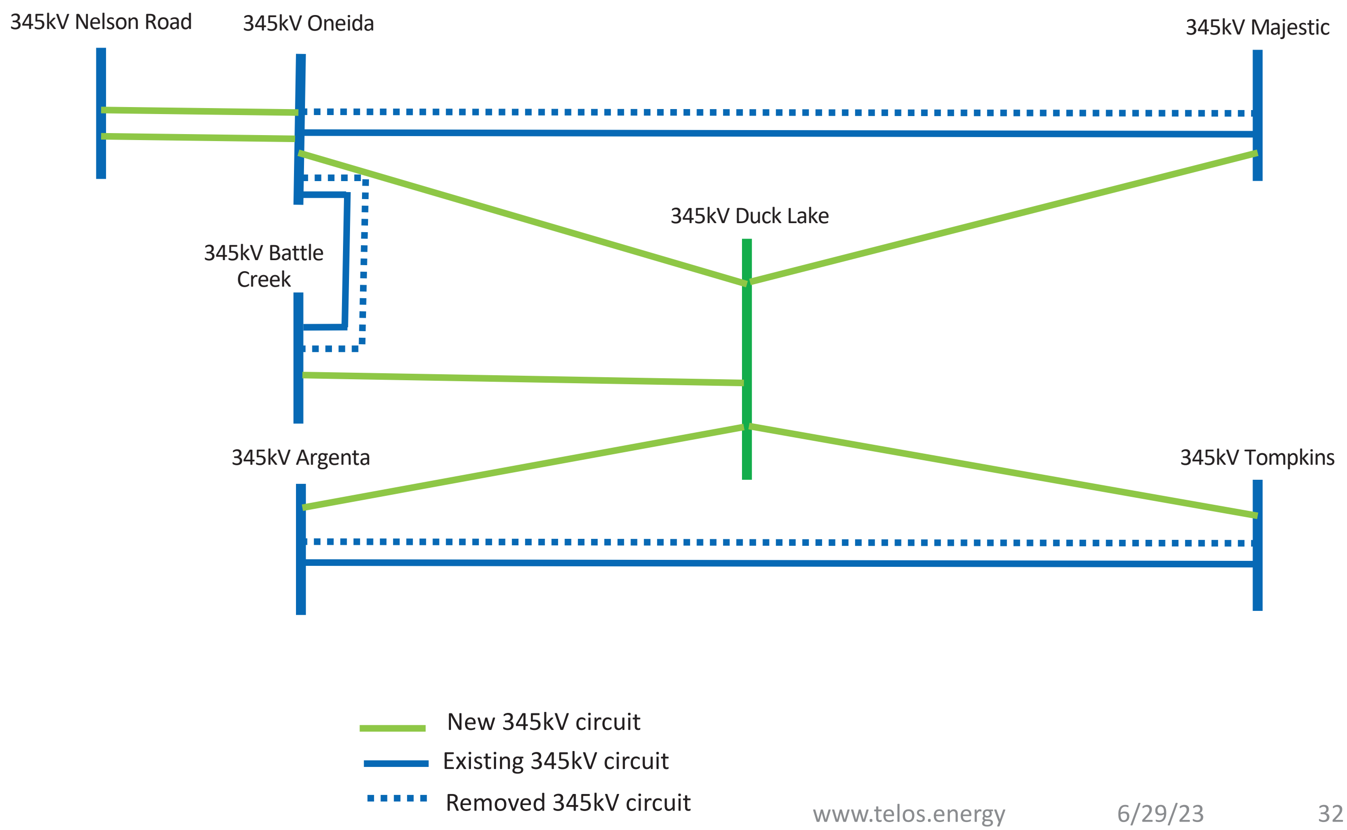
Tranche 1 Representation

- All assumptions and modifications considered for case 1x
- 345kV lines from IN to MI
- 345kV lines from IL to IN
- New substation in MI (Duck Lake) – Added to existing Loop in Argenta-Tompkins, Battle Creek-Oneida, and Oneida-Majestic



Loop in Argenta-Tompkins, Battle Creek-Oneida, and Oneida-Majestic

- Length and ratings of new lines are given in MTEP20 Appendix A
- R, X, and B calculated using length and typical 345kV line parameters

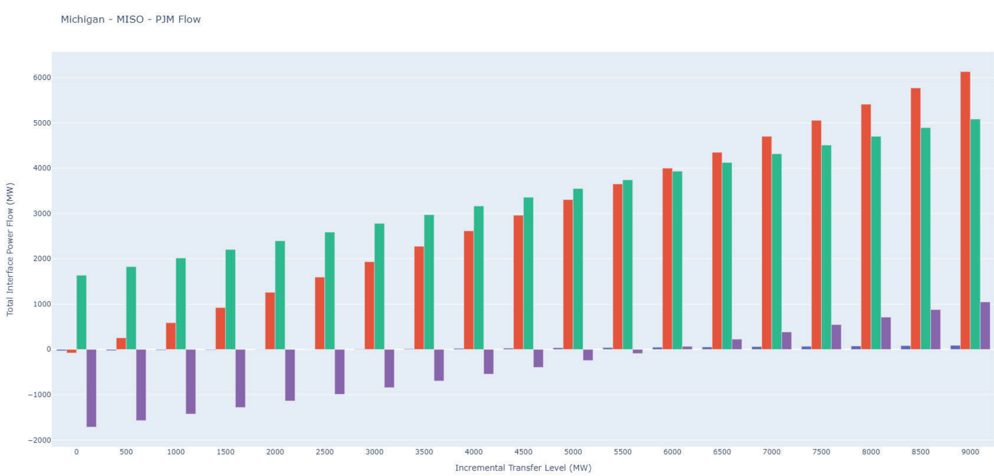


Regional Power Transfers – Tranche 1 Sensitivity

- In our cases, the Tranche 1 double circuit into Michigan is set to transfer about 1 GW of additional power
- The dispatch could have been further adjusted to maximize utilization of the line's thermal capability

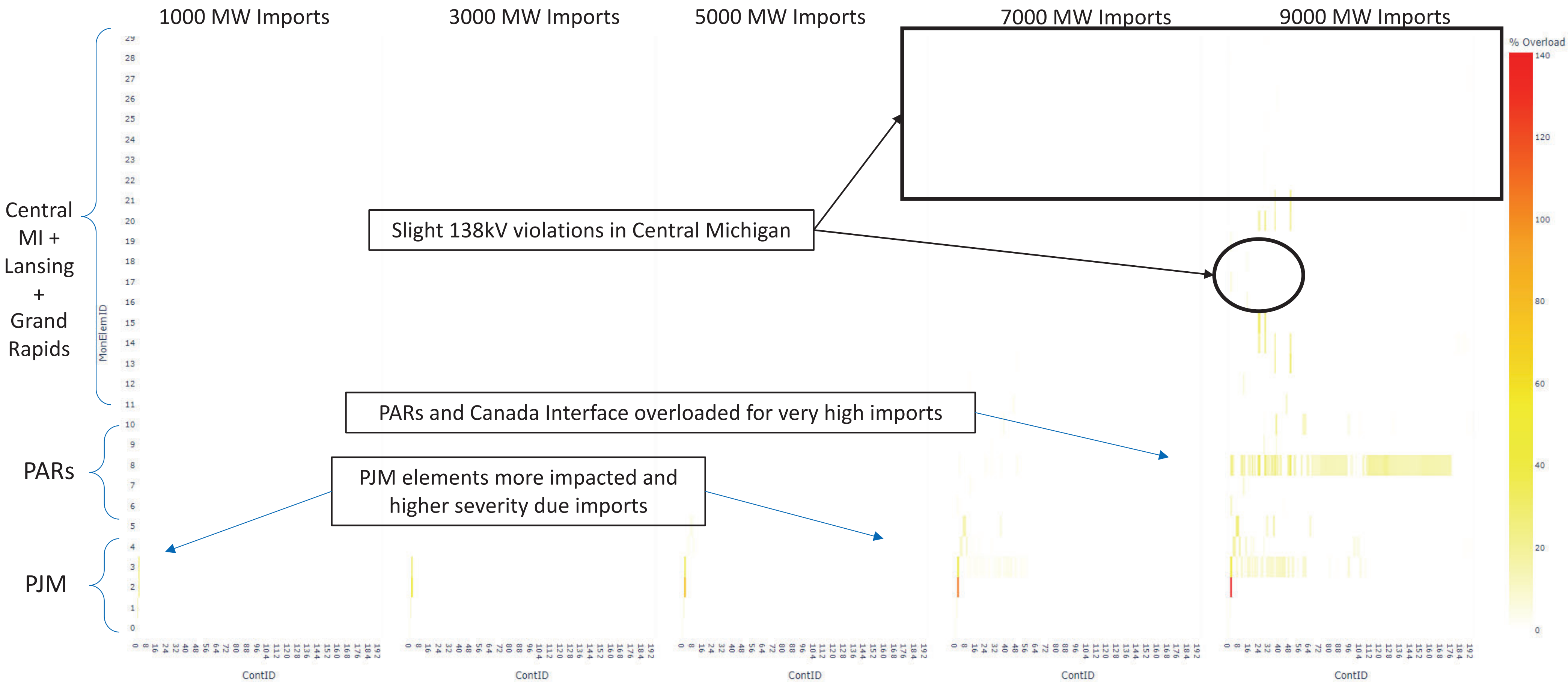
Substation from	Substation to	Length	Rating
Hiple (IN – existing substation)	Duck Lake (MN – new substation)	127 miles	1793 MVA

Regional Power Transfer without Tranche 1

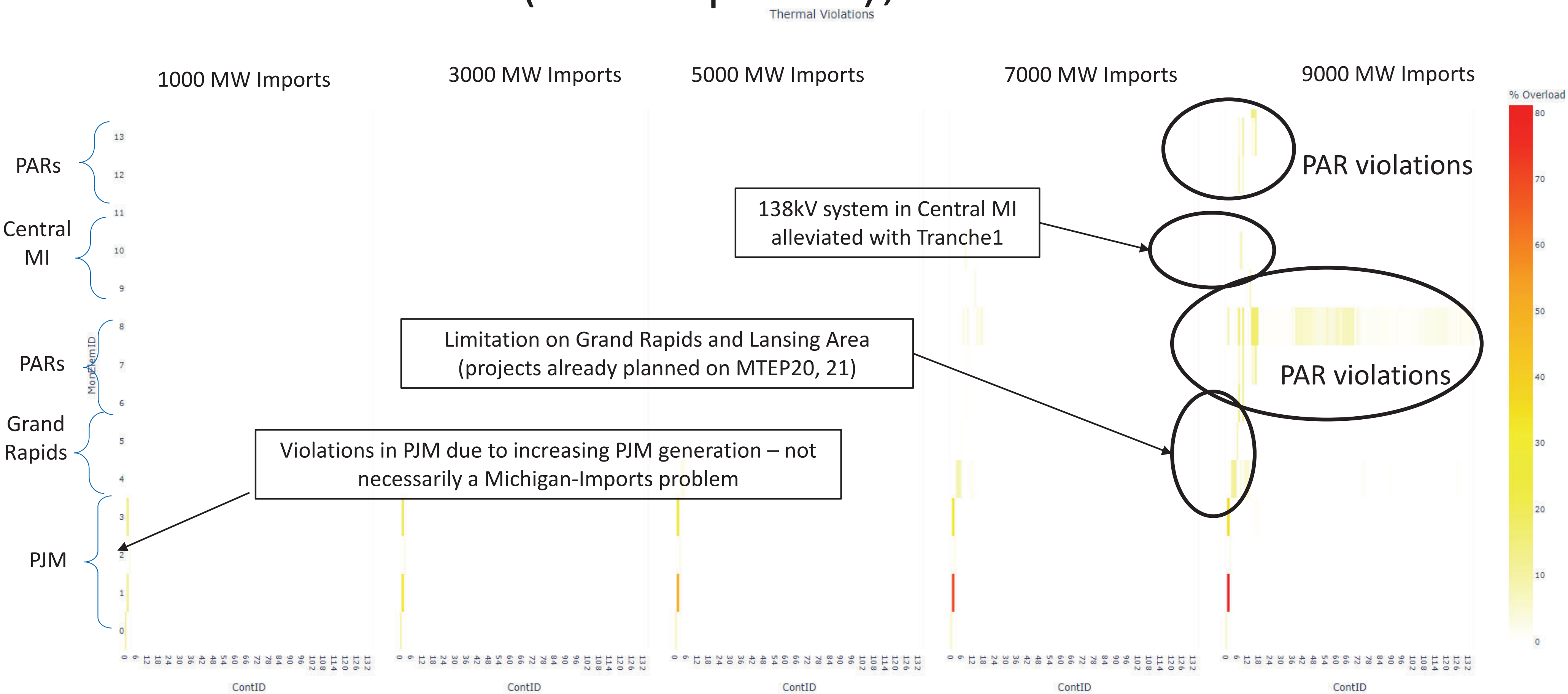


Regional Power Transfer with Tranche 1 Included

Without Tranche 1(All Imports), Thermal



With Tranche 1 (All Imports), Thermal



Thermal Violations, Graphically

Lansing Region:
Violations reduced with Tranche 1 (6 violations were mitigated)

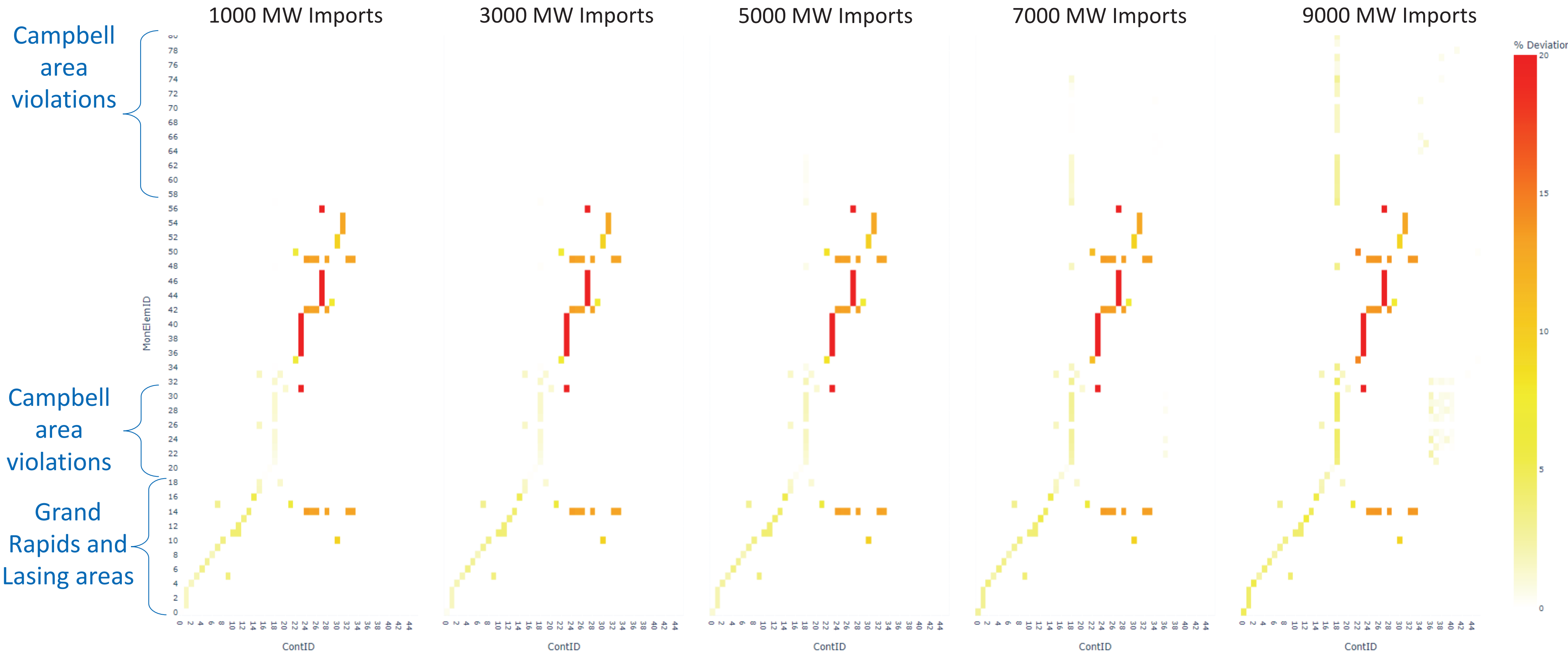
MI-ONT Region:
PARs and lines not impacted by Tranche 1

PJM*:
Some thermal violations mitigated with Tranche 1 (138kV)

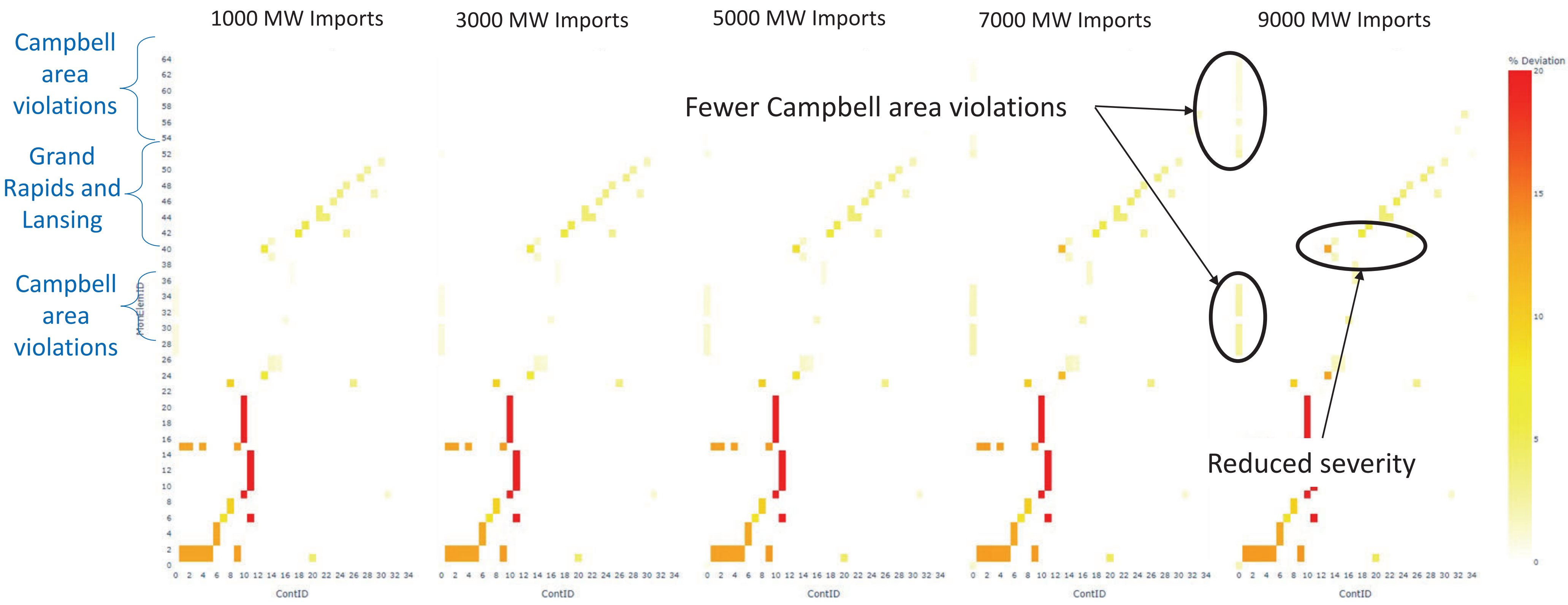
Grand Rapids Region:
Violations reduced with Tranche 1 (5 violations were mitigated)

*The largest violation in PJM is related to generation dispatch, which can be mitigated operationally

Without Tranche 1 (All Imports), Voltage



With Tranche 1 (All Imports), Voltage



Voltage violations are similar for all import levels

Summary of Tranche 1 Impact

- 15 (15 v. 30) fewer thermal violations
- 41 (66 v. 107) fewer voltage violations
- Approximately 800 MW more imports from MISO, which could be nearly 1.7GW if the case is re-dispatched to maximize flow on Tranche 1
- The addition of Tranche 1 enables more imports from PJM and IESO before violations are reached because of its redistribution of import power flows

Topic	Without Tranche 1	With Tranche 1 (800MW Import)
Elements thermally impacted	30	15
Import level with major violations	4.33 GW	6.31 GW
Import level when PAR area is impacted	7 GW	7 GW
Elements with Voltage violations	107	66

Ludington Operations

A Sensitivity to Ludington's Charging/Discharging Operations

Setting up the Ludington Sensitivity

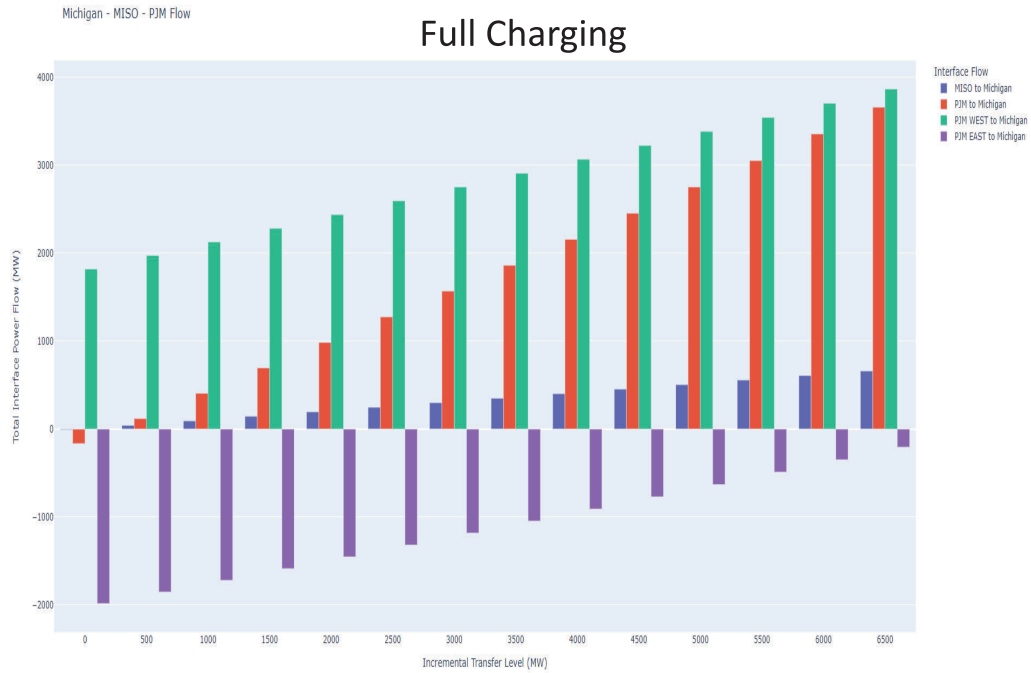
- MISO MTEP summer and shoulder cases had Ludington fully discharging (2.1GW)
- We did a sensitivity on the shoulder case with and without Tranche 1
- We set Ludington to charge at 2.3 GW (full charging)
- To make up the power (net new demand of 4.5 GW):
  - Increased the new renewable generation (installed capacity) to compensate for the 4.5 GW of Ludington
  - This was in addition to making up for the thermal retirement generation

Target	Power Change
Retirements	- 3.89 GW
Ludington	- 4.57 GW
New generation	+ 8.46 GW

Ludington Impact on Imports

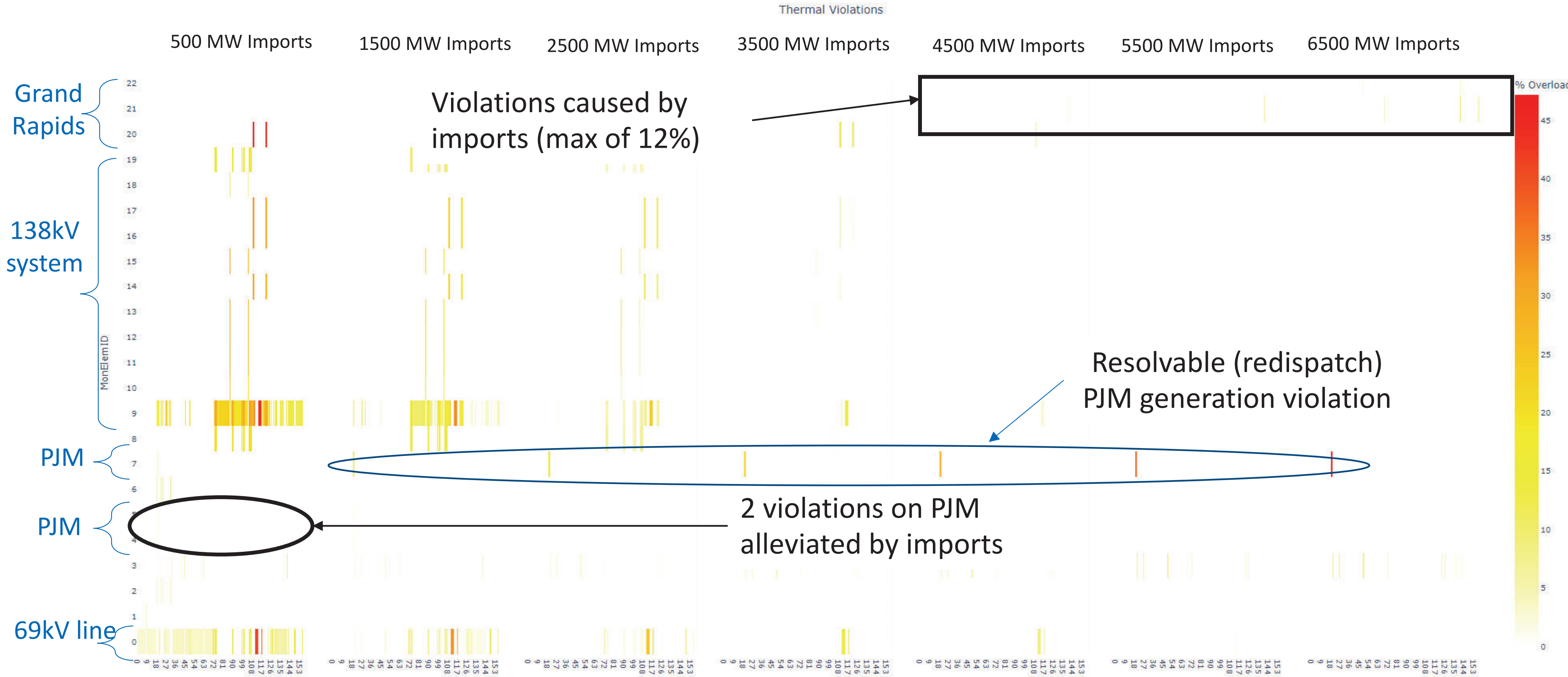
Full Discharging

Full Charging



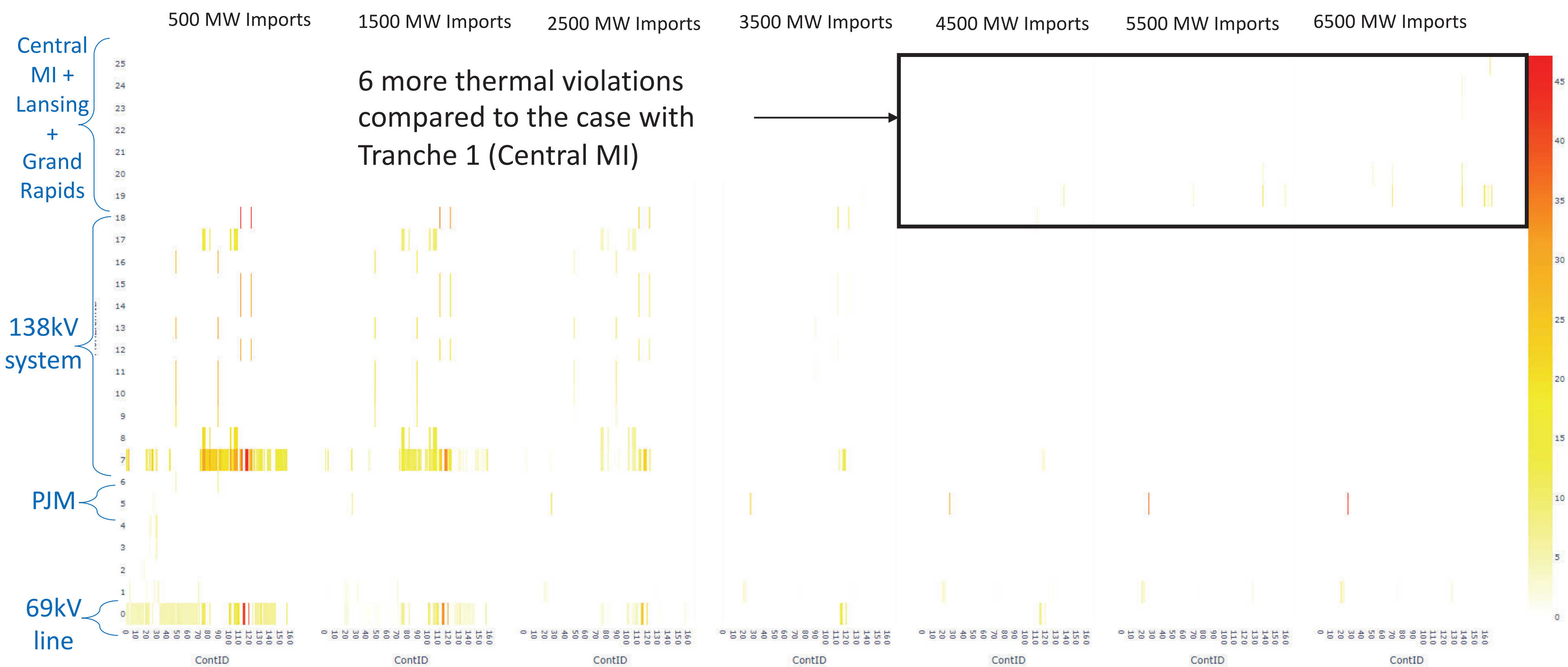
Ludington charging draws incremental power from PJM West

Shoulder Case Imports (Full Charging) – Thermal Violations

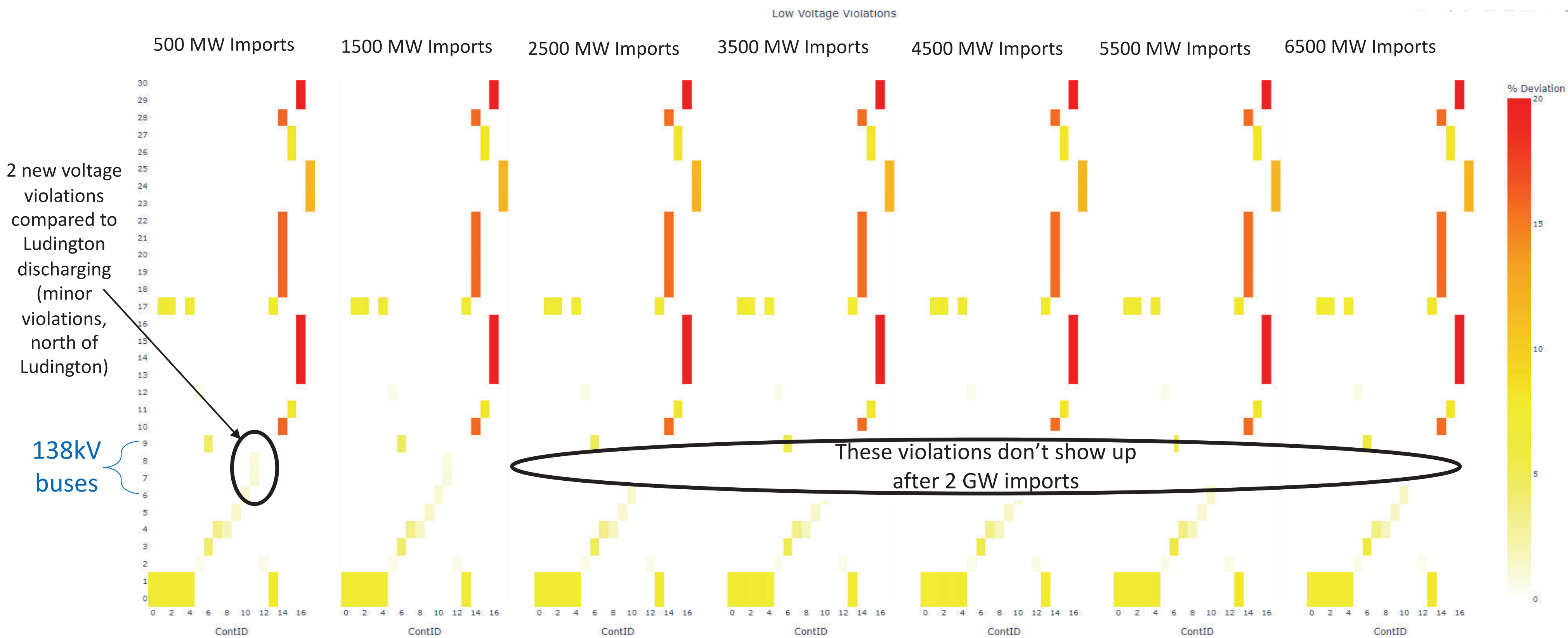


Michigan grid is most stressed when Ludington is charging heavily and generation in SW Michigan is low

Shoulder Case, Tranche 1 Out (Full Charging) – Thermal



Voltage Violations – Ludington Full Charging Shoulder Case



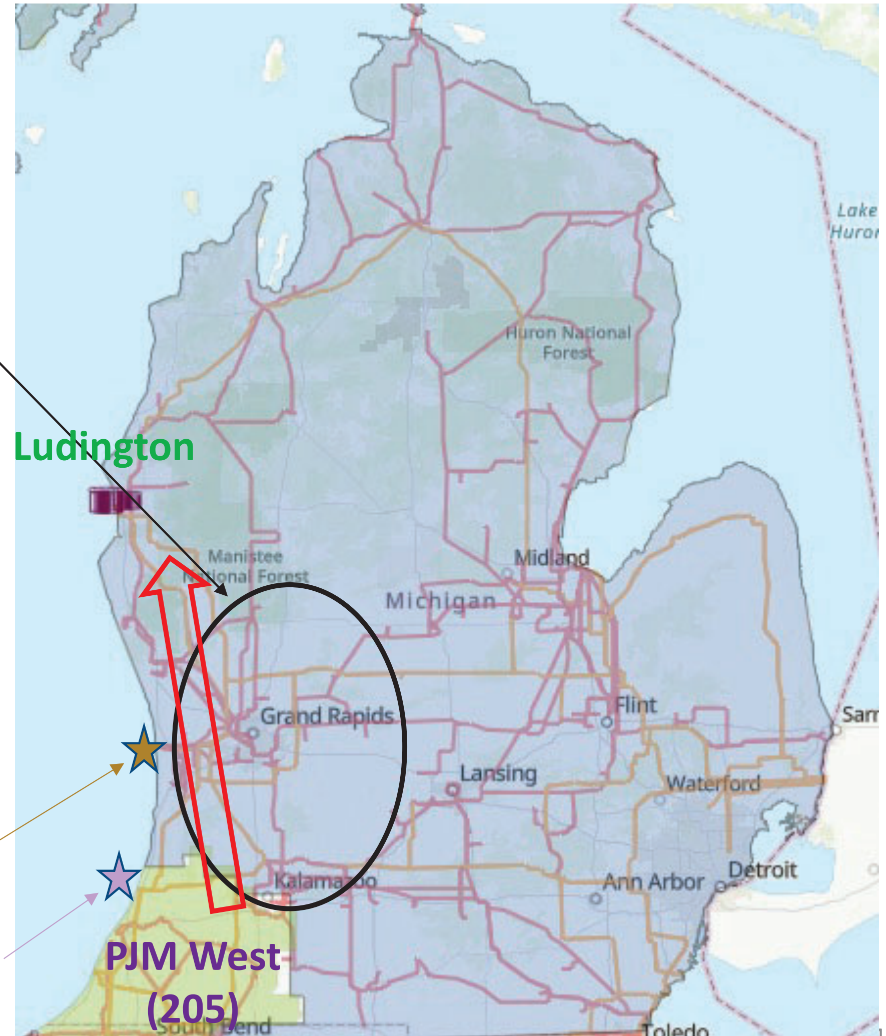
Voltage violations are similar for all import levels

Ludington Charging Impact

Thermal violations increase in the Grand Rapids region when charging is high and generation in SW MI is low

Shoulder Case	Count of elements thermally impacted	Count of elements with voltage impacted
Tranche 1 Out Ludington Discharging	17	29
Tranche 1 In Ludington Discharging	11	29
Tranche 1 Out Ludington Charging	29	33
Tranche 1 In Ludington Charging	25	32

- Voltage violations are slight, north of Ludington
- Tranche 1 has a modest positive impact on violations in the Grand Rapids region



Campbell Plant is Out

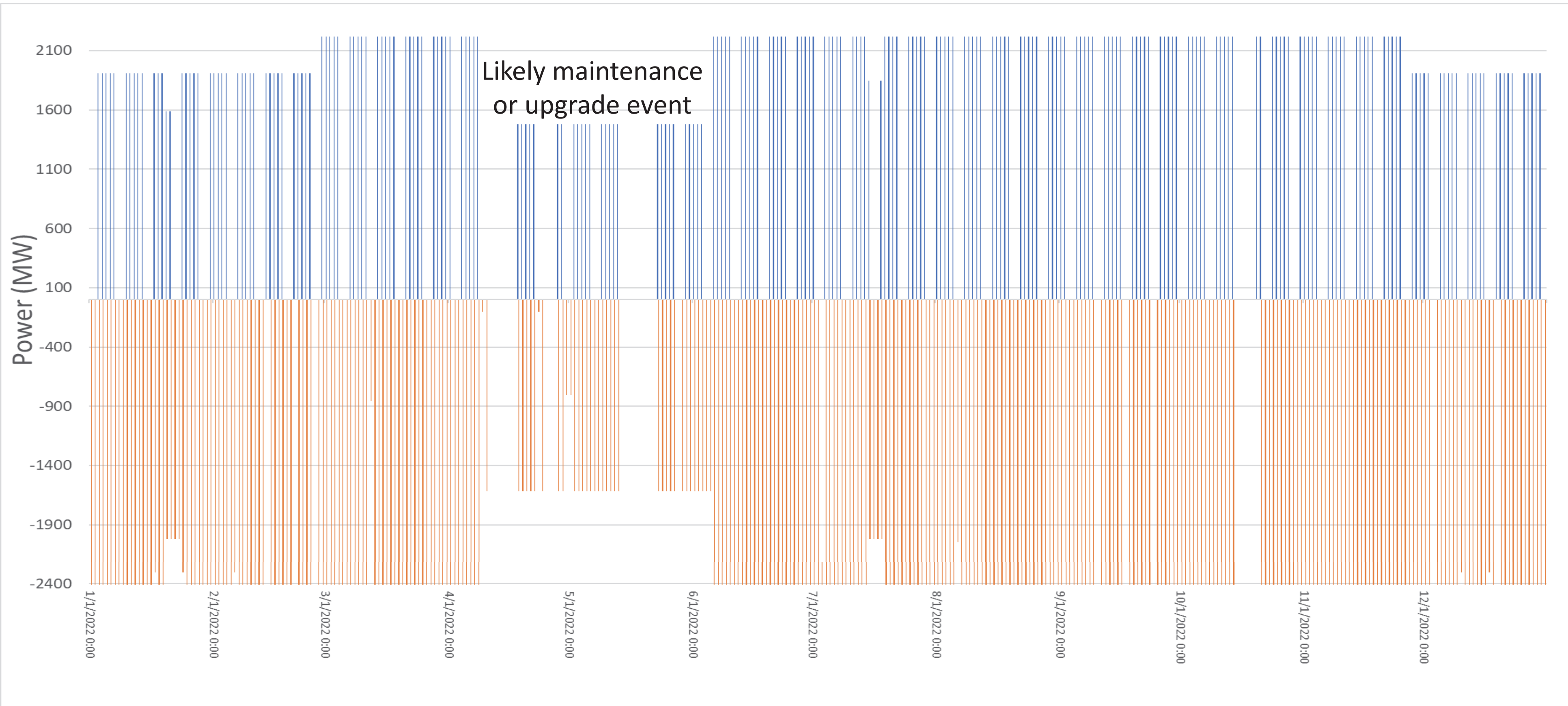
Palisades Plant is Out

TELOS ENERGY

Ludington Historical Data

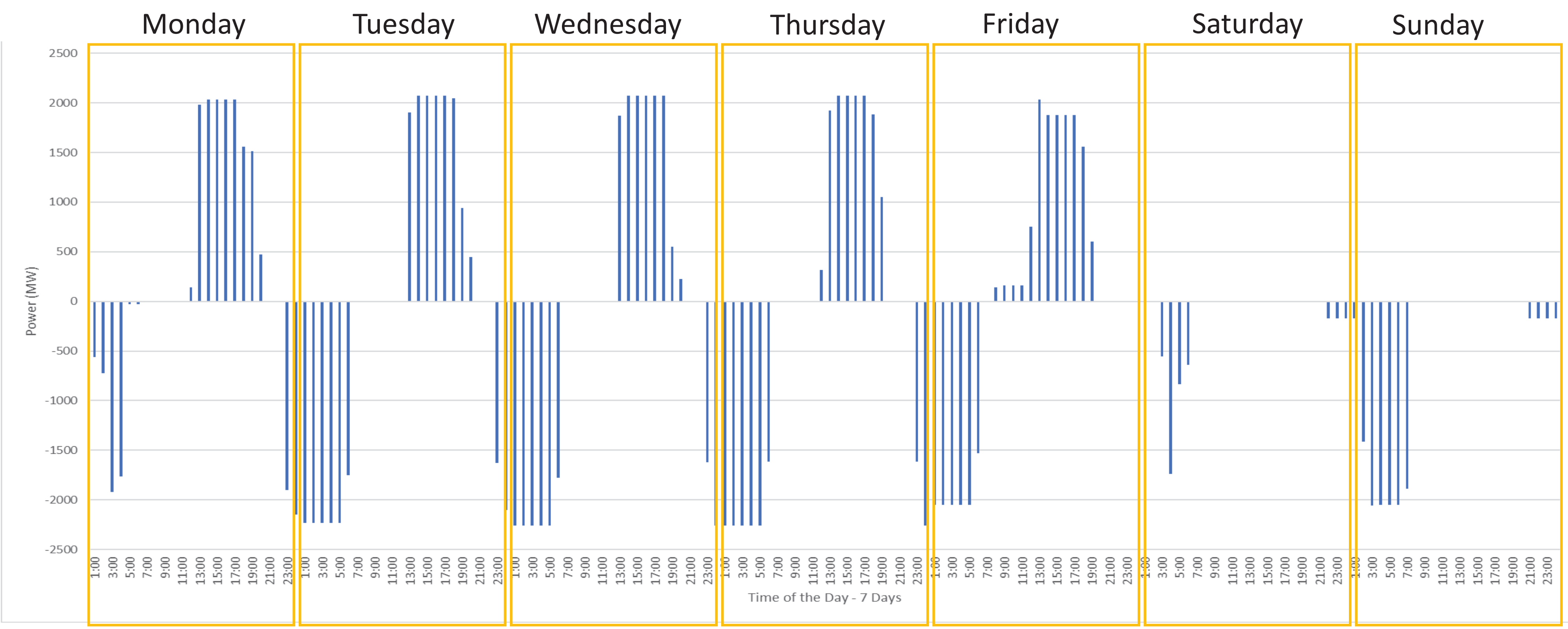
Analysis of Charging/Discharging Patterns

Ludington Operation Data - 2022



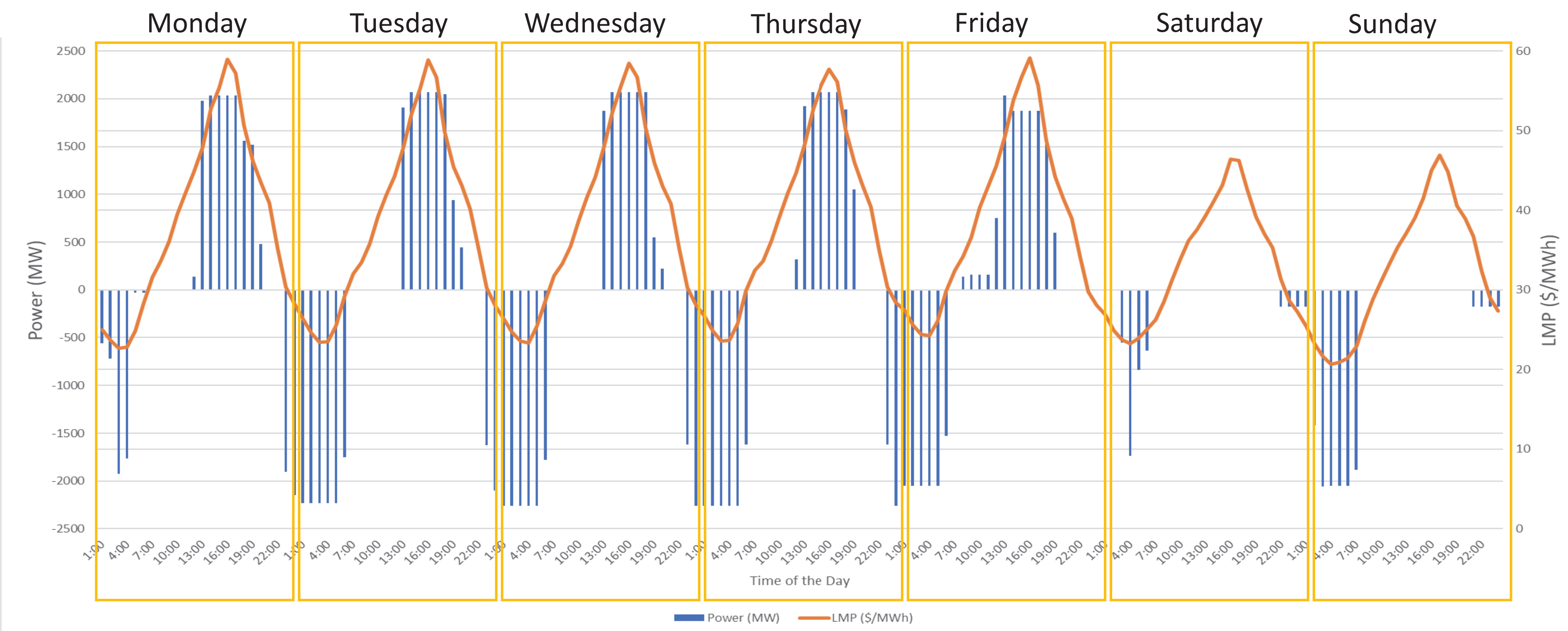
Ludington Summer Average Week

Summer 2022 (June 20 – Sep 20) Average
Discharging: Afternoon and early evening weekdays
Charging: Overnights, lighter on weekends



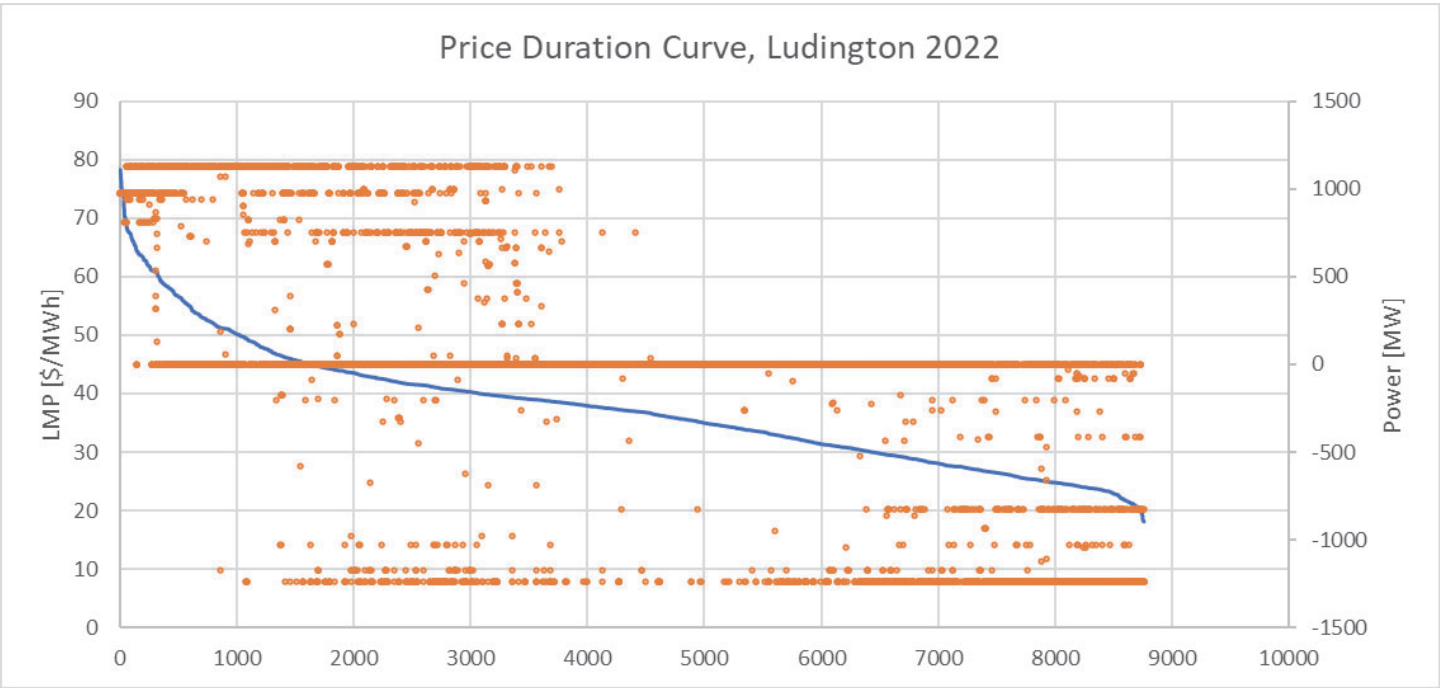
Ludington Summer with LMP

Summer 2022 (June 20 – Sep 20) Average (hour-by-hour average)



Ludington Price Duration Curve with Operations

No significant discontinuities in the price duration curve
Operations generally reflects an arbitrage between weekday evenings (high prices) and nighttime (low prices)



Transmission Analysis Summary

Power Import Capability to Lower Michigan

Summary of Transmission Analysis (1)

Benchmarking Findings

- MISO CIL/CEL: Different constraints were identified, likely because of lots of existing thermal gens (Trenton & St Clair) online, over all the ~4GW import is in the ballpark
- MISO Appendix A: Many thermal violations we've found have been noted and proposed to be addressed

Power Imports to Michigan

- The major path of power transfer to Michigan is PJM West
- By increasing the generation in the MISO region, the power is transferred to Michigan through PJM
- It is possible to import ~4 GW without excessive thermal violations
- The biggest thermal limitations are
  - PARs, given an assumed participation factor
  - PJM, violations driven by increasing PJM generation
- Voltage violations did not increase much with imports (Note: No major Detroit area retirements assumed)

Summary of Transmission Analysis (2)

Michigan/Canada Transfer

- The only connection of Ontario to MISO are the four PARs in the Detroit area
- It is possible to import ~2 GW from Canada; rating of transmission lines is similar to PAR ratings
- SW Ontario is expected to have substantial load growth by 2030 – several new transmission projects planned
- Ontario is quite peninsular on the EI; Southwest Ontario is electrically far from Michigan
- Therefore, the generation in IESO relative to MISO, PJM, NY impacts how the PARs are used (taps needed to reach desired power flow)
  - When IESO is a net gen, the PARs are used to restrain flow
  - When IESO is a net load, the PARs can be used for force flow to MI (reverse of the natural flow)

Interregional Transfers, Particularly ISO Seams

- Increasing interregional power transfers will likely require evaluating transmission contingencies not only at the seams (as is done today), but also contingencies across the border from the primary study region
- This may cause some additional overlap in the contingency analysis but would help capture constraints on imports/exports due to contingencies in a different region or ISO

Summary of Transmission Analysis (3)

Tranche 1

- Tranche 1 enabled 1GW of imports from MISO territory
- Considering all the interface imports, it is possible to import 6.3 GW without major violations (>2 GW more than without Tranche 1)
- Tranche 1 is effective in mitigating some thermal violations near Lansing and PJM
- Voltage violations are essentially unchanged
- The addition of Tranche 1 helps reduce the violations (system stress) when Ludington is charging

Ludington Operation

- When Ludington is fully charging, a power deficit is created in the area, which Michigan's generation is not capable of supplying, especially in N-1 operation
- With more imports from PJM, thermal overloads caused by Ludington operation are reduced and even mitigated in some cases
- Voltage violations are essentially unchanged
- Tranche 1 has a positive impact on thermal violations, reducing overloads in Central Michigan (Thermal violations caused by larger imports decreased from 8 to 2, which were around 6% lower)

MISO

LRTP Tranche 1 Portfolio Detailed Business Case

June 25, 2022

Summary

- Long Range Transmission Planning (LRTP) addresses the future challenges of the resource fleet evolution
- The LRTP Detailed Business Case summarizes the analysis of the reliability and economic benefits used to demonstrate that the value exceeds the total cost of the projects and supports recommendation of the portfolio
- The LRTP Tranche 1 portfolio provides a total 20-year present value benefit to cost ratio of 2.6

MISO Transmission Planning Objectives

- The goal of MISO Planning is to identify and support development of transmission infrastructure that is sufficiently robust to meet reliability needs and support a competitive energy market, policy goals and competitive transmission development
- MISO Board of Directors Guiding Principles
  - Ensure a reliable and resilient transmission system to meet operational needs
  - Make benefits of an economically efficient electricity market available to customers by identifying transmission solutions that enable access to the electricity at the lowest total electric system cost
  - Support federal, state and local energy policy and member goals by planning for access to a changing resource mix
  - Provide an appropriate cost allocation mechanism that ensures that costs are allocated in a manner roughly commensurate with the projected benefits
  - Analyze system scenarios and make results available to energy policy makers and stakeholders to provide context and inform their choices
  - Coordinate planning process with neighbors and work to eliminate barriers to reliable and efficient operations

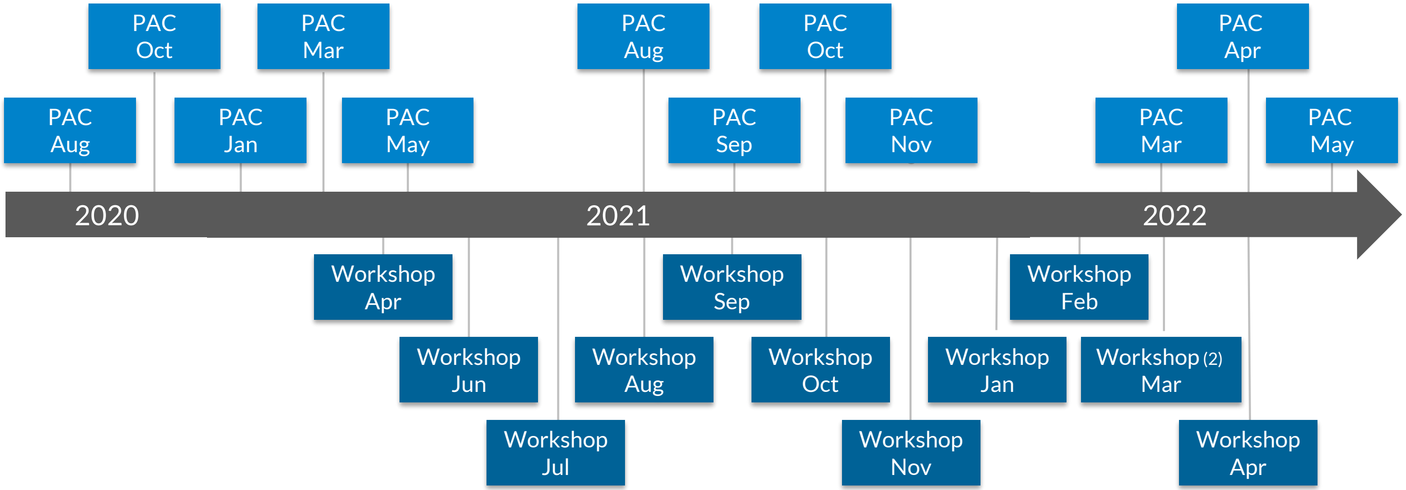
Long range focus on system planning needed in response to unprecedented industry changes

- The initial 2019 MISO Forward report began to examine industry trends around resource and technology developments that highlighted growing challenges around resource availability, flexibility and visibility of the resource fleet in meeting future energy needs
- The Renewable Integration Impact Assessment explored challenges of increased renewable penetration and identified significant reliability issues that would need to be addressed through possible reinforcements to maintain robust performance
- In recognition of the need for more long-term proactive planning to meet the pace of change, Long Range Transmission Planning began with a conceptual roadmap of ideas to help guide development of planning analysis that would be needed to identify possible transmission solutions

Timeline of LRTP development

- MISO introduced the LRTP conceptual roadmap to stakeholders in June 2020 to begin discussions on the study scope and approach
- MISO began a series of technical discussions in Aug 2020 to seek input from stakeholders on the study methods and assumptions and to provide regular status updates on the ongoing work and analysis findings
- MISO initiated discussions on cost allocation mechanisms with the Regional Expansion Criteria and Benefits Working Group in Feb 2021 to investigate possible Tariff changes that would be needed before recommendation of projects
- MISO introduced Business Case development in the Sept 2021 LRTP workshop to begin identifying the benefit components and defining the metrics for quantifying the benefits provided by the initial portfolio of LRTP transmission investments

Workshops and Stakeholder feedback are critical to the LRTP process and success



LRTP Projects must meet one of three MVP criteria defined in the MISO Tariff

MISO Tariff - Attachment FF, II.C.2…

a. *Criterion 1. A Multi-Value Project must be developed through the transmission expansion planning process for the purpose of enabling the Transmission System to reliably and economically deliver energy in support of documented energy policy mandates or laws that have been enacted or adopted through state or federal legislation or regulatory requirement that directly or indirectly govern the minimum or maximum amount of energy that can be generated by specific types of generation. The MVP must be shown to enable the transmission system to deliver such energy in a manner that is more reliable and/or more economic than it otherwise would be without the transmission upgrade*

b. *Criterion 2. A Multi-Value Project must provide multiple types of economic value across multiple pricing zones with a Total MVP Benefit-to-Cost ratio of 1.0 or higher where the Total MVP Benefit -to-Cost ratio is described in Section II.C.7 of this Attachment FF. The reduction of production costs and the associated reduction of LMPs resulting from a transmission congestion relief project are not additive and are considered a single type of economic value.*

c. ***Criterion 3. A Multi-Value Project must address at least one Transmission Issue associated with a projected violation of a NERC or Regional Entity standard and at least one economic-based Transmission Issue that provides economic value across multiple pricing zones. The project must generate total financially quantifiable benefits, including quantifiable reliability benefits, in excess of the total project costs based on the definition of financial benefits and Project Costs provided in Section II.C.7 of Attachment FF.***

The MISO MVP Tariff further defines the 'specific types of economic value' which may be included

MISO Tariff - Attachment FF, II.C.5...

a. *Production cost savings where production costs include generator startup, hourly generator no-load, generator energy and generator Operating Reserve costs. Production cost savings can be realized through reductions in both transmission congestion and transmission energy losses. Productions cost savings can also be realized through reductions in Operating Reserve requirements within Reserve Zones and, in some cases, reductions in overall Operating Reserve requirements for the Transmission Provider.*

b. *Capacity losses savings where capacity losses represent the amount of capacity required to serve transmission losses during the system peak hour including associated planning reserve.*

c. *Capacity savings due to reductions in the overall Planning Reserve Margins resulting from transmission expansion.*

d. *Long-term cost savings realized by Transmission Customers by accelerating a long-term project start date in lieu of implementing a short-term project in the interim and/or long-term cost savings realized by Transmission Customers by deferring or eliminating the need to perform one or more projects in the future.*

e. *Any other financially quantifiable benefit to Transmission Customers resulting from an enhancement to the transmission system and related to the provisions of Transmission Service.*

The objective of LRTP is to enable reliable and economic delivery of energy in the future with lower-carbon resources

- Provide a cost-effective solution to allow future resources to serve load throughout the footprint
- Enable access to lower-cost energy production
- Provide more flexibility in fuel mix for customer choice
- Maintain robust and reliable performance in future conditions with greater uncertainty and variability in supply

The scope of LRTP business case analysis includes quantifying the reliability and economic benefits

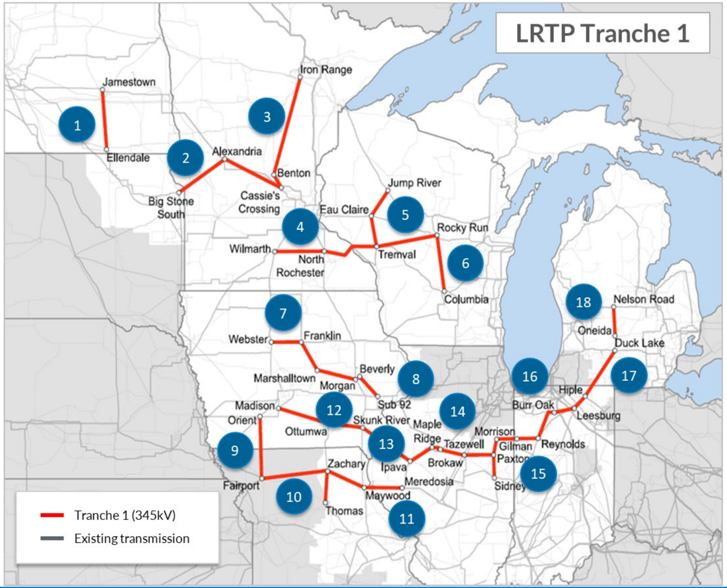
A. Congestion and fuel savings
B. Avoided capital costs of local resource investments
C. Avoided transmission investment
D. Reduced resource adequacy requirements
E. Avoided risk of load shedding
F. Decarbonization
G. Reliability issues addressed by LRTP
H. Other qualitative and indirect benefits

LRTP business case analysis uses a range of variables

- LRTP benefits examine value over the 20- to 40-year period from the in-service date (All projects assumed in service by 2030)
  - Benefit/cost calculations are evaluated on a 20-year time horizon
  - Additional benefits are shown for the 40-year horizon to align with assumed life of the assets
- LRTP benefits are evaluated for a range of discount rates from 3.0 – 6.9%
  - The social discount rate of 3.0% represents the value a ratepayer would typically receive on their risk-adjusted investment
  - The Weighted Average Cost of Capital (WACC) of 6.9% is the gross-plant weighted average of the Transmission Owners' cost of capital and represents the minimum return required on their transmission investments

Tranche 1 Portfolio proposal is the culmination of two years of Futures development, modeling, and engineering and represents the most complex transmission planning study effort in MISO's history

- Portfolio embodies needed transmission for the ever-changing fleet
- Addresses needs across the MISO Midwest subregion
- Analysis of reliability needs and benefits associated with Future 1 resource expansion



Total portfolio cost estimate for LRTP Tranche 1 is $10.3 B for projects located across the MISO Midwest subregion

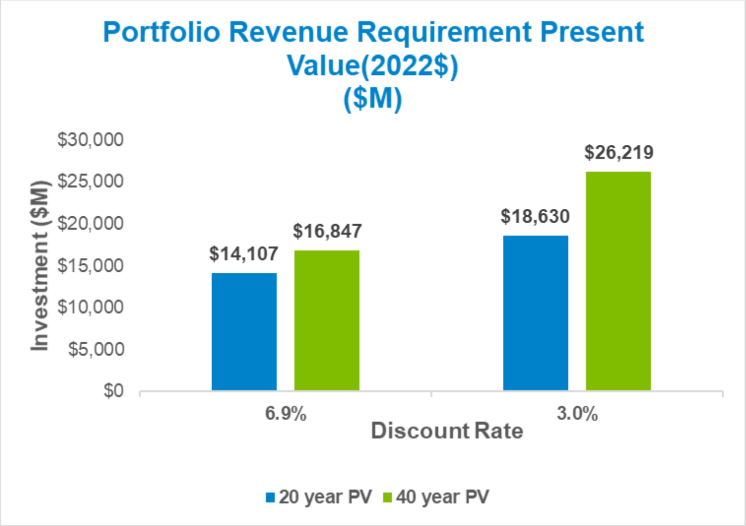
ID	Project Description	Est. Cost ($M, 2022)
1	Jamestown – Ellendale	$439
2	Big Stone South – Alexandria – Cassie's Crossing	$574
3	Iron Range – Benton County – Cassie's Crossing	$970
4	Wilmarth – North Rochester – Tremval	$689
5	Tremval – Eau Clair – Jump River	$505
6	Tremval – Rocky Run – Columbia	$1,050
7	Webster – Franklin – Marshalltown – Morgan Valley	$755
8	Beverly – Sub 92	$231
9	Orient – Denny - Fairport	$390
10	Denny – Zachary – Thomas Hill – Maywood	$769
11	Maywood – Meredosia	$301
12	Madison – Ottumwa – Skunk River	$673
13	Skunk River – Ipava	$594
14	Ipava – Maple Ridge – Tazewell – Brokaw – Paxton East	$572
15	Sidney – Paxson East – Gilman South – Morrison Ditch	$454
16	Morrison Ditch – Reynolds – Burr Oak – Leesburg – Hiple	$261
17	Hiple – Duck Lake	$696
18	Oneida – Nelson Rd.	$403
	Total Project Portfolio Cost	**$10,324**

Costs as of 7/25/2022
(costs represent "overnight" costs)

The LRTP Tranche 1 portfolio cost (20-year and 40-year present value at 6.9% and 3.0% discount rate)

The total capital cost of LRTP Tranche 1 portfolio is estimated to be $10.3B

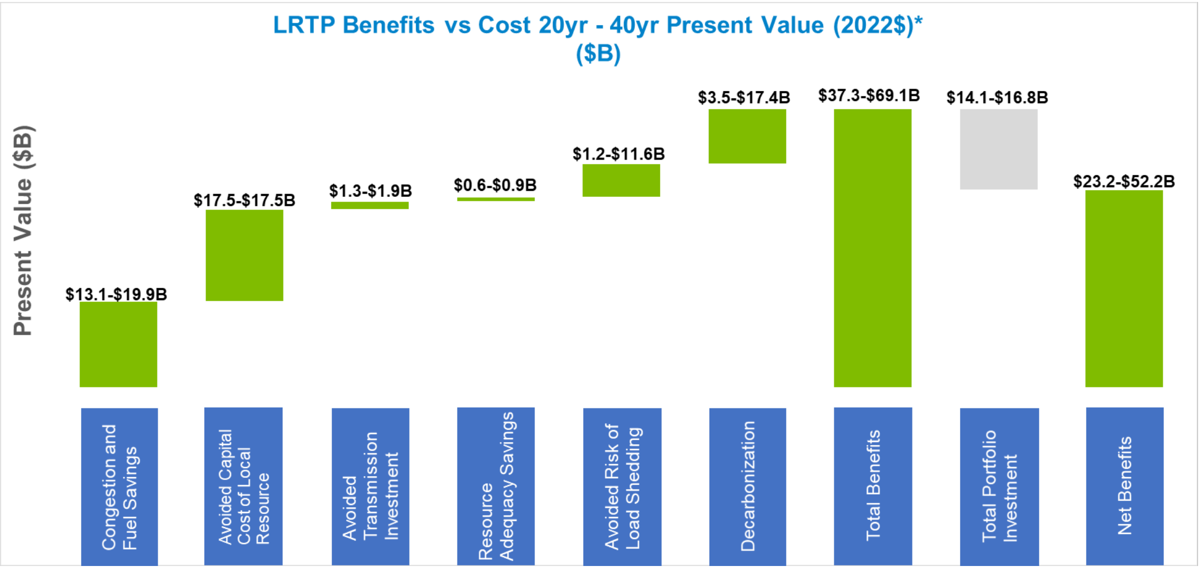
The 20-40yr Present Value (in 2022$) of the portfolio total revenue requirement is expected to be in the range of $14.1B-$16.8B*



*6.9% Discount Rate

Benefit Metrics

The business case analysis indicates total economic benefits significantly exceed cost of the Tranche 1 LRTP portfolio



*6.9% Discount Rate

A. Congestion and Fuel Savings

APC Benefits will be determined by comparing MISO Midwest APC in the LRTP Reference Case with the MISO Midwest APC in the LRTP Change Case

Make-up of LRTP Reference Case Model

- MTEP Topology
- Future Load Forecast
- Existing + Signed GIA
- RRF DGPV
- IRP/RRF Battery Storage
- IRP/RRF Thermal
- Renewable RRFs < 5% DFAX

Compare APC Change →

Make-up of LRTP Change Case Model

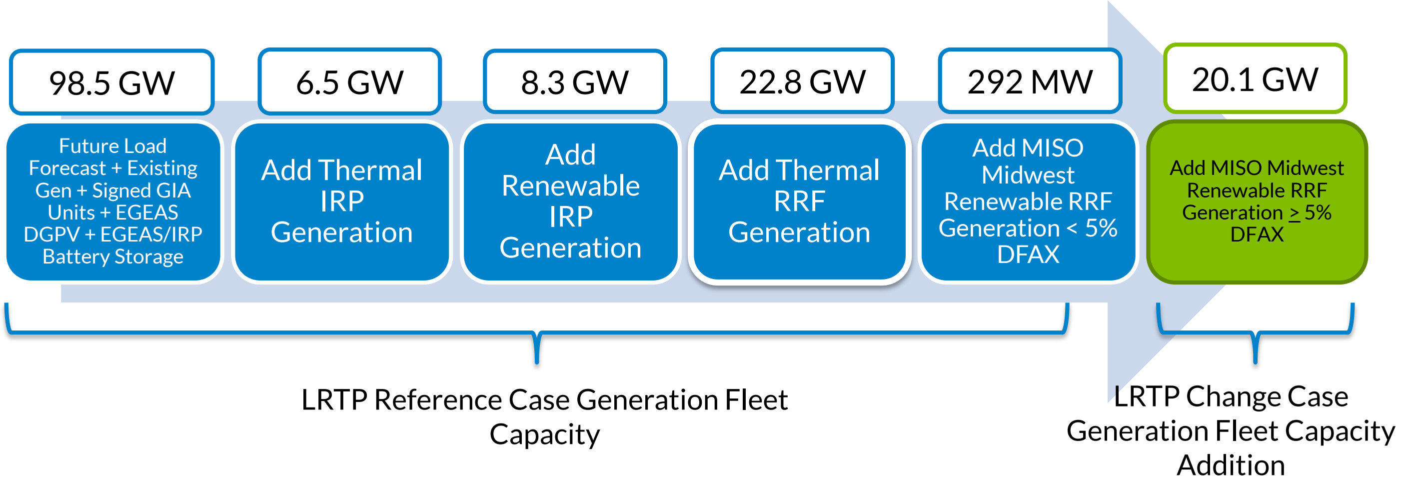
- Reference Case
- Renewable RRFs ≥5% DFAX
- LRTP Transmission

- The LRTP Reference Case represents necessary generation to serve Futures Load Forecast (on copper sheet)
- The LRTP Change Case includes Renewable RRFs located in MISO Midwest which have ≥ 5% DFAX on reliability constraints addressed by LRTP projects

MISO

A. Congestion and Fuel Savings

MISO Midwest-focused Reference Case generation determination process and results to meet copper sheet energy requirements in Future 1

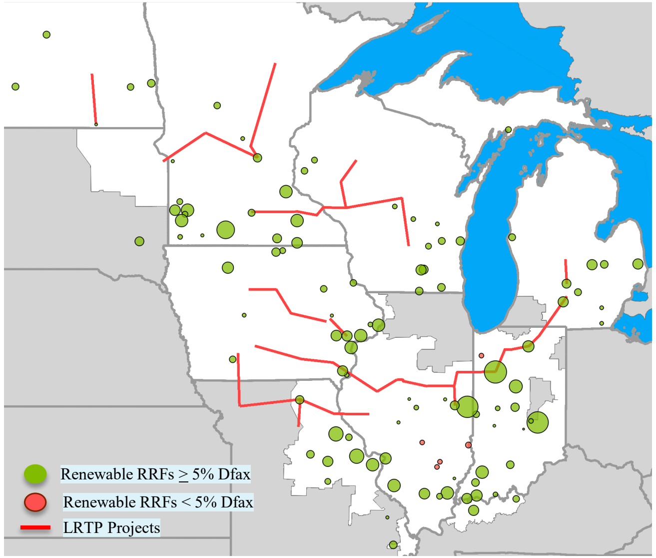


MISO

A. Congestion and Fuel Savings

LRTP Tranche 1 projects congestion and fuel savings results

Present Value	20 year PV (Millions-2022$)		40 year PV (Millions-2022$)	
Discount Rate	6.9%	3.0%	6.9%	3.0%
CAZ				
1	$3,169	$4,455	$4,668	$8,797
2	$1,049	$1,511	$1,667	$3,313
3	$2,195	$3,060	$3,151	$5,823
4	$1,352	$1,934	$2,107	$4,133
5	$1,471	$2,078	$2,205	$4,210
6	$2,884	$4,133	$4,517	$8,890
7	$1,006	$1,432	$1,543	$2,993
	$13,125	**$18,603**	**$19,858**	**$38,160**



B. Avoided Capital Costs of Local Resource Investments

Resource capital investments can be avoided by taking advantage of broader regional renewables instead of purely local resources

- Past experiences with transmission studies like the 2011 Multi-Value Projects indicate that a regional approach will be more cost-effective than a purely local buildout:
  - Magnitude, cost, & locations of resources differ based upon approach used
  - Regional transmission is the bridge between these scenarios
- To determine avoided capital cost of local resource investment savings created by LRTP transmission MISO developed
  - EGEAS LBA (local) granularity expansion models utilizing Future 1 assumptions
  - Calculation to relate the LBA and Regional expansion to LRTP transmission and determine what the avoided capital costs of local resource investments would be

B. Avoided Capital Costs of Local Resource Investments

Overview of EGEAS LBA expansion models used to determine what a local build out would be

- Each EGEAS run represents one of the 39 LBAs in MISO, with a Future 1 basis
    - The runs treat each LBA as its own pool.
    - Each LBA then self-constructs resources necessary to meet the simulation constraints such as PRM and emissions.
    - Utilizes the same assumptions as the regional Future 1 analysis and resources are ascribed to LBAs based on resource ownership.
    - Capacity purchases are enabled for the first year to meet each LBA's PRM and is driven by the construction lead time for new resource alternatives.
    - LBA-specific wind and solar profiles are used instead of the regional profiles which averaged multiple profiles from different locations across MISO.
- The MISO PRM value of 18% is scaled for each LBA based upon its alignment to the MISO coincident peak.

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B. Avoided Capital Costs of Local Resource Investments

Calculation to relate the LBA and Regional expansion to LRTP transmission to determine cost savings

- Calculation Overview
  - Due to Regional and LBA modeling assumptions, the avoided capital costs of local resources investments can not be determined by subtracting Regional expansion costs from the total LBA expansion costs (doing so would over-state realized benefit)
  - Regional and LBA Regional Resource Forecasting (RRF) expansion reflects Local Resource Zones (LRZ) that make up MISO Midwest (LRZ 1 – LRZ 7)
  - Enabled RRF capacity reflects RRF resources enabled by LRTP transmission, meaning those resources have $\geq$ 5% Dfax for LRTP transmission resolved reliability issues
  - Utilizes costs of LRTP transmission enabled capacity to infer avoided capital cost of local resources savings

$$Adjusted\ Capital\ Cost_{LBA\ Expansion}$$
$$= \sum_{Year\ 2020}^{Year\ 2040} Enabled\ RRF\ Capital\ Cost_{Region\ Expansion} \times \frac{\sum_{LRZ\ 1}^{LRZ\ 7}(Total\ RRF\ Capacity_{LBA\ Expansion})}{\sum_{LRZ\ 1}^{LRZ\ 7}(Total\ RRF\ Capacity_{Regional\ Expansion})}$$

$$Avoided\ Capital\ Cost\ of\ Local\ Resource\ Investments$$
$$= Adjusted\ Capital\ Cost_{LBA\ Expansion} - Enabled\ RRF\ Capital\ Cost_{Region\ Expansion}$$

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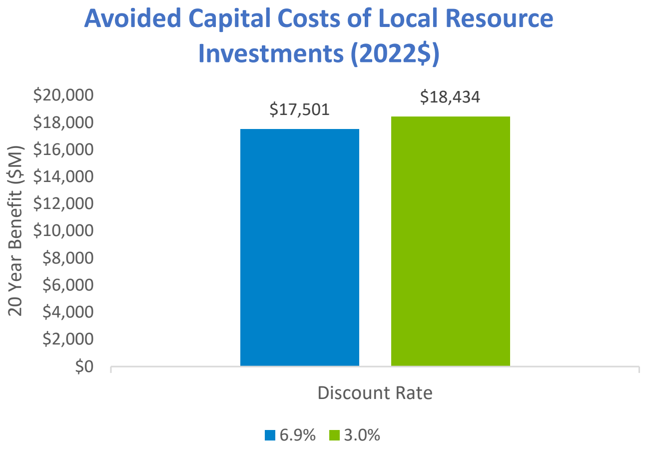
B. Avoided Capital Costs of Local Resource Investments

Avoided capital costs of local resource investments benefit

$$Adjusted\ Capital\ Cost_{LBA\ Expansion} = \sum_{Year\ 2020}^{Year\ 2040} \$16.0B \times \frac{90{,}969\ MW}{43{,}431\ MW} = \$33.58B$$

$$Avoided\ Capital\ Cost\ of\ Local\ Resource\ Investments = \$33.58B - \$16.0B = \$17.5B$$

- LRTP enables regional resource sharing and reduces local overbuild yielding a 20-year present value benefit of $17.5B*



* using the 6.9% Discount Rate

C. Avoided Transmission Investment

Transmission investment is avoided by developing regional solutions vs incremental fixes

- Captures the avoided cost of reliability upgrades and replacements that will not be required in the future as a result of the addition of LRTP projects
- Includes facilities where thermal loading is approaching the rating but not overloaded
  - Avoided reliability upgrades are determined by using the 10-year and 20-year analysis results to project future loading on facilities loaded near the rating with and without LRTP projects

$$Flow_{proj} = Flow_{20} + (Flow_{20} - Flow_{10})$$

Example: Facility is included in avoided costs of future transmission investment							
Line name	kv	RatingMVA	case	Flow10	Flow20	Flowproj	
Forest - Valley 161kV	161kV	335	w/o LRTP	324	331	338	without LRTP, future upgrade is needed
			w/ LRTP	315	322	329	with LRTP the overload is resolved

- Includes replacement of existing facilities due to age and condition that would not be required because the LRTP projects use existing ROW of aging facilities

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C. Avoided Transmission Investment

Re-use of existing ROW for LRTP projects offsets the costs of age and condition replacement of aging facilities

- The LRTP Tranche 1 portfolio of projects potentially use 836 miles of existing facilities where age and condition of the facilities is expected to require replacement of assets
- Construction of LRTP on the existing right-of-way would include replacement of existing structures and equipment that would avoid the future cost of replacing the existing facilities

C. Avoided Transmission Investment

Transmission investment is avoided by developing regional solutions vs incremental fixes

- Avoided transmission investment uses exploratory cost estimates based on type of facility improvement required
- Like in the 2011 MVP business case, an adjustment is applied to avoided reliability upgrades >=345kV to reduce value by 50% to account for potential production cost benefits provided by the upgrades
- Capital investment for future transmission is assumed to be spread equally over the 5-year period prior to the in-service date (2040) of the avoided reliability upgrades
- The Annual Transmission Revenue Requirement was calculated to obtain the 20-year net present value discounted to 2022$ values

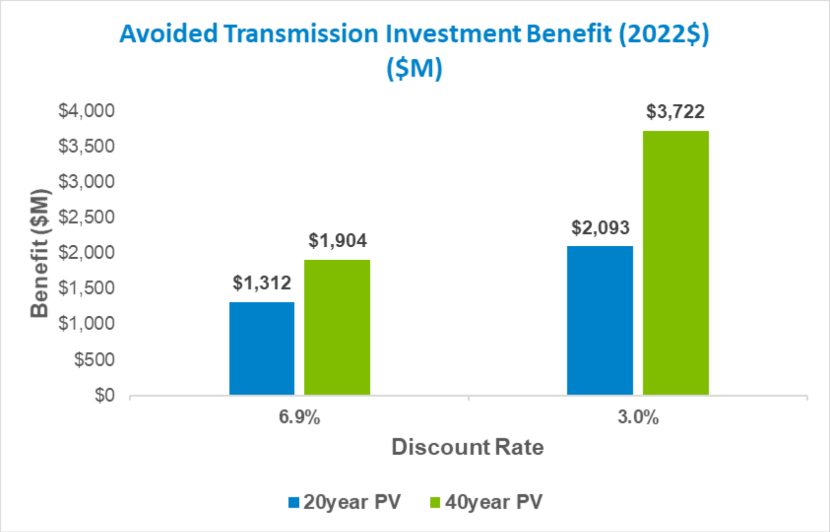
Facility Improvement Type	Unit Cost ($M)	Quantity/Miles	Cost ($M)*
Bustie Replacement	$1.50	2	$3
Transformer Replacement =345	$5.00	4	$20
Transformer Replacement <345	$3.00	5	$15
Transmission line Replacement =345kV (per mile)	$2.65	21	$56
Transmission line Replacement <345kV (per mile)	$1.60	1012	$1,617
Transmission line upgrade=345kV (per mile)	$0.56	230	$64
Transmission line upgrade <345kV (per mile)	$0.34	124	$43
		Total	**$1,819**

*MISO Estimates

C. Avoided Transmission Investment

LRTP provides benefits by eliminating the need for other transmission projects

- LRTP avoids the need for transmission investment that yields 20- to 40-year present value benefits from $1.3B to $1.9B*



* using the 6.9% Discount Rate

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D. Reduced Resource Adequacy Requirements

The resource adequacy benefits are related to an increase in transfer capability and a reduction in the total LCR*

- As LRTP increases the transfer capability within the footprint, the increase in transfer limit is quantified
- The potential economic value unlocked by the availability of least-cost resources across the footprint due to increase in transfer capability is estimated
- A two-step process was developed to quantify the LCR reduction benefits and approximate the monetary value

*Local Clearing Requirement

D. Reduced Resource Adequacy Requirements

Step 1: Perform a transfer analysis to determine the LCR for each local resource zone (LRZ)

1. Calculate the capacity import limit (CIL) for each LRZ and case*
   - Determine the import limit (e.g., TrLim) for each LRZ and study case
   - Determine the area interchange for each LRZ and study case
2. Determine the LCR for each LRZ and case*
   - The LRR UCAP** percentages from the PY22-23 LOLE Study and the 2040 non-coincident peak load forecasts are used to set the LRR for each LRZ

Local Resource Zone	CIL (Base)	CIL (With LRTP)	Delta CIL (MW)
LRZ1	5412	6070	658
LRZ2	4188	5223	1035
LRZ3	5062	6453	1391
LRZ4	7117	7609	492
LRZ5	6131	6183	52
LRZ6	6005	6171	166
LRZ7	3367	4659	1292

*With and without LRTP projects (14 total cases) | **Unforced capacity

MISO

D. Reduced Resource Adequacy Requirements

Step 2: Monetize the benefits identified in Step 1

1. The 2040 unforced capacity for each LRZ is determined using forced outage rates (thermal) and ELCC* (non-thermal)
2. The excess capacity within each LRZ is calculated as follows:
   - Excess Capacity = 2040 Unforced Capacity – LCR (without LRTP)
3. The RA benefit is estimated as follows:
   - If Excess Capacity < 0 → Benefit = (CONE**) x (-Excess Capacity)
   - If Excess Capacity > 0 → Benefit = $0/year

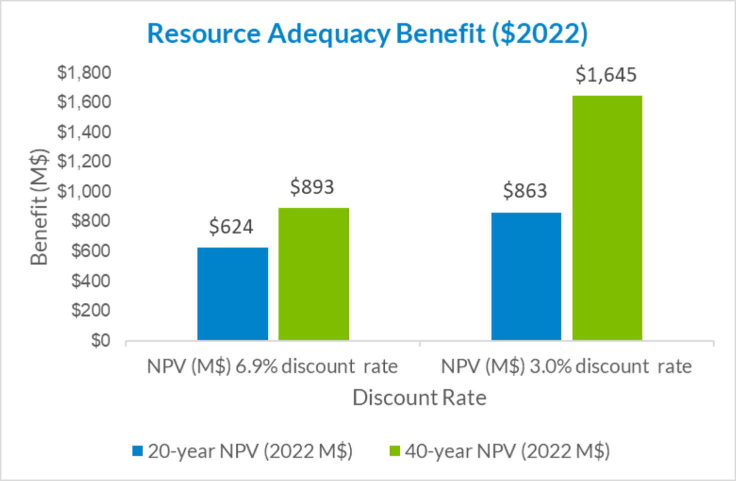
LRZ	1	2	3	4	5	6	7
PY22-23 CONE ($/MW-yr)	$91,270	$89,490	$86,380	$90,300	$97,190	$89,040	93,770

* Effective Load Carrying Capability | ** Cost of new entry

D. Reduced Resource Adequacy Requirements

The annual economic benefits related to resource adequacy are estimated to be $44M per year

- LRTP reduces the total LCR and yields 20- to 40-year present value benefits from $624-$893M*



* using a 6.9% Discount Rate

E. Avoided Risk of Load Shedding

LRTP transmission can reduce risk of load shedding due to unplanned generation events

- Large scale unexpected loss of generation in an area presents a risk of significant load shedding
- Transmission reinforcements provided by LRTP increase transfer capability to allow load to be served from resources located in other areas
- Benefits are associated with avoided risk of load shedding focus on risks of large-scale generation loss caused by severe weather
  - Renewable production is dependent on weather conditions
  - Thermal resources have operational limitations under extreme temperature conditions
- Weather-related events occur in various scales
  - Event scenarios examine generation and load balance after loss of significant resources to determine if import capability is sufficient to cover generation deficiency
  - Risk of load shedding exists where generation deficiency cannot be covered by existing import capability
- Benefits are calculated using Value of Lost Load (VOLL) ranging from $3500-$23,000* /MWh

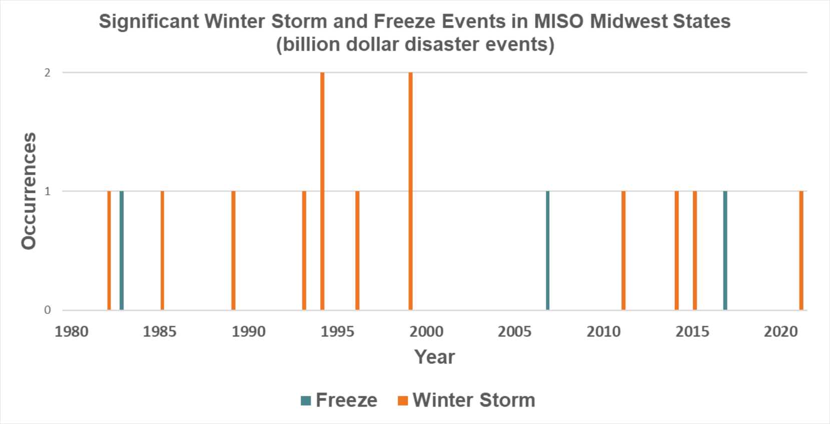
*IMM Quarterly Report: Summer 2020, https://cdn.misoenergy.org/IMM%20Quarterly%20Report_Summer%202020478028.pdf

E. Avoided Risk of Load Shedding

Analysis of risk focus on recurring severe winter weather events and variability of renewable resources

Severe winter weather events have been occurring at regular intervals over the past 40 years

More recent extreme winter events (e.g., Uri) have brought operational challenges caused by unplanned generation outages



Data Source: NOAA National Centers for Environmental Information (NCEI) U.S. Billion-Dollar Weather and Climate Disasters (2022). https://www.ncei.noaa.gov/billions/, DOI: 10.25921/stkw-7w73

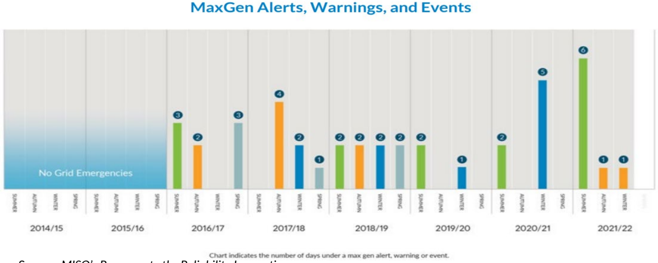
E. Avoided Risk of Load Shedding

Weather conditions affect the availability of resources

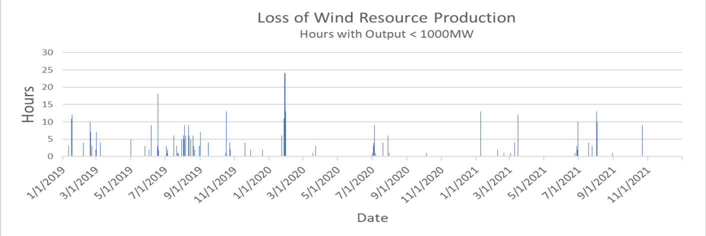
- Generation capacity events have become more common in recent years with the existing resource fleet

- Weather impacts will become more significant with greater dependency on renewable resources and gas-fired dispatchable resources

- Renewable resources regularly experience periods of low output lasting several hours



Source: *MISO's Response to the Reliability Imperative*,
https://cdn.misoenergy.org/MISO%20Response%20to%20the%20Reliability%20Imperative504018.pdf



Data Source: MISO Historical Hourly Wind, https://www.misoenergy.org/markets-and-operations/real-time--market-data/market-reports/#nt=%2FMarketReportType%3ASummary&t=10&p=0&s=MarketReportPublished&sd=desc

MISO

E. Avoided Risk of Load Shedding

LRTP transmission can reduce risk of load shedding due to unplanned loss of generation due to severe winter weather events

Area/Zonal Event Scenario

Generation Loss:
Thermal: 40% Pmax, Wind: 90% of Pmax, Solar 50% of Pmax
Load Forecast margin: 5% margin

Import Limit: Capacity Import Limit (CIL)

For all LRZ 1-7

LoadLossMW =
$GenMW_{net}$ – 1.05 * LoadMW – TxLossMW + Capacity Import Limit(MW)
where $GenMW_{net} = GenMW_{cap} - GenMW_{loss}$

+

Regional Event Scenario

Generation Loss:
Thermal: 50% Pmax, Wind: 90% of Pmax, Solar 50% of Pmax
Load Forecast margin: 5% margin

Import Limit: Total Transfer Capability

Scenario 1: Source: MISO Zones 4-7 + PJM
Sink: MISO Zones 1-3 + SPP

Scenario 2: Source: MISO Zones 1-3 + SPP
Sink: MISO Zones 4-7

LoadLossMW =
$GenMW_{net}$ - 1.05 * LoadMW – TxLossMW + Total Transfer Capability(MW)
where $GenMW_{net} = GenMW_{cap} - GenMW_{loss}$

E. Avoided Risk of Load Shedding

Total avoided risk of load shedding includes all winter event scenarios

Zonal

zone	GenLoss(therm)	GenLoss(wind)	GenLoss(solar)	Gen Remaining		Gen Surplus	CIL (no LRTP)	shortfall	newCIL (LRTP)	CIL diff	benefit
1	6607	6693	4612	12178		-5083	5412	-329	6070	658	
2	5369	1082	1049	8246		-3527	4188	-661	5223	1035	
3	3762	8001	3306	9529		-195	5062	-4867	6453	1391	
4	3358	2442	2065	6645		-2532	7117	-4585	7609	492	
5	2414	691	1185	5499		-2092	6131	-4039	6183	52	
6	7362	1461	2858	11873		-6680	6005	675	6171	166	166
7	6164	1714	3445	13387		-3574	3368	206	4659	1291	206
							Total Avoided Load shed				372
							Assumed duration				16
							Total Avoided Load shed hours				5954

Regional

zone	GenLoss(th)	GenLoss(w)	GenLoss(s)	Gen Remaining	Extimp	Gen Surplus	TTC (no LRTP)	shortfall	newTTC (LRTP)	TTC diff	benefit
Lrz1-3	19672.34	15776.433	8967.45	26018.897	7500	-20239.783	7260.8	12978.983	9391	2130.2	2130.2
Lrz4-7	24123.405	6307.11	9553.2	32579.295	0	-19702.2	6192.5	13509.695	8185	1992.5	1992.5
							Total Avoided Load shed				4122.7
							Assumed duration				16
							Total Avoided Load shed hours				65963.2
							Total for all Events				71917.1

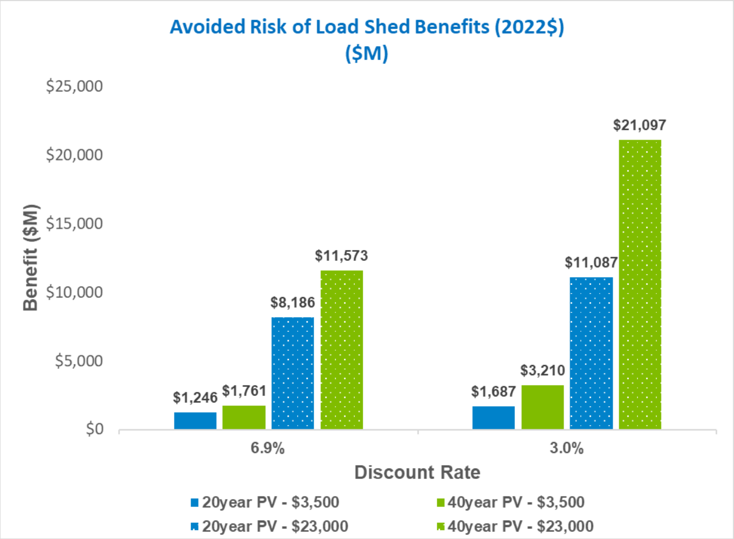
Risk of load shedding is assumed to occur every three years based on the frequency of severe winter weather events

E. Avoided Risk of Load Shedding

Value of avoided risk of load shedding is determined by applying the Value of Lost Load (VOLL)

Avoided Risk of Load Shed Value($) = VOLL * LoadLossMW * duration(hrs)
where VOLL – Value of Lost Load: $3500- $23,000*

LRTP reduces risk of load shedding and provides 20-40 year net present value benefits of $1.2B to $11.6B**



*IMM Quarterly Report: Summer 2020, https://cdn.misoenergy.org/IMM%20Quarterly%20Report_Summer%202020478028.pdf

 ** using a 6.9% Discount Rate

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F. Decarbonization

MISO has developed a carbon price range to capture LRTP's long-term benefits of reducing CO_2 emissions by enabling reliable delivery of low-cost, clean energy

- Calculate emissions reduced between LRTP Reference Case and LRTP Change Case used for the congestion and fuel cost savings benefit metric.
- Convert to metric tons.
- Using 2.5% annual inflation and discount rates below, apply range of carbon costs to calculate 20- and 40-year NPV of reduced carbon emissions.

20-Year CO_2 Emissions Reduced: 399M metric tons

40-Year CO_2 Emissions Reduced: 677M metric tons

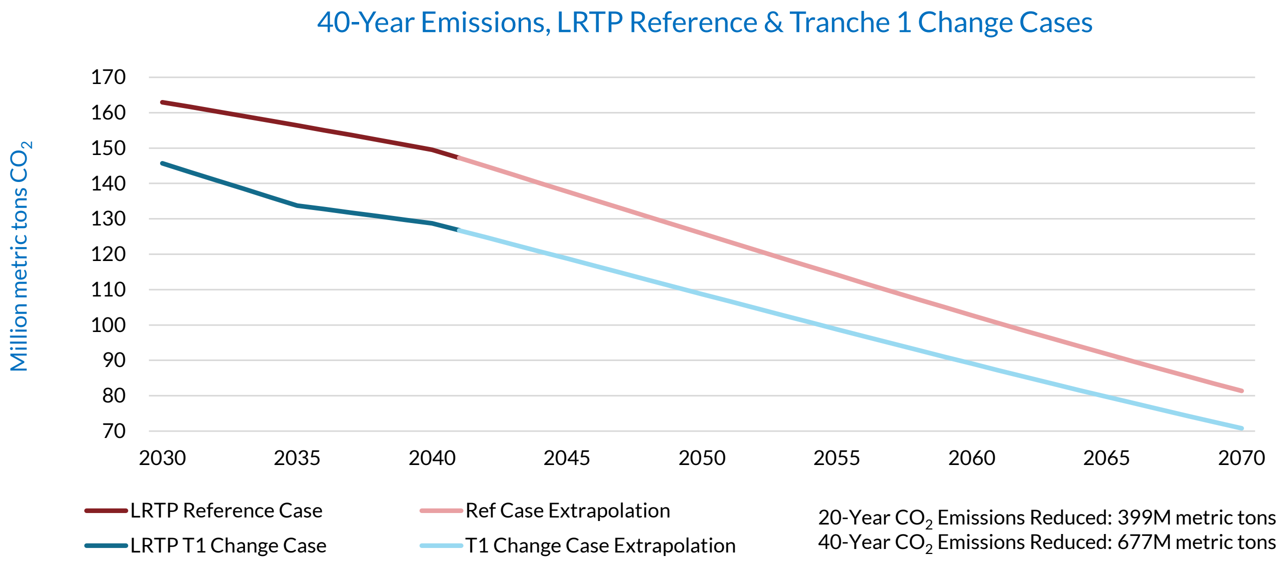
	6.9% Discount Rate		3% Discount Rate	
2022$/metric ton	MN PUC (Min) $12.55	Federal (Max) $47.80	MN PUC (Min) $12.55	Federal (Max) $47.80
20-Year Benefit (2022$, M)	$3,473	$13,438	$4,781	$18,404
40-Year Benefit (2022$, M)	$4,548	$17,364	$7,818	$29,498

Prices converted to 2022$. Full range of carbon prices demonstrated in previous workshops.
20-year and 40-year benefits = projects' in-service value to 2050 and 2070, respectively.
Emissions data interpolated between PROMOD model years 2030, 2035, and 2040; and extrapolated post-2040.

Minnesota Public Utility Commission (2022 Low)
Federal = Average of 45Q Federal Tax Credit and Federal Social Cost of Carbon

F. Decarbonization

LRTP Change Case illustrates the emissions reduced through enabled resources

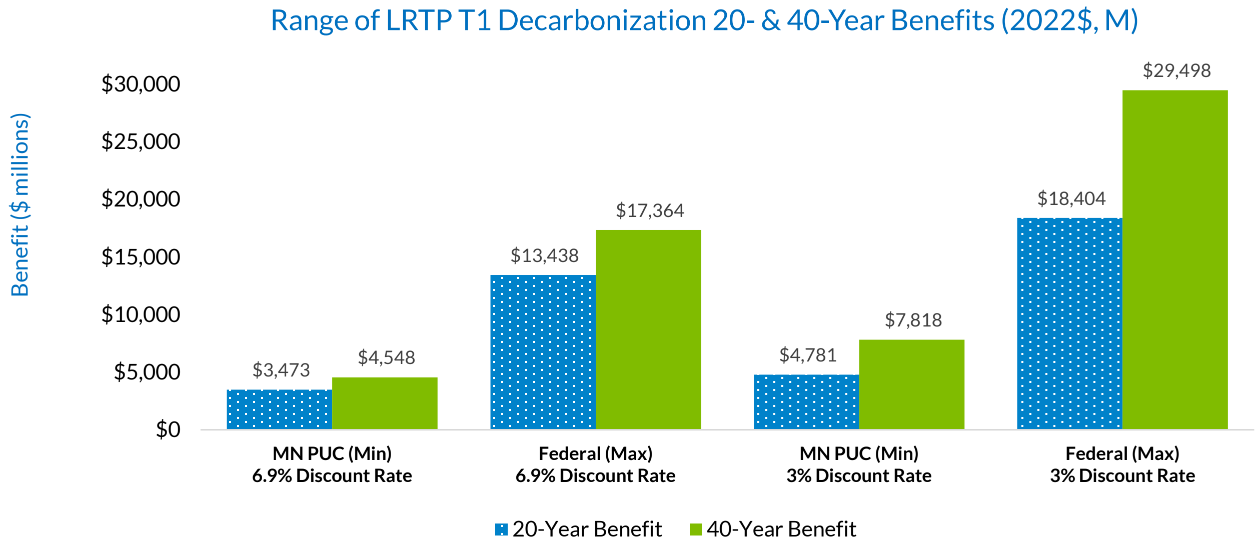


20-Year CO_2 Emissions Reduced: 399M metric tons
40-Year CO_2 Emissions Reduced: 677M metric tons

Emissions data interpolated between PROMOD model years 2030, 2035, and 2040; and extrapolated post-2040.

F. Decarbonization

With the price range considered, Decarbonization benefits range from $3.5B to $29.5B over 40 years of project life



NPV benefits in millions of 2022 dollars, including 2.5% annual inflation for Min/Max prices at discount rates above.
20-year and 40-year benefits refer to projects' in-service value to 2050 and 2070, respectively.
Emissions data interpolated between PROMOD model years 2030, 2035, and 2040; and extrapolated post-2040.

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G. Reliability issues addressed by LRTP Tranche 1

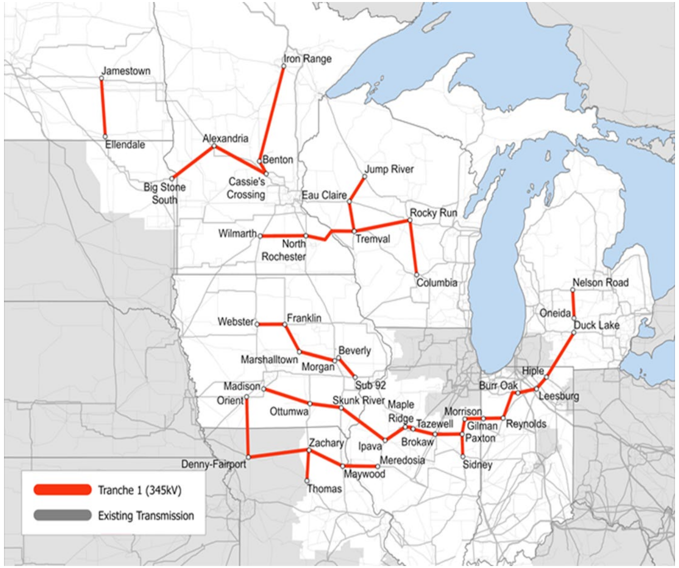
LRTP Tranche 1 portfolio allows reliable delivery of energy from future resource portfolio to serve load across the footprint

Reliability analysis was performed to assess the impact of the LRTP projects on steady state system performance

- Thermal and voltage issues were mitigated by the LRTP projects under base conditions reflecting varying load and dispatch patterns
- Additional upgrades were identified to mitigate issues resulting from the addition of LRTP projects

Transfer Analysis

- Improvements in transfer capability allows energy requirements to be met under varying dispatch patterns driven by differences in weather conditions across the Midwest subregion
- LRTP projects provides more robust interconnection to improve system stability during periods of heavy power transfers



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G. Reliability issues addressed by LRTP Tranche 1

MN-Dakotas Reliability Needs Addressed

Jamestown - Ellendale 345kV, Big Stone South – Alexandria - Cassie's Crossing 345kV

- Assists in transport of energy out of Dakotas toward central MN and Twin Cities area
- Relieves issues on the 230kV system and improves connections between 345kV systems to improve long distance movement of power
- Relieves 40 elements with excessive thermal loading for N-1 contingencies and 70 elements with excessive loading for N-1-1 contingencies
- Performs better than other six alternatives removing almost all existing congestion with only minimal new congestion.

Iron Range - Benton County – Cassie's Crossing 345kV

- Provides low impedance path from Northern to Central Minnesota improving Voltage stability and transfer performance with >10% increase in Manitoba Import limit performing better with higher capacity and lower cost than the four other alternatives
- Relieves 15 elements with excessive thermal loading for N-1 contingencies and 25 elements with excessive loading for N-1-1 contingencies

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G. Reliability issues addressed by LRTP Tranche 1

MN-WI Reliability Needs Addressed

Wilmarth - N. Rochester – Tremval - Eau Claire - Jump River
Tremval – Rocky Run – Columbia 345kV

- Provides outlet for renewables located in Minnesota
- Congestion relief and raises stability limit by 250MW to increase transfer capability on the MN-WI interface
- Improves connectivity to serve load centers
- Relieves 39 elements with N-1 heavy loading and severe overloads in MN and WI and 96 elements for N-1-1 contingencies

G. Reliability issues addressed by LRTP Tranche 1

Central Iowa Reliability Needs Addressed

Webster-Franklin-Marshalltown-Morgan 345kV
Beverly-Sub92 345kV

- Provides outlet for renewables located in IA and SW Minnesota
- Provides corridor for delivery of energy to load centers in central portions of MISO
- Addresses 21 elements with N-1 heavy thermal loading and severe overloads in Iowa and 34 elements for N-1-1 contingencies

G. Reliability issues addressed by LRTP Tranche 1

Iowa, Illinois, Indiana, Michigan Reliability Needs Addressed

Madison – Ottumwa – Skunk River – Ipava – Maple Ridge 345kV
Tazewell – Brokaw - Paxton – Gilman – Morrison – Reynolds – Hiple – Duck Lake 345kV
Paxton – Sidney 345kV
Oneida – Nelson Road 345kV

- Delivers significant increase in transfer capability to support generation deficient areas due to unexpected decrease in renewable output
- Mitigates 28 thermal overloads in Michigan, 16 thermal overload in Indiana, 19 thermal overloads in Missouri and Illinois, 14 thermal overloads in Iowa
- Provides more robust performance under large shifts in dispatch of generation across the region

G. Reliability issues addressed by LRTP Tranche 1

Missouri Reliability Needs Addressed

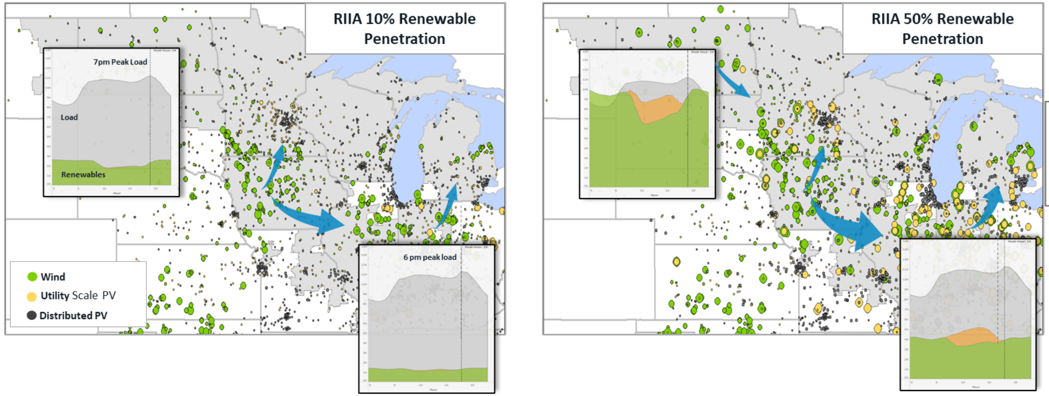
Orient – Fairport – Zachary – Maywood – Meredosia 345kV
Zachary – Thomas Hill 345kV

- Provides increased transfer capability of 250MW West-to-East and 438MW MISO-to-Michigan to address voltage collapse conditions in Missouri
- Mitigates heavy loading and severe overloads on 19 elements for N-1 and N-1-1 contingencies
- Provides more robust performance under large shifts in dispatch of generation across the region addressing 14 thermal overloads

H. Other Qualitative and Indirect Benefits

Transmission investment provides other qualitative benefits that support the LRTP Tranche 1 business case

- An increasingly connected system is needed to balance generation resource variability across an increasingly heterogeneous footprint.
- Additional transmission reinforcements provided by LRTP increases the ability of the system to manage the increasing different regional flows and operational events without adverse impacts to system performance



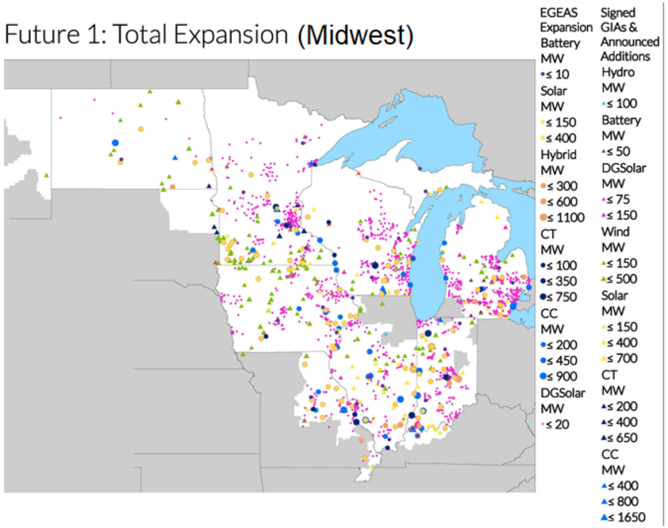
Regional energy transfers increase in magnitude and becomes more variable, leading to a need for increased extra-high voltage transfer capabilities

Illustration of flow changes with increasing renewable penetration spread throughout the MISO footprint (MISO Renewable Integration Impact Assessment (RIIA) Summary Report, February 2021 https://cdn.misoenergy.org/RIIA%20Summary%20Report520051.pdf)

H. Other Qualitative and Indirect Benefits

Transmission investment provides other qualitative benefits that support the LRTP Tranche 1 business case

- Increased transmission capacity better leverages the geographic and fuel diversity of the broader footprint to more effectively manage dispatch variability due to changing weather patterns



MISO Futures Report (December 2021) https://cdn.misoenergy.org/MISO%20Futures%20Report538224.pdf

H. Other Qualitative and Indirect Benefits

Transmission investment provides other qualitative benefits that support the LRTP Tranche 1 business case

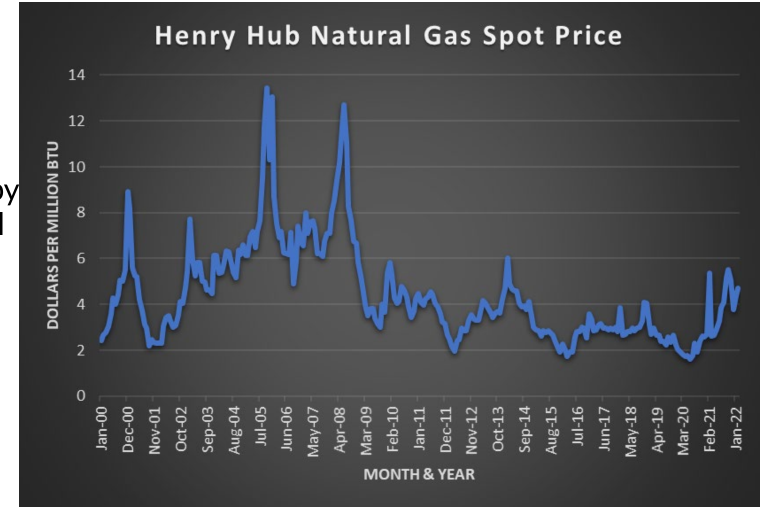
- Transmission expansion provides additional operational flexibility and allows more opportunity for planning of transmission and generation outages with less risk of operational issues or rescheduling of outages
- Transmission expansion allows better use of the transmission network and provides more flexibility to meet changing customer needs and diverse policy goals

Congestion and Fuel Savings Natural Gas Price Sensitivity

A. Congestion and Fuel Savings – Natural Gas Price Fuel Sensitivity

LRTP projects decrease system-wide impacts of natural gas volatility

- Local transmission investment cannot completely insulate electric consumers from the risks associated with fuel price volatility
- However, LRTP projects offset the risk by providing additional congestion and fuel savings benefits under high natural gas prices by enabling renewable energy
- Congestion and fuel savings benefits were analyzed through a series of production cost analyses, with higher natural gas cost assumptions



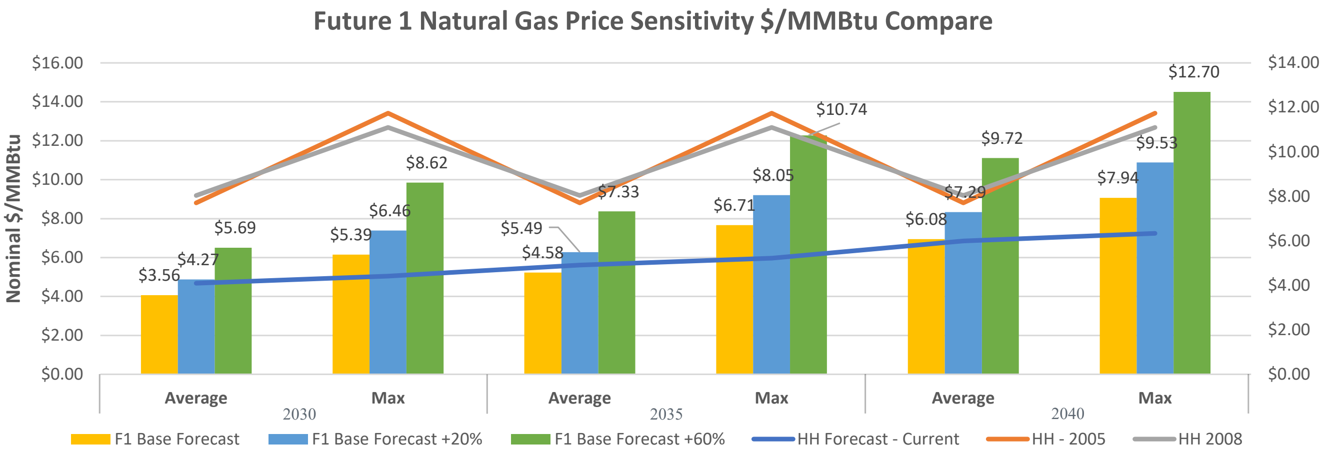
A. Congestion and Fuel Savings – Natural Gas Price Fuel Sensitivity

MISO Futures used for the LRTP study utilized new natural gas price forecast methodology

- GPCM Natural Gas Market Forecasting System was used to develop forecasts instead of locked-down Henry Hub (HH) and blend of three different forecasts
- Use on base forecast gas price in EGEAS for all Futures
- Using the same assumptions, but referencing PROMOD output, create Future-specific and area-specific gas prices for use in PROMOD models
- A range of gas prices were tested on LRTP Reference and Change Case PROMOD models

A. Congestion and Fuel Savings – Natural Gas Price Fuel Sensitivity

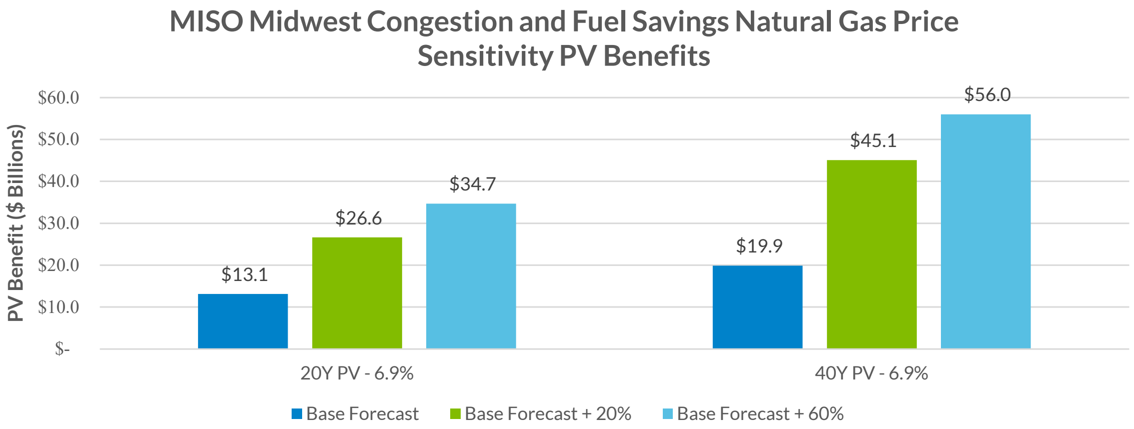
Future 1 Natural Gas prices were increased by 20 – 60% for sensitivity evaluation



- When comparing to HH prices, a 20% increase was found to facilitate the best starting point, which ensures year 2040 average price is greater than HH projected price
- A 60% increase was selected as the endpoint, to create a year 2040 value that represented HH highest sale prices historically (2005 and 2008)

A. Congestion and Fuel Savings – Natural Gas Price Fuel Sensitivity

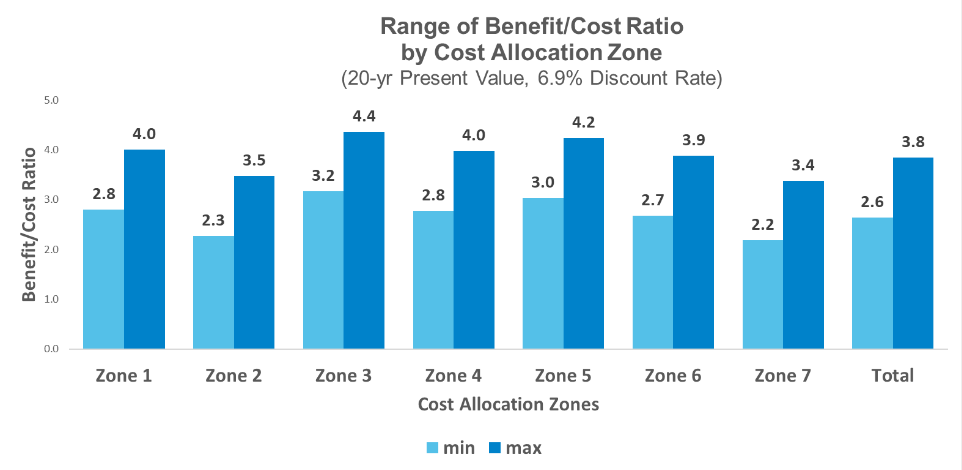
LRTP Tranche 1 transmission will provide greater congestion and fuel savings as natural gas price increases



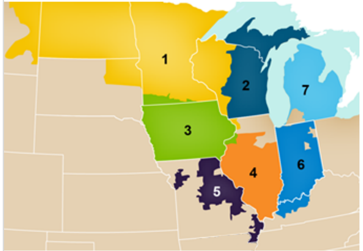
- 20% price increase generates a $13.4B congestion and fuel savings increase
- 60% price increase generates a $21.5B congestion and fuel savings increase

Distribution of Benefits for Midwest Subregion

The benefits provided by the LRTP Tranche 1 Portfolio are distributed across the Midwest subregion in a manner commensurate with the costs



Map of Midwest Cost Allocation Zone Boundaries*



*MISO Tariff, Attachment WW

For the lower range of quantifiable benefits, benefit to cost ratio for the cost allocation zones is at least 2.2 where VOLL=$3,500 and with a carbon price of $12.55 per metric ton

Footprint Benefits (minimum)- 20 Year NPV, 6.9%, 2022$		($M)							
Benefit Metric	CAZ Allocation Method	Zone 1	Zone 2	Zone 3	Zone 4	Zone 5	Zone 6	Zone 7	Total
Congestion and Fuel Savings	Derived directly from PROMOD resutls	$3,169	$1,049	$2,195	$1,352	$1,471	$2,884	$1,006	**$13,125**
Avoided Capital Cost of Local Resource Investment	Based on load share ratio	$3,481	$2,358	$1,864	$1,707	$1,351	$3,280	$3,460	**$17,501**
Avoided Transmission Investment	Based on the zonal location of upgrade	$278	$283	$201	$305	$125	$45	$74	**$1,312**
Resource Adequacy Savings	Based on zonal capacity savings	$0	$0	$0	$0	$0	$0	$624	**$624**
Avoided Risk of Load Loss*	Based on load ratio share	$248	$168	$133	$121	$96	$233	$246	**$1,246**
Decarbonization**	Based on load ratio share	$691	$468	$370	$339	$268	$651	$687	**$3,473**
Total Benefits		$7,867	$4,326	$4,763	$3,824	$3,311	$7,094	$6,096	**$37,281**
Total Costs		$2,806	$1,901	$1,502	$1,376	$1,089	$2,644	$2,789	**$14,107**
B/C		2.8	2.3	3.2	2.8	3.0	2.7	2.2	**2.6**

*VOLL=$3,500
**Carbon Price=$12.55 /metric ton

For the upper range of quantifiable benefits, benefit to cost ratio for the cost allocation zones is at least 3.4 where VOLL=$23,000 and with a carbon price of $47.80 per metric ton

Footprint Benefits (maximum)- 20 Year NPV, 6.9%, 2022$		($M)							
Benefit Metric	CAZ Allocation Method	Zone 1	Zone 2	Zone 3	Zone 4	Zone 5	Zone 6	Zone 7	Total
Congestion and Fuel Savings	Derived directly from PROMOD resutls	$3,169	$1,049	$2,195	$1,352	$1,471	$2,884	$1,006	**$13,125**
Avoided Capital Cost of Local Resource Investment	Based on load share ratio	$3,481	$2,358	$1,864	$1,707	$1,351	$3,280	$3,460	**$17,501**
Avoided Transmission Investment	Based on the zonal location of upgrade	$278	$283	$201	$305	$125	$45	$74	**$1,312**
Resource Adequacy Savings	Based on zonal capacity savings	$0	$0	$0	$0	$0	$0	$624	**$624**
Avoided Risk of Load Loss*	Based on load ratio share	$1,629	$1,103	$872	$798	$632	$1,534	$1,618	**$8,186**
Decarbonization**	Based on load ratio share	$2,673	$1,811	$1,431	$1,311	$1,037	$2,519	$2,656	**$13,438**
Total Benefits		$11,231	$6,604	$6,563	$5,472	$4,616	$10,262	$9,438	**$54,187**
Total Costs		$2,806	$1,901	$1,502	$1,376	$1,089	$2,644	$2,789	**$14,107**
B/C		4.0	3.5	4.4	4.0	4.2	3.9	3.4	**3.8**

*VOLL=$23,000
**Carbon Price=$47.80 /metric ton

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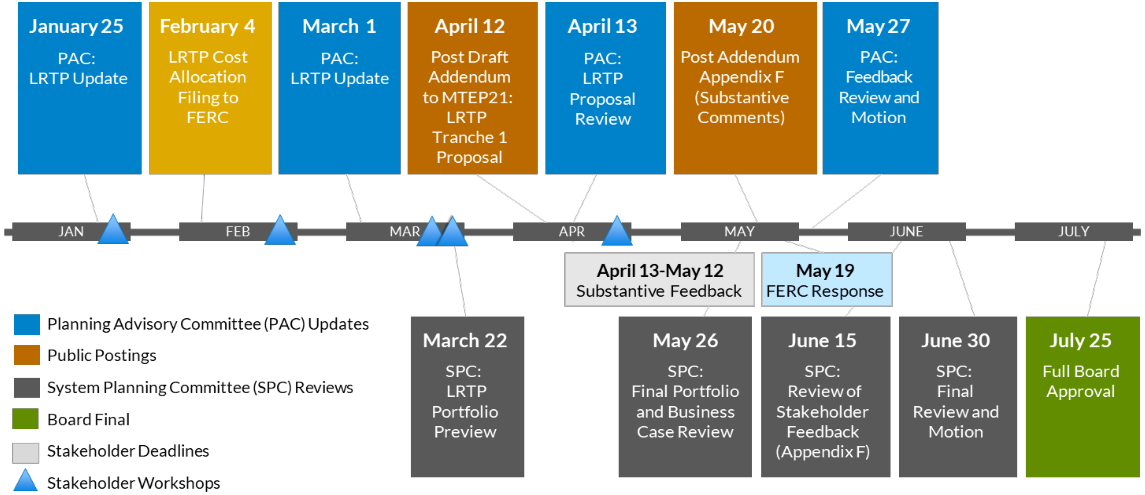
Conclusion

The LRTP Tranche 1 portfolio provides a regional transmission solution to addressing future energy needs

- For a capital investment of $10.3B, the LRTP portfolio provides $37.0B in financially quantifiable benefits over 20 years
- LRTP transmission projects enhance system performance to maintain reliable operation in the future with more variability and uncertainty in energy supply
- The LRTP Tranche 1 portfolio reflects a cost-effective set of solutions that enable delivery of energy to support future energy requirements of the MISO customers
- The LRTP Tranche 1 portfolio provides economic and reliability benefits that exceed the cost of the investment and are broadly distributed across the MISO Midwest subregion

The timeline for approval of Tranche 1 is targeted for July 25



MISO

STATE OF MICHIGAN

BEFORE THE MICHIGAN PUBLIC SERVICE COMMISSION

In the matter of the application of **MICHIGAN TRANSMISSION COMPANY, LLC** for an Act 30 certificate of public convenience and necessity for the construction of a major transmission line between Oneida Substation in Eaton County and Nelson Road Substation in Gratiot County, Michigan.	Case No. U-21471 (Lead Case for Filing)
In the matter of the application of **MICHIGAN ELECTRIC TRANSMISSION COMPANY, LLC** for an Act 30 certificate of public convenience and necessity for the construction of a major transmission line between the Indiana/Michigan state border at Gilead Township in Branch County and the new Helix Substation in Calhoun County, Michigan.	Case No. U-21472

PROOF OF SERVICE

On the date below, an electronic copy of **Direct Testimony and Exhibits of Douglas B. Jester on behalf of Citizens Utility Board of Michigan and Sierra Club (CUB-1 through CUB-4)** was served on the following:

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The statements above are true to the best of my knowledge, information and belief.

TROPOSPHERE LEGAL, PLC
Counsel for CUB & SC

Date: December 4, 2024

By: Natasha L. Fowles

Digitally signed by Natasha Fowles
Date: 2024.12.04 12:51:27 -05'00'

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