PJM/MISO Interregional Transfer Capability Study

Study Update/Executive Summary

- Newly refreshed study results were developed using updated models, incorporating recently approved transmission
- Summarized results have been included in this presentation with supplemental data posted to RTO IPSAC pages
- MISO conducted a stakeholder conceptual solution window, open May 2nd to May 30th, and received 34 solution ideas
- PJM identified ITCS issues that could be addressed leveraging existing regional and interregional processes – 12 of 20 top three transfer limits
- The RTOs have outlined next steps and are committed to evaluating pathways to realize solutions

Agenda

- Review of models and analyses
- Study results
- MISO Stakeholder Solution Window Review
- Next steps

Models & Analyses

MISO-PJM Blended Models

- The ITCS uses blended models that combine plausible long-term assumptions for two RTOs, factoring the impact of federal and state policies
  - PJM LTRTP Workshop Policy Study (WPS; 2032) assumptions for PJM's footprint
    - PJM's 2024 Load Forecast
    - PJM Independent State Agency Committee (ISAC) Policy Workbook (policy-driven retirements and new generation policies)
    - 2024 RTEP topology
  - MISO LRTP Future 2A (2032) assumptions for MISO's footprint
    - Details available in MISO's Series 1A Futures Report[2]
- Topology updates since March 7th IPSAC preliminary results include recently approved MISO Tranche 2.1 facilities, RTEP Window 1 Solutions, and Merchant HVDC facilities which have executed Interconnection and Facilities Construction Agreements (GIAs and TCAs)

[1]PJM LTRTP WPS Model Overview – October PJM TEAC Special Session – Order 1920 Presentation
[2]MISO LRTP Future Series 1A Report – MISO Series1A Futures Report

Analyses

	Reliability	Transfer (1)	Economic	Extreme Cold Weather Scenarios (2)
Analyses:	• Summer Peak • Winter Peak • Light Load	• 5 Bi-directional transfers • 3 Informational NERC ITCS Transfers • PJM-MISO Classic Transfer (1) Transfers were analyzed using all three reliability cases	• 2032 Production Cost Analysis	• MISO – Winter Storm Uri • PJM – Winter Storm Elliot (2) To be performed to validate solutions

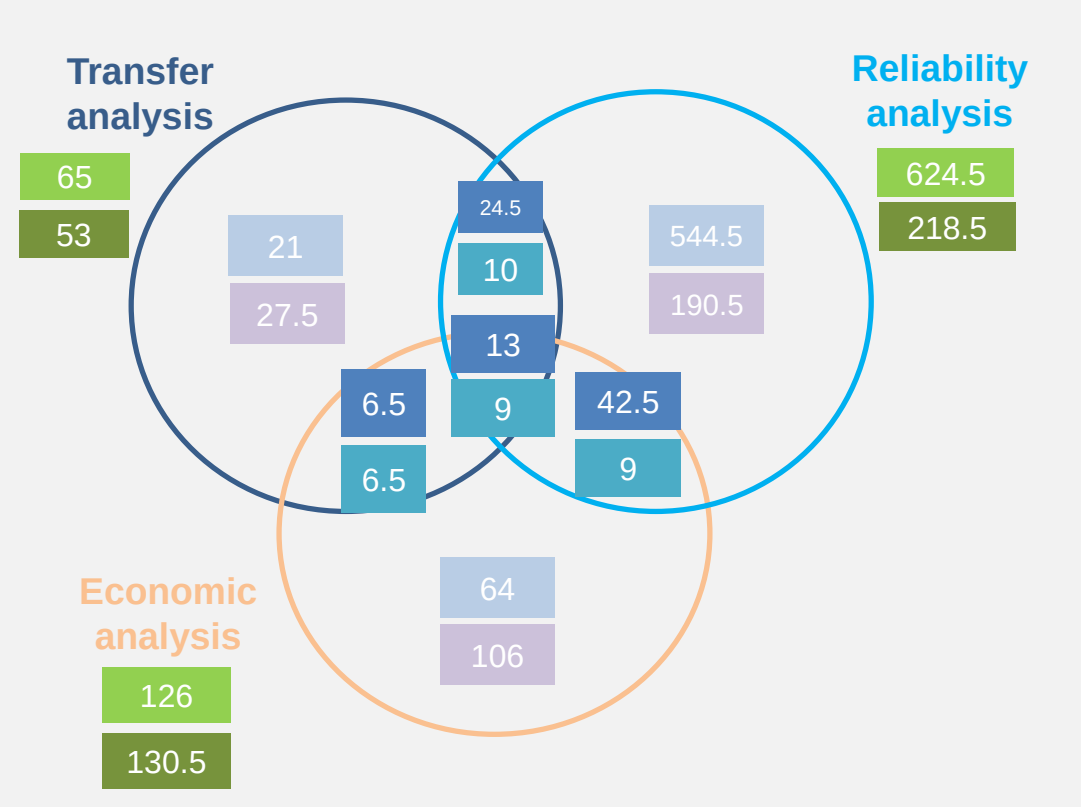
Transfers analyzed

NERC ITCS Transfers Between MISO & PJM (see next slide)
E12: MISO West <-> PJM West
E16: MISO Central <-> PJM West
E22: MISO East <-> PJM West

General Transfers Between MISO & PJM
MISO Classic <-> PJM

PJM-MISO ITCS Results

Summary count of issues by analysis area and footprint



PJM MISO	Reflects **total** issues by RTO under Reliability, Transfer, and Economic categories
PJM MISO	Reflects **unique** issues by RTO under only Reliability, Transfer, and Economic categories
PJM MISO	Reflects **unique** issues by RTO under overlapping Reliability, Transfer, and Economic categories

Notes:

Individual RTO footprint results from the joint study reflect analysis on the blended model

Issue counts represent RTO lines and tie-lines; tie lines are counted with 0.5 weight to avoid double counting at regional level.

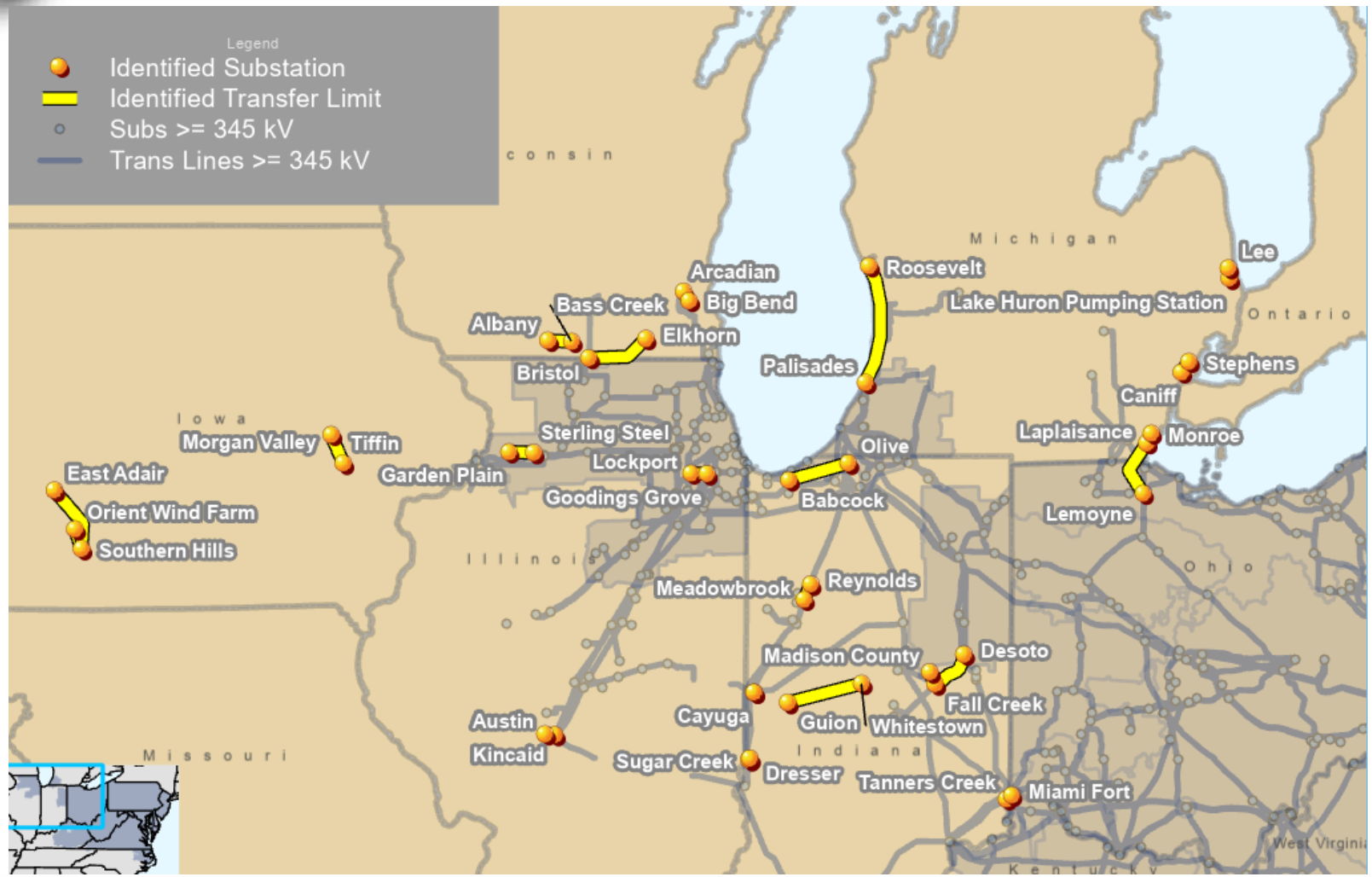
Top Three Transfer Limits, PJM

Area	RTO	Facility Name	kV	Total Transfers Impacted ● : >10 ■ : 4-10 ▲ : 1-3	Transfer Rank	Facility Loading From Reliability Study ● : >150% ■ : 100% - 150% ▲ : <100%	Annual Congestion ($) ● : > $1M ■ : $100k - $1M ▲ : < $100k
FE/ITCT	Tie Line	[FE]Lemoyn - [ITCT]Laplaisance 345 kV	345	■	1	▲	■
CE	PJM	[CE]Garden Pl - [CE]ESSH71 138 kV	138	■	1	●	●
AEP/DEO&K	PJM	[AEP] Tanners Creek - [DEOK] Miami Fort 345 kV	345	■	1	■	●
AEP/IPL	Tie Line	[AEP] Fall Creek - [IPL] Madison County 345 kV	345	■	1	▲	●
AEP/NIPS	Tie Line	[AEP] Meadow - [NIPS] Reynolds 345 kV	345	■	1	■	▲
AEP	PJM	[AEP] Desoto - [AEP] Fall Creek 345 kV	345	■	1	▲	▲
CE/AMIL	Tie Line	[CE]Austin - [AMIL]Kincaid 345 kV	345	■	1	■	▲
AEP/NIPS	Tie Line	[AEP] Olive - [NIPS] Babcock 345 kV	345	▲	1	▲	▲
CE	PJM	[CE]Goodings - [CE]Lockport 345 kV	345	▲	1	▲	▲
CE/ALTE	Tie Line	[CE]Albany (South Desk) - [ALTW]Garden Pl 138 kV	138	●	2	●	●
AEP/DEI	Tie Line	[AEP]Eugene - [DEI]Cayuga Sub 345 kV	345	■	2	●	●
AEP	PJM	[AEP]Benton Harbor - [AEP]Segreto 345 kV	345	■	2	■	●
AEP/DEI	Tie Line	[AEP]Dresser - [DEI]Sullivan 345 kV	345	■	2	■	▲
AEP/AMIL	Tie Line	[AEP]Snyder - [AMIL]Sullivan 345 kV	345	■	3	■	●
AEP	PJM	[AEP]Cook - [AEP]Segreto 345 kV	345	■	3	■	▲
CE/AMIL	Tie Line	[CE]Powerton - [AMIL]Towerline 138 kV	138	▲	3	■	●
CE	PJM	[CE]Lee - [CE]Byron 345 kV	345	▲	3	■	■
AEP/DEI	Tie Line	[AEP]Sullivan - [DEI]Fairbanks 345 kV	345	▲	3	●	▲
AEP	PJM	[AEP]Hyatt - [AEP]Malis 345 kV	345	▲	3	■	▲
CE/ALTW	Tie Line	[CE]Quad Cities - [ALTW]Rock Creek (South Desk) 345 kV	345	▲	3	▲	▲

Top Transfer Limits (Rank 1), MISO

Area	RTO	Facility Name	kV	Total Transfers Impacted ● : >10 ■ : 4-10 ▲ : 1-3	Transfer Rank	Facility Loading From Reliability Study ● : >150% ■ : 100% - 150% ▲ : <100%	Annual Congestion ($) ● : > $1M ■ : $100k - $1M ▲ : < $100k
DEI	MISO	[DEI] Sugar Creek - [DEI] Dresser 345 kV	345	●	1	▲	▲
DEI	MISO	[DEI] Cayuga Sub - [DEI] Cayuga 345 kV	345	●	1	■	■
ITCT/FE	Tie Line	[ITCT]Laplaisance - [FE]Lemoyne 345 kV	345	■	1	▲	▲
ITCT	MISO	[ITCT]Laplaisance - [ITCT]Monroe 345 kV	345	■	1	▲	▲
AEP/IPL	Tie Line	[AEP] Fall Creek - [IPL] Madison County 345 kV	345	■	1	▲	▲
AEP/NIPS	Tie Line	[AEP] Meadow - [NIPS] Reynolds 345 kV	345	■	1	▲	▲
CE/AMIL	Tie Line	[CE]Austin - [AMIL]Kincaid 345 kV	345	■	1	▲	▲
ITCT	MISO	[ITCT] Lee - [ITCT] Lake Huron Pumping 120 kV	120	■	1	●	▲
NIPS	MISO	[NIPS] Reynolds 138 kV - [NIPS] Reynolds 345 kV	138/345	■	1	▲	▲
NIPS	MISO	[NIPS] Reynolds 138 kV - [NIPS] Reynolds 345 kV x2	138/345	■	1	■	▲
ALTW/MEC	Tie Line	[ALTW]Morgan Valley - [MEC]Tiffin 345 kV	345	■	1	▲	▲
ITCT	MISO	[ITCT]Stephens - [ITCT]Caniff 345 kV	345	▲	1	▲	▲
AEP/NIPS	Tie Line	[AEP] Olive - [NIPS] Babcock 345 kV	345	▲	1	▲	▲
ALTE	MISO	[ALTE]Albany - [ALTE]Bass Creek 138 kV	138	▲	1	■	▲
DEI/IPL	Tie Line	[DEI] Whitestown - [IPL] Guion 345 kV	345	▲	1	■	■
MEC	MISO	[MEC]Southern Hills - [MEC]East Adair 345 kV	345	▲	1	▲	▲
METC	MISO	[METC] Palisades - [METC] Roosevelt 345 kV	345	▲	1	■	▲
ALTE	MISO	[ALTE]Bristol - [ALTE]Elkhorn 138 kV	138	▲	1	●	▲
MEC	MISO	[MEC]Orient Wind Farm - [MEC]Southern Hills 345 kV	345	▲	1	▲	▲
WEC	MISO	[WEC]Big Bend - [WEC]Arcadian 345 kV	345	▲	1	■	▲

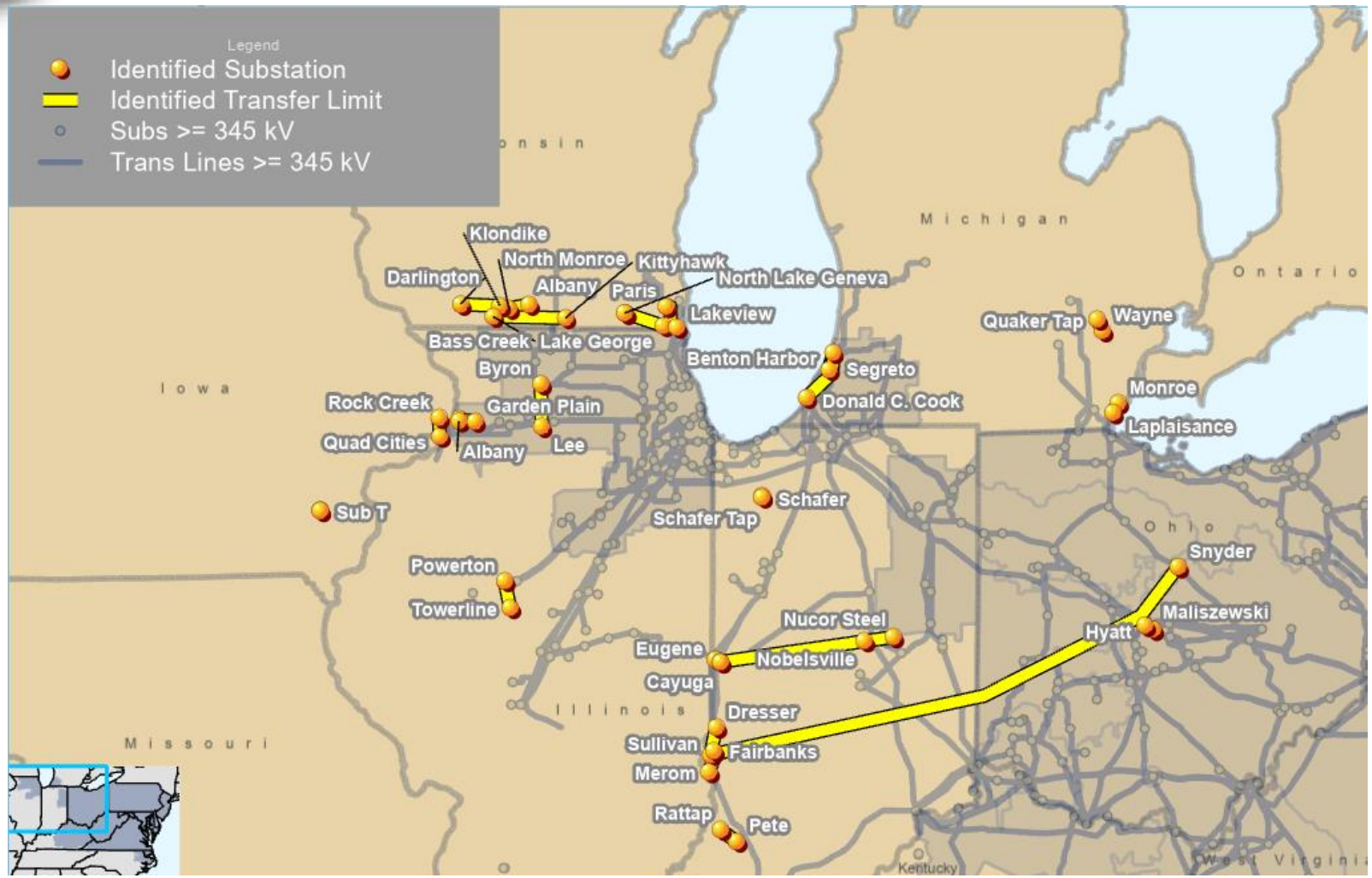
Rank #1 Transfer Limits PJM, MISO, and Tie Lines



Top Transfer Limits (Rank 2 & 3), MISO

Area	RTO	Facility Name	kV	Total Transfers Impacted ● : >10 ■ : 4-10 ▲ : 1-3	Transfer Rank	Facility Loading From Reliability Study ● : >150% ■ : 100% - 150% ▲ : <100%	Annual Congestion ($) ● : > $1M ■ : $100k - $1M ▲ : < $100k
AEP/DEI	Tie Line	[AEP]Eugene - [DEI]Cayuga Sub 345 kV	345	■	2	■	■
CE/ALTW	Tie Line	[CE]Garden Pl - [ALTW]Albany (South Desk) 138 kV	138	●	2	▲	▲
AEP/DEI	Tie Line	[AEP]Dresser - [DEI]Sullivan 345 kV	345	■	2	■	▲
ITCT	MISO	[ITCT]Wayne - [ITCT]Quaker Tap 345 kV	345	■	2	▲	▲
ITCT	MISO	[ITCT]Laplaisance - [ITCT]Monroe 345 kV	345	▲	2	▲	▲
ALTE	MISO	[ALTE]North Monroe - [ALTE]Albany 138 kV	138	▲	2	■	■
NIPS	MISO	[NIPS]Schafer Tap - [NIPS]Schafer 138 kV	138	▲	2	●	▲
ALTE	MISO	[ALTE]Darlington - [ALTE]Klondike 138 kV	138	▲	2	▲	▲
ALTE/WEC	MISO	[ALTE]North Lake Geneva - [ALTE]North Lake Geneva Tap 138 kV	138	▲	2	■	▲
MEC	MISO	[MEC]Sub T - [MEC]Sub T 345 kV	345	▲	2	▲	▲
WEC	MISO	[WEC]Lakeview - [WEC]Paris 345 kV	345	▲	2	▲	▲
AEP/AMIL	Tie Line	[AEP]Snyder - [AMIL]Sullivan 345 kV	345	■	3	■	▲
ALTW	MISO	[ALTW]Albany (South Desk) 138 kV - [ALTW]Albany (South Desk) 161 kV	138/161	■	3	▲	▲
ALTE	MISO	[ALTE]Bass Creek - [ALTE]Kitty Hawk 138 kV	138	▲	3	■	▲
DEI	MISO	[DEI]Cayuga - [DEI]Nucor Steel 345 kV	345	▲	3	▲	■
AEP/DEI	Tie Line	[AEP]Sullivan - [DEI]Fairbanks 345 kV	345	▲	3	■	▲
HE/IPL	MISO	[HE]Rattap - [IPL]Pete 138 kV	138	▲	3	▲	▲
ALTE	MISO	[ALTE]Klondike - [ALTE]North Monroe 138 kV	138	▲	3	▲	▲
CE/ALTW	Tie Line	[CE]Quad Cities - [ALTW]Rock Creek (South Desk) 345 kV	345	▲	3	▲	▲
CE/AMIL	Tie Line	[CE]Powerton - [AMIL]Towerline 138 kV	138	▲	3	▲	■
HE/DEI	MISO	[HE]Fairbanks - [DEI]Merom 345 kV	345	▲	3	▲	▲

Rank #2 & 3 Transfer Limits PJM, MISO, and Tie Lines



Overlapping Reliability, Transfer, and Economic Issues

(Center of the Venn Diagram on Slide 8)

Overlapping Issues Identified in All Analyses, PJM (Top 10 Transfers, Reliability, Economic)

Area	RTO	Facility Name	kV	Total Transfers Impacted ● : >10 ■ : 4-10 ▲ : 1-3	Facility Loading From Reliability Study ● : >150% ■ : 100% - 150% ▲ : <100%	Annual Congestion ($) ● : > $1M ■ : $100k - $1M ▲ : < $100k
AEP	PJM	[AEP] Marysville765 kV Reactor (to Sorenson)	765	■	■	●
AEP	PJM	[AEP] Marysville765 kV Reactor (To Maliszewski)	765	■	■	●
AEP	PJM	[AEP] East Lima - [AEP] Fostoria Central 345 kV	345	▲	■	▲
AEP	PJM	[AEP]Benton Harbor - [AEP]Segreto 345 kV	345	■	■	●
AEP/AMIL	Tie Line	[AEP]Eugene - [AMIL] Bunsonville 345 kV Bus 1	345	■	■	■
AEP/AMIL	Tie Line	[AEP]Snyder - [AMIL]Sullivan 345 kV	345	●	■	●
AEP/DEI	Tie Line	[AEP]Eugene - [DEI]Cayuga Sub 345 kV	345	■	●	●
AEP/DEO&K	PJM	[AEP] Tanners Creek - [DEOK] Miami Fort 345 kV	345	●	■	●
AEP/NIPS	Tie Line	[AEP] Meadow - [NIPS] Reynolds 345 kV	345	■	■	▲
CE/ALTW	Tie Line	[CE]Albany (South Desk) - [ALTW]Garden Pl 138 kV	138	■	●	●
CE/AMIL	Tie Line	[CE]Austin - [AMIL]Kincaid 345 kV	345	■	■	▲
CE/AMIL	Tie Line	[CE]Powerton - [AMIL]Towerline 138 kV	138	■	■	●
CE	PJM	[CE]Lee - [CE]Byron 345 kV	345	■	■	■
CE	PJM	[CE]Enbridge - DeKalb tap (R) - Waterman 138 kV	138	■	■	●
CE	PJM	[CE]Garden Pl - [CE]ESSH71 138 kV	138	■	●	●
CE	PJM	[CE] Haumesser – [CE] Dekalb 138 kV	138	■	■	●
NIPS/CE	Tie Line	[CE] Crete-[NIPS] St. John 345 kV tie line	345	■	■	●

Overlapping Issues Identified In All Analyses, MISO

Area	RTO	Facility Name	kV	Total Transfers Impacted ● : >10 ■ : 4-10 ▲ : 1-3	Facility Loading From Reliability Study ● : >150% ■ : 100% - 150% ▲ : <100%	Annual Congestion ($) ● : > $1M ■ : $100k - $1M ▲ : < $100k
DEI	MISO	[DEI] Cayuga Sub - [DEI] Cayuga 345 kV	345	●	■	■
CE/AMIL	Tie Line	[CE]Austin - [AMIL]Kincaid 345 kV	345	■	▲	▲
ALTW/MEC	Tie Line	[ALTW]Morgan Valley - [MEC]Tiffin 345 kV	345	■	▲	▲
DEI/IPL	MISO	[DEI] Whitestown - [IPL] Guion 345 kV	345	▲	■	■
ALTE	MISO	[ALTE]Albany - [ALTE]Bass Creek 138 kV	138	▲	■	▲
ALTE	MISO	[ALTE]Bristol - [ALTE]Elkhorn 138 kV	138	▲	●	▲
AEP/DEI	Tie Line	[AEP]Eugene - [DEI]Cayuga Sub 345 kV	345	▲	■	■
ALTE	MISO	[ALTE]North Monroe - [ALTE]Albany 138 kV	138	■	▲	▲
AEP/AMIL	Tie Line	[AEP]Snyder - [AMIL]Sullivan 345 kV	345	■	■	▲
DEI	MISO	[DEI]Cayuga - [DEI]Nucor Steel 345 kV	345	▲	■	▲
AMIL	MISO	[AMIL] Casey - [AMIL] Snyder 345 kV	345	▲	▲	▲

MISO Solution Window Review

MISO Stakeholder Conceptual Solution Window Review

- MISO solicited conceptual solutions to ITCS issues (MISO and Tie Line issues) via a ~30-day conceptual solution window in May
- MISO received 34 unique solution ideas from 8 entities
- After review and preliminary consideration of submissions, combined with MISO developed alternative concepts, 54 solution ideas remain for further evaluation by MISO and PJM
- Some pending or recently approved MTEP projects may mitigate identified ITCS issues

Overview of Solution Ideas from MISO Stakeholder Conceptual Window

Summary reflects conceptual solution submissions and alternatives MISO recommends for further evaluation

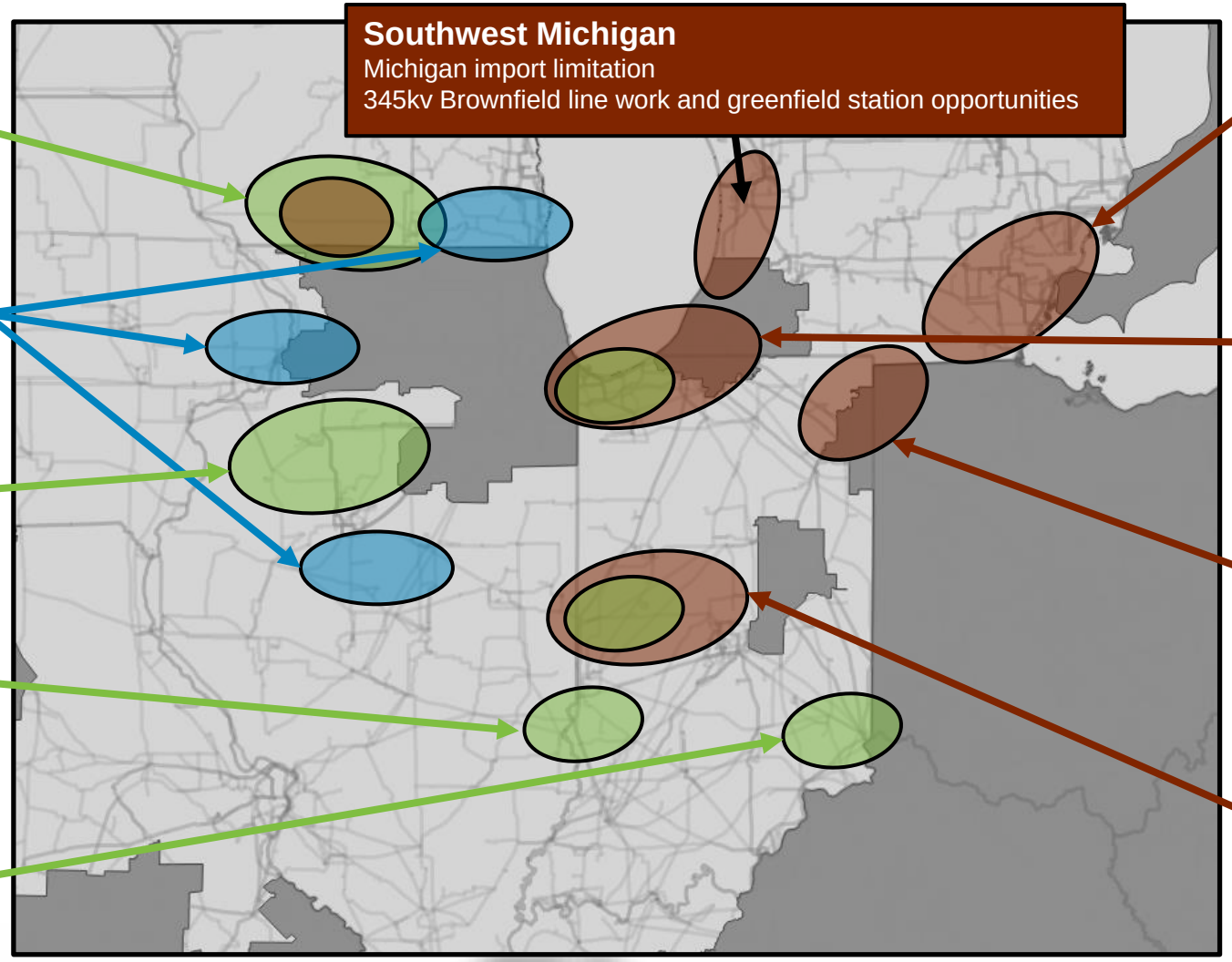
Southwest Wisconsin
Top transfer limitation and reliability driver
345kV greenfield line
138kV rebuild

Illinois & Wisconsin
Approved 345 & 138kV MTEP projects may mitigate top transfer, reliability & economic issues

Central Illinois
Supports reliability and additional transfer capability
Multiple submissions (345kV)

Southern Indiana/Illinois
Top transfer limitation and economic driver
345kV greenfield (~50 mi.)
Monitor: Large load expansion in area

Southeast Indiana/Ohio
Supports transfers in tri-state area
*345kV greenfield line (~40 mi.) and station expansion



Southeast Michigan
Import export limitations
*Sag remediation (MISO/PJM)
345kV Double Circuit Rebuild (4 mi.)

NW Indiana/SE Chicago
Top transfer limitation
Economic & reliability drivers

*138kV rebuild
† 345kV rebuild
*345kV greenfield

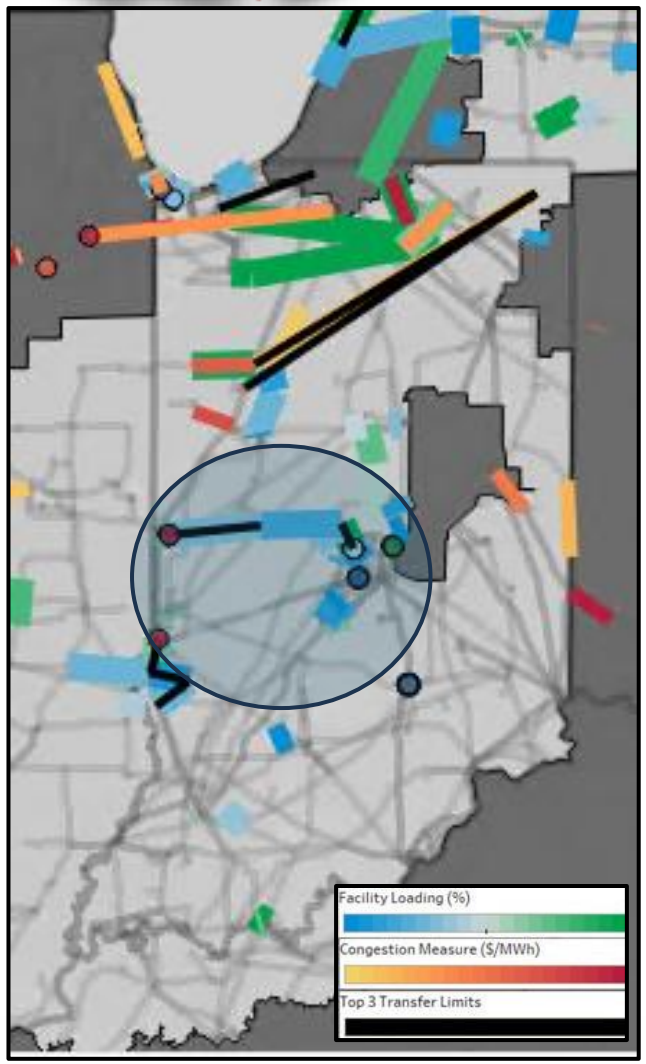
***NE Indiana/NW Ohio**
Supports transfer capability in the tri-state area
† 345kV rebuild to double circuit

Central/West Indiana
Top transfer limitation across scenarios
Economic & reliability drivers

*Brownfield submissions; alternatives include greenfield
345kV Substation Expansion
Monitor: Large load expansion in area

MISO Solution Ideas – Indiana

Expand existing and add new infrastructure in Central Indiana to reduce congestion and reliability overloads in the MISO footprint and improve transfer capability



Facility Name	Transfer Rank	Total Transfers Impacted	Facility Loading From Reliability Study (%)	Congestion Measure ($/MW)
[DEI] Cayuga Sub - [DEI] Cayuga 345 kV	1	11	144.54	$150,575
[DEI] Whitestown - [IPL] Guion 345 kV	1	2	137.88	$158,835
[AEP] Eugene - [DEI] Cayuga Sub 345 kV*	2	7	111.03	$3,690
[DEI] Cayuga - [DEI] Nucor Steel 345 kV	3	3	100.4	$21,771
[DEI] Sugar Creek - [DEI] Dresser 345 kV	1	12	-	$232,225
[DEI]Dresser - [AEP] Sullivan 345 kV*	2	4	109.82	-

Idea 1

Project	Details	Stakeholder/ MISO	Brownfield/ Greenfield	Est. Cost ($M)
[DEI] Expand Vermillion/Cayuga Sub 345 kV	Expand Vermillion/Cayuga sub to allow second circuit to Eugene and other future line positions.	Stakeholder	Brownfield	65.5
[DEI] Cayuga to [DEI] Nucor to [DEI] Whitestown 345 kV	Uprate existing Cayuga to Nucor to Whitestown 345 kV circuit to 3000 A	MISO	Brownfield	264.6
[DEI] Cayuga to [AEP] Eugene 345 kV*	Reconductor to 3000 A or add second parallel 345 kV	Stakeholder	Brownfield	37.1

Idea 2

Includes Idea 1

[DEI] Nucor to [WVPA] Witt (LEAP Data Center) 345 kV 345 kV	Add a 345 kV line	MISO	Greenfield	137.1
2nd [DEI] Cayuga - [DEI] Nucor 345 kV Circuit	Add a 345 kV circuit	MISO	Greenfield	148.7

Idea 3

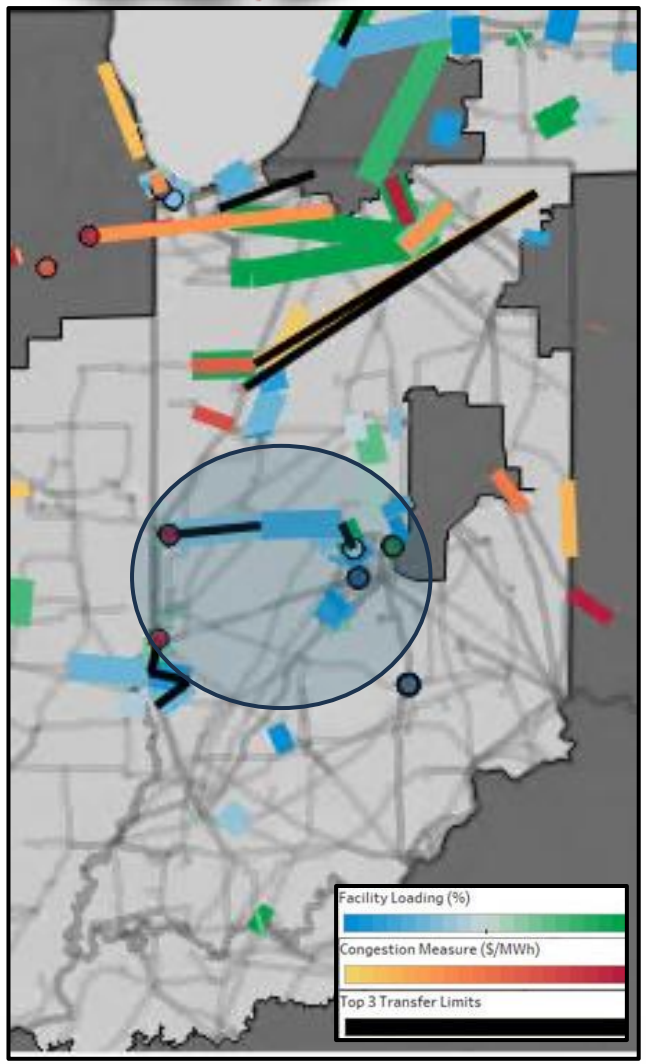
Includes Idea 1

2nd [DEI] Cayuga - [DEI] Nucor 345 kV Circuit	Add a 345 kV circuit	MISO	Greenfield	148.7
[DEI] Nucor to [DEI] Qualitech 345 kV	Add a 345 kV line	MISO	Greenfield	75.2

Issues Identified | Potential Solutions | * MISO/PJM Tie Line | † PJM Facility

MISO Solution Ideas – Indiana

Expand existing and add new infrastructure in Central Indiana to reduce congestion and reliability overloads in the MISO footprint and improve transfer capability



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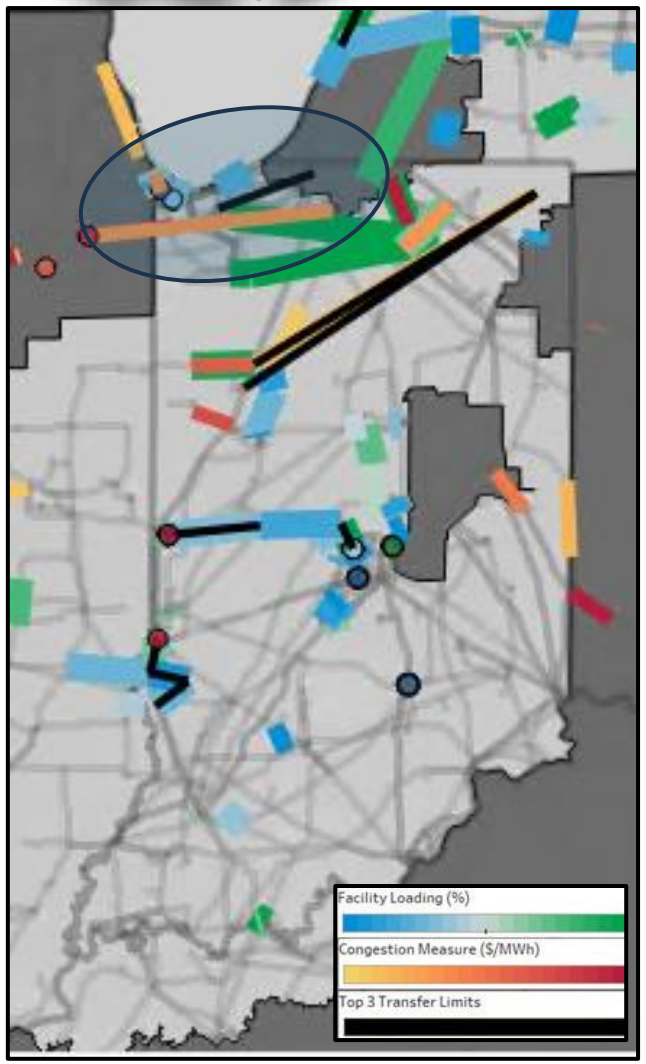
[DEI] Cayuga - [DEI] Nucor Steel 345 kV	3	3	100.4	$21,771
[DEI] Sugar Creek - [DEI] Dresser 345 kV	1	12	-	$232,225
[DEI]Dresser - [AEP] Sullivan 345 kV*	2	4	109.82	-

	Project	Details	Stakeholder/ MISO	Brownfield/ Greenfield	Est. Cost ($M)
Idea 4	***Includes Idea 1***				
	[DEI] Nucor to [WVPA] Witt (LEAP Data Center) 345 kV	Add a 345 kV line	MISO	Greenfield	137.1
	2nd [DEI] Cayuga - [DEI] Nucor 345 kV Circuit	Add a 345 kV circuit	MISO	Greenfield	148.7
	[DEI] Whitestown to [IPL] Guion Road 345 kV Circuit	Uprate existing Whitestown to Guion Road 345 kV circuit to 3000 A	MISO	Brownfield	38.6
	Upgrade existing [DEI] Whitestown and [IPL] Guion Road 345 kV ring buses	Replace breakers, switches, bus conductor and other equipment to obtain 3000 A rating	MISO	Brownfield	42.2
Idea 5	***Includes Idea 1***				
	[DEI/NIPS] Sugar Creek to [DEI] Amo to [IPL]	New 345 kV Line – Add 345 kV positions at Sugar Amo (2), and Monrovia (1)	MISO	Greenfield	296.8
Idea 6	***Includes Idea 1***				
	[NIPS] Reynolds to [AEP] Sullivan to [DEI] Gwynneville 765 kV Tie Lines*	New 765 kV Line – Add 765 kV Positions at Reynolds, Sullivan and Gwynneville	MISO	Greenfield	1,678.2

Issues Identified | Potential Solutions | * MISO/PJM Tie Line | † PJM Facility

MISO Solution Ideas – Indiana

New and upgraded 345 kV & 138 kV network to relieve reliability overloads and create additional transfer capability in the Northern Illinois/Northwest Indiana area



Facility Name	Transfer Rank	Total Transfers Impacted	Facility Loading From Reliability Study (%)	Congestion Measure ($/MW)
[NIPS] Roxana to [CE] Stateline 138 kV*	-	-	-	$23,456
[AEP] Kline to [NIPS] Northeast 138 kV*	-	-	164.49	$701,685

Idea 1

Project	Details	Stakeholder/ MISO	Brownfield/ Greenfield	Est. Cost ($M)
[NIPS] Roxana to [CE] Stateline 138 kV*	Uprate Roxana to Stateline	Stakeholder	Brownfield	11.3

Idea 2

Project	Details	Stakeholder/ MISO	Brownfield/ Greenfield	Est. Cost ($M)
[NIPS] Roxana to [CE] Stateline 138 kV*	Upgrade Roxana substation conductor and upgrade/reconfig. Stateline line exit	Stakeholder	Brownfield	3.3

Idea 3

Project	Details	Stakeholder/ MISO	Brownfield/ Greenfield	Est. Cost ($M)
[AEP] Kline to [NIPS] Northeast 138 kV*	Uprate Northeast to Kline line	Stakeholder	Brownfield	2

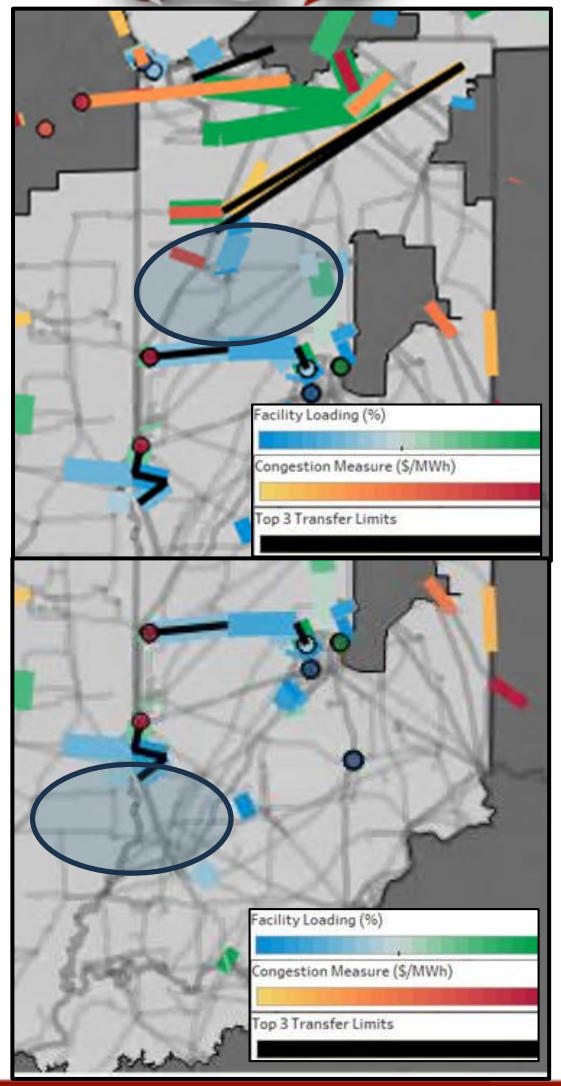
Facility Name	Transfer Rank	Total Transfers Impacted	Facility Loading From Reliability Study (%)	Congestion Measure ($/MW)
[AEP] Olive – [NIPS] Babcock 345 kV*	1	2	-	-
[NIPS] Roxanna – [COMED] Stateline 138kV*	NA	NA	108%	23,456

Idea 1

Project	Details	Stakeholder/ MISO	Brownfield/ Greenfield	Est. Cost ($M)
The CrossState Power link	New Golden Grove Substation	Stakeholder	Greenfield	26.0
The CrossState Power link	Build 345 kV line to loop in [CE] Bloom Davis – [CE] Creek 345 kV line to new Golden Grove substation.	Stakeholder	Greenfield	45.0
The CrossState Power link	Tie [CE]Crete – [NIPS]St. John and [CE]University Park-[NIPS]Green Acres to New Golden Grove substation	Stakeholder	Greenfield	4.9

MISO Solution Ideas – Indiana

Increase line capacity by replacing circuit breakers & rebuilding lines along the Indiana/Illinois border



Facility Name	Transfer Rank	Total Transfers Impacted	Facility Loading From Reliability Study (%)	Congestion Measure ($/MW)
[AEP] Meadow Lake – [NIPS] Reynolds 345kV*	1	5	100.4	-

Idea 1

Project	Details	Stakeholder /MISO	Brownfield/ Greenfield	Est. Cost ($M)
[AEP] Meadow Lake Breaker Replacement	Replace 345kV circuit breakers A, A1, B, and B1 at Meadow Lake 345kV	Stakeholder	Brownfield	5.5

Facility Name	Transfer Rank	Total Transfers Impacted	Facility Loading From Reliability Study (%)	Congestion Measure ($/MW)
[AEP] Sullivan - [AMIL] Snyder 345 kV*	3	8	100.37	-

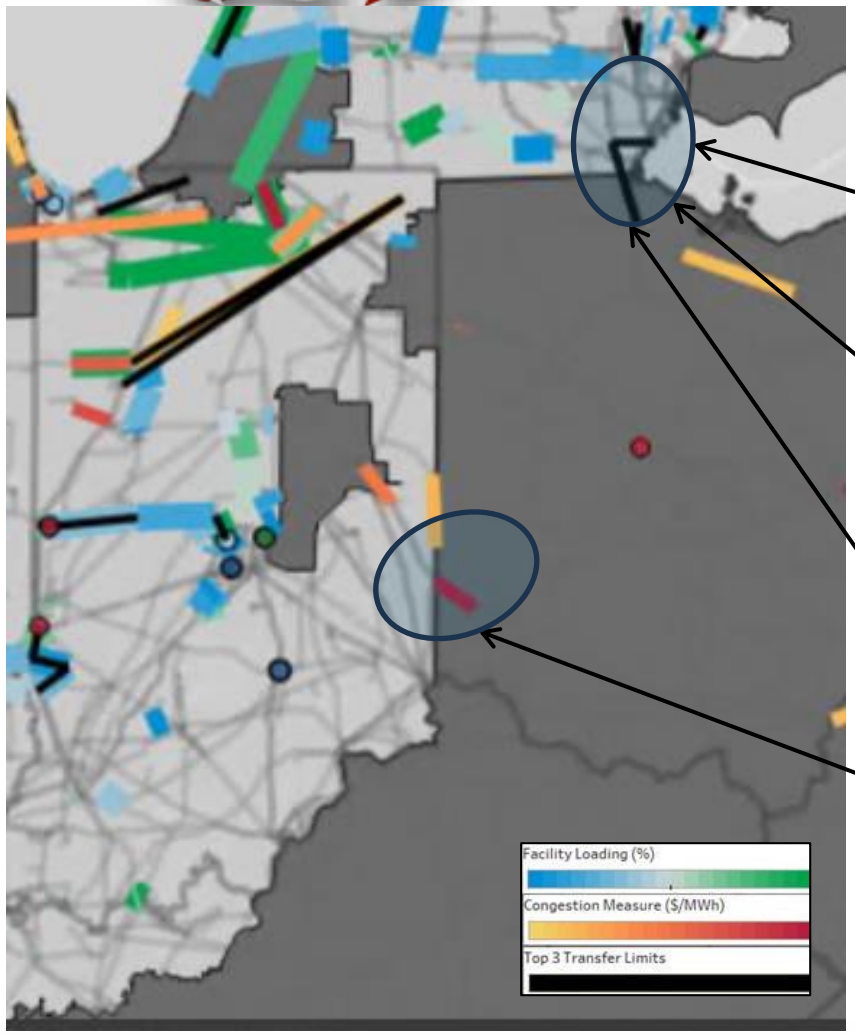
Idea 1

Project	Details	Stakeholder/MISO	Brownfield/ Greenfield	Est. Cost ($M)
[AEP] Sullivan - [AMIL] Snyder 345 kV* rebuild	Rebuild ~4.74 miles double circuit capable 345kV line. AEP only owns ~2 miles of this 345kV line from Sullivan-IN/IL border.	Stakeholder	Brownfield	17.9

Issues Identified | Potential Solutions | * MISO/PJM Tie Line | † PJM Facility

MISO Solution Ideas – Indiana

Add a new tie line between MISO and PJM to mitigate transfer issues between Indiana, Ohio, and the Kentucky interface



Facility Name	Transfer Rank	Total Transfers Impacted	Facility Loading From Reliability Study (%)	Congestion Measure ($/MW)
[FE] Lemoyne - [ITCT] Laplaisance 345 kV*	2	9	-	-
[AEP] Tanners Creek - [DEOK] Miami Fort 345 kV†	1	7	-	3,972

Idea 1

Project	Details	Stakeholder/ MISO	Brownfield/ Greenfield	Est. Cost ($M)
[DEI] Batesville to [DEOK] Willey 345 kV*	Add new 345 kV line	Stakeholder	Greenfield	194.5
[DEOK] Willey Sub 345 kV†	Expand the 138 kV sub to 345 kV	Stakeholder	Brownfield	15.8

Idea 2

[AEP] Sorenson to [AEP] Allen to [AEP] East Lima Rebuild†	Rebuild 345 KV line to double circuit to allow Sorenson to SW Lima 345 kV circuit	MISO	Brownfield	328.0
[AEP]Sorenson to [AEP] SW Lima Circuit 345 kV†	Add second 345 kV circuit	MISO	Brownfield/ Greenfield	201.4

Idea 3

Includes Idea 1

Includes Idea 2

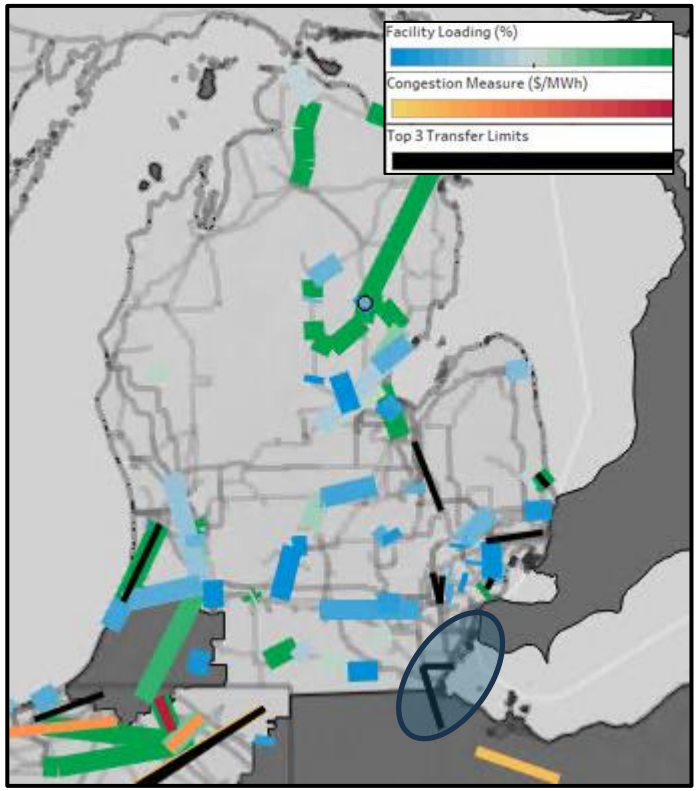
Idea 4

[DEI] Batesville to [DEOK] Willey 345 kV*	Add new 345 kV line	Stakeholder	Greenfield	194.5
[DEOK] Willey Sub 345 kV†	Expand the 138 kV sub to 345 kV	Stakeholder	Brownfield	15.8
[DEI] Whitewater River Station 345 kV	Tie [DEI]Batesville – [DEOK] Willey* to [AEP] Tanners Creek† – [AEP] DeSoto Circuits†	Stakeholder	Greenfield	26.9

Issues Identified | Potential Solutions | * MISO/PJM Tie Line | † PJM Facility

MISO Solution Ideas – Michigan

Improve import and export limitations through brownfield upgrade in the ITC footprint



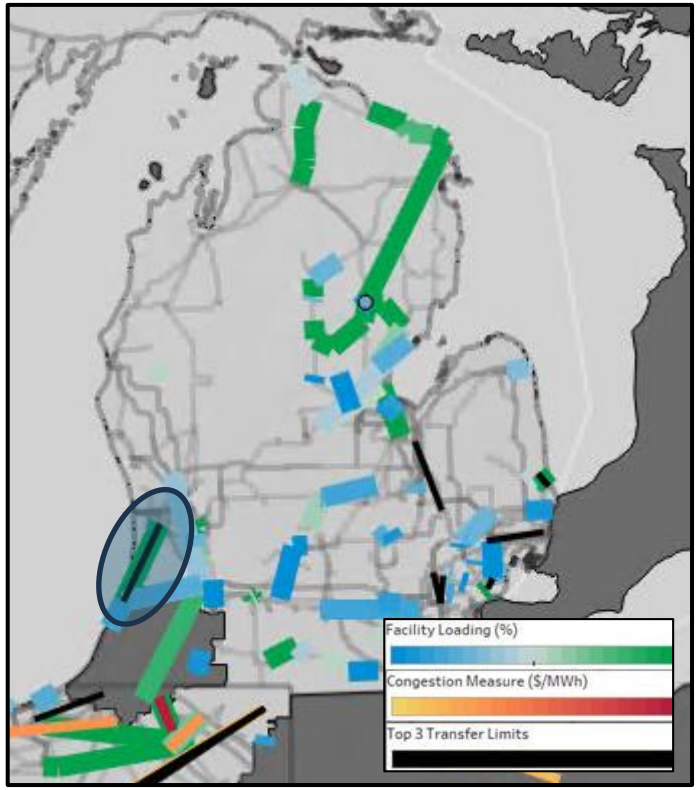
Facility Name	Transfer Rank	Total Transfers Impacted	Facility Loading From Reliability Study (%)	Congestion Measure ($/MW)
[ITCT] Laplaisance – [ITCT] Monroe 345 kV	1	7	-	334.08
[ITCT] Laplaisance – [FE] Lemoyne 345 kV*	1	9	-	316.024

Idea 1

Project	Details	Stakeholder/ MISO	Brownfield/ Greenfield	Est. Cost ($M)
[ITCT] Laplaisance – [FE] Lemoyne 345 kV*	Sag remediation to increase ratings	Stakeholder	Brownfield	2.4
[ITCT] Laplaisance – [ITCT] Monroe 345 kV	Rebuild ~4 miles of double circuit line	Stakeholder	Brownfield	27.4

MISO Solution Ideas – Michigan

Improve import and export limitations through brownfield upgrade in the ITC footprint



Facility Name	Transfer Rank	Total Transfers Impacted	Facility Loading From Reliability Study (%)	Congestion Measure ($/MW)
[METC] Palisades – [METC] Roosevelt 345 kV	1	2	124.87	-
[METC] Palisades – [METC] Argenta 345 kV	-	-	103.58	-

Idea 1

Project	Details	Stakeholder/ MISO	Brownfield/ Greenfield	Est. Cost ($M)
[METC] Palisades to [METC] Roosevelt 345 kV	Sag remediation to increase ratings	Stakeholder	Brownfield	2.4

Idea 2

	Includes Idea 1			
[METC] Palisades to [METC] Vergennes 345 kV	Sag remediation to increase ratings between [METC] Palisades and Macatawa River site.	MISO	Brownfield	6
[METC] New Macatawa River Substation 345 kV	Tie [METC]Palisades – [METC]Roosevelt, [METC]Palisades – [METC]Vergennes and [METC]Roosevelt – [METC]Gaines 345 kV circuits together where they cross	MISO	Greenfield	26.9

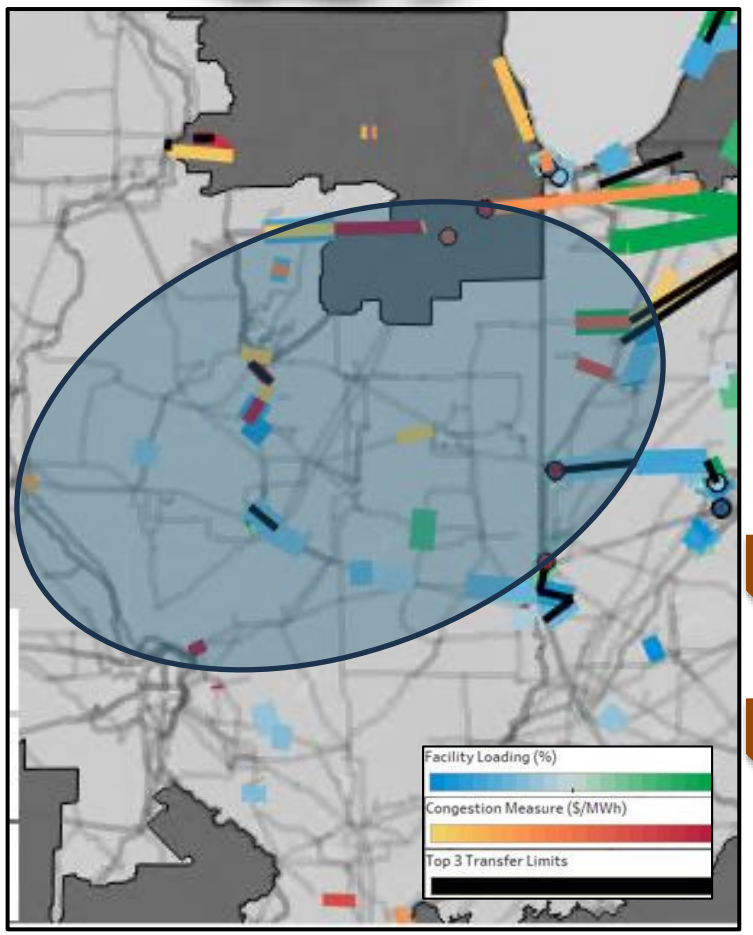
Idea 3

	Includes Idea 1			
[METC] Palisades to [METC] Vergennes 345 kV	Sag remediation to increase ratings between [METC]Palisades and Macatawa River site.	MISO	Brownfield	6
[METC] New Macatawa River Substation 345 kV	Tie [METC]Palisades – [METC]Roosevelt, Palisades – Vergennes and Roosevelt – Gaines 345 kV circuits together where they cross	MISO	Greenfield	26.9
[METC] New Ottogan Substation 345kV	Tie [METC] Macatawa – [METC]Gaines 345 kV, and [METC]Macatawa – [METC]Vergennes 345 kV , and [METC]Argenta – [METC]Tallmadge 345 kV, and [METC]Argenta – [METC]Meyer 345 kV circuits where they cross.	Stakeholder	Greenfield	39.6

Issues Identified | Potential Solutions | * MISO/PJM Tie Line | † PJM Facility

MISO Solution Ideas – Illinois

New and upgraded 345 kV network to relieve reliability overloads and create additional transfer capability in the central Illinois area



Facility Name	Transfer Rank	Total Transfers Impacted	Facility Loading From Reliability Study (%)	Congestion Measure ($/MW)
[DEI] Cayuga Sub – [DEI] Cayuga 345 kV line	1	11	144.54	11,803
[NIPS] Reynolds 345/138 kV XFMR	1	4	100.11	8,614
[AEP] Olive – [NIPS] Babcock 345 kV line*	1	2	-	-
[AEP] Meadow – [NIPS] Reynolds 345 kV line*	1	5	-	-
[NIPS] Schafer Tap – [NIPS] Schafer 138 kV line	2	2	167.15	$4,308
[AEP] Eugene – [DEI] Cayuga Sub 345 Kv*	2	9	111.03	
[DEI] Cayuga – [DEI] Nucor Steel 345 kV	3	3	100.4	$9,903
[CE] Quad Cities – [ALTW] Rock Creek 345 kV*	3	1	-	$42,193
[NIPS] Starke – [NIPS] Valparsio138 kV	-	-	217.41	-
[NIPS] Schafer – [NIPS] Starke 138 kV	-	-	194.88	-
[NIPS] Flint Lake – [NIPS] Valparaiso 138 kV	-	-	172.46	-
[AEP] Kline – [NIPS] Northeast 138 kV*	-	-	164.49	-

Idea 1

Project	Details	Stakeholder/ MISO	Brownfield/ Greenfield	Est. Cost ($M) ($M)
Ameren Large Project	New Transmission Lines with Expanded/New Substations	Stakeholder	Mix	1,585

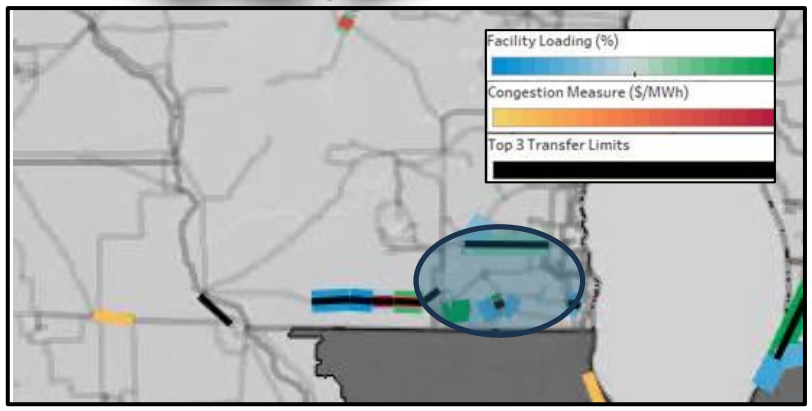
Idea 2

Project	Details	Stakeholder/ MISO	Brownfield/ Greenfield	Est. Cost ($M)
[AMIL]Baldwin 345kV/138kV XFMR	Substation Expansion	Stakeholder	Brownfield	7.5
[AMIL]Neoga – [AMIL]Shelbyville 138kV	Upgrade Line	Stakeholder	Brownfield	41.3
[AMIL]Shelbyville – [AMIL]Pana 138kV	Upgrade Line	Stakeholder	Brownfield	42.5
[AMIL]Frederick – [AMIL]Flannigan 138kV	Upgrade Line	Stakeholder	Brownfield	152.2
[AMIL]Barrel – [AMIL]Oakville – [AMIL]North Nashville 138kV	Upgrade Line	Stakeholder	Brownfield	63.7
[AMIL]Oakville 138kV	Substation Expansion	Stakeholder	Brownfield	0.66

Issues Identified | Potential Solutions | * MISO/PJM Tie Line | † PJM Facility

MISO Solution Ideas – Wisconsin

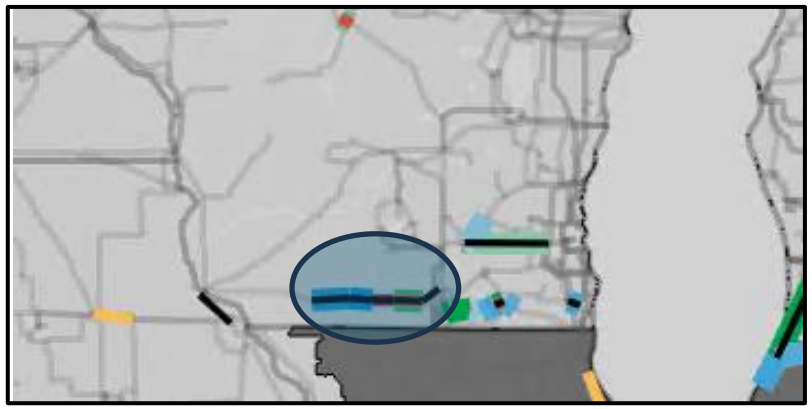
Relieve congestion, reliability and transfer issues along SW Wisconsin through a new 345 kV line and improve transfer capability and relieve reliability overloads between S. Wisconsin and N. Illinois



Facility Name	Transfer Rank	Total Transfers Impacted	Facility Loading From Reliability Study (%)	Congestion Measure ($/MW)
[ATC North Lake Geneva - [ATC] North Lake Geneva Tap 138 kV	2	1	114.6	-
[ATC] Bristol - [ATC] Elkhorn 138 kV	1	1	157.12	$45,005

Idea 1

Project	Details	Stakeholder/MISO	Brownfield/ Greenfield	Est. Cost ($M)
[ATC] Bristol – [ATC] Elkhorn 138 kV	Line Rebuild	Stakeholder	Brownfield	TBD



Facility Name	Transfer Rank	Total Transfers Impacted	Facility Loading From Reliability Study (%)	Congestion Measure ($/MW)
[ATC] Darlington – [ATC] Klondike 138kV	2	1	91.8	$679
[ATC] Albany - [ATC] Bass Creek 138 kV	1	2	115.12	$35,486
[ATC]North Monroe - [ATC] Albany 138 kV	2	2	103.45	$293,100
[ATC] Klondike - [ATC] North Monroe 138 kV	3	1	90.64	-

Idea 1

Project	Details	Stakeholder/MISO	Brownfield/ Greenfield	Est. Cost ($M)
[ATC] New Hill Valley to [ATC] Paddock 345 kV	New 345kV line in SW WI – expected to pull a lot of existing flow off the 138kV and 69kV system.	Stakeholder	Greenfield	669.5

Solution Pathways

Next Steps

- PJM and MISO do not have a project type, and related cost allocation, to capture the full suite of issues identified and value provided (e.g. economic, reliability and transfer capability) by the solutions evaluated in the ITCS process
- PJM and MISO are considering pathways to pursue solutions to the ITCS findings:
  - *MISO*: Continue efforts to refine a set of interregional transmission solutions with MISO states and stakeholders
  - *PJM*: RTEP processes (reliability and market efficiency processes) and M3 (local projects, for example end-of-life facilities)
    - PJM identified upgrades that are a part of RTEP or M3 processes will proceed on their own time schedules
  - *PJM / MISO*: Consider the applicability of TMEP/IMEP project types
- PJM and MISO will coordinate with states and stakeholders on the above pathways and work to finalize an approach on additional next steps to pursue solutions to ITCS findings that are not actionable via current processes

Immediate Next Steps: PJM

- PJM is reviewing MISO conceptual window solutions
- PJM has investigated if facilities identified in the PJM/MISO ITCS are:
  - Identified also in the RTEP reliability process, including operational flexibility, or
  - Identified also in the RTEP Market Efficiency process, or
  - Are also in M3
- In the case of any overlaps (e.g. ITCS/RTEP reliability) PJM may:
  - Consider the ITCS needs in the identification of the solutions
  - Investigate opportunities to right-size solutions to, e.g. the RTEP reliability need(s)

ITCS and PJM RTEP/M3 Overlaps (preliminary)

Area	RTO	Facility Name	kV	Total Transfers Impacted ● : >10 ■ : 4-10 ▲ : 1-3	Transfer Rank	Facility Loading From Reliability Study ● : >150% ■ : 100% - 150% ▲ : <100%	Annual Congestion ($) ● : > $1M ■ $100k - $1M ▲ : < $100k	Potential Path Forward Under Existing Processes?*
FE/ITCT	Tie Line	[FE]Lemoyn - [ITCT]Laplaisance 345 kV	345	■	1	▲	■	Yes
CE	PJM	[CE]Garden Pl - [CE]ESSH71 138 kV	138	■	1	●	●	Yes
AEP/DEO&K	PJM	[AEP] Tanners Creek - [DEOK] Miami Fort 345 kV	345	■	1	■	●	Yes
AEP/IPL	Tie Line	[AEP] Fall Creek - [IPL] Madison County 345 kV	345	■	1	▲	●	No
AEP/NIPS	Tie Line	[AEP] Meadow - [NIPS] Reynolds 345 kV	345	■	1	■	▲	Yes
AEP	PJM	[AEP] Desoto - [AEP] Fall Creek 345 kV	345	■	1	▲	▲	Yes
CE/AMIL	Tie Line	[CE]Austin - [AMIL]Kincaid 345 kV	345	■	1	■	▲	No
AEP/NIPS	Tie Line	[AEP] Olive - [NIPS] Babcock 345 kV	345	▲	1	▲	▲	Yes
CE	PJM	[CE]Goodings - [CE]Lockport 345 kV	345	▲	1	▲	▲	No
CE/ALTE	Tie Line	[CE]Albany (South Desk) - [ALTW]Garden Pl 138 kV	138	●	2	●	●	No
AEP/DEI	Tie Line	[AEP]Eugene - [DEI]Cayuga Sub 345 kV	345	■	2	●	●	Yes
AEP	PJM	[AEP]Benton Harbor - [AEP]Segreto 345 kV	345	■	2	■	●	Yes
AEP/DEI	Tie Line	[AEP]Dresser - [DEI]Sullivan 345 kV	345	■	2	■	▲	No
AEP/AMIL	Tie Line	[AEP]Snyder - [AMIL]Sullivan 345 kV	345	■	3	■	●	Yes
AEP	PJM	[AEP]Cook - [AEP]Segreto 345 kV	345	■	3	■	▲	No
CE/AMIL	Tie Line	[CE]Powerton - [AMIL]Towerline 138 kV	138	▲	3	■	●	Yes
CE	PJM	[CE]Lee - [CE]Byron 345 kV	345	▲	3	■	■	No
AEP/DEI	Tie Line	[AEP]Sullivan - [DEI]Fairbanks 345 kV	345	▲	3	●	▲	No
AEP	PJM	[AEP]Hyatt - [AEP]Malis 345 kV	345	▲	3	■	▲	Yes
CE/ALTW	Tie Line	[CE]Quad Cities - [ALTW]Rock Creek (South Desk)	345	▲	3	▲	▲	Yes

* Results given ITCS model assumptions reported on slide 5, including PJM 2024 Load Forecast and Workshop Policy Study resource fleet

Immediate Next Steps: MISO

- Continue collaboration on solution ideas with submitters and PJM to refine solution recommendations and potential alternatives
- Perform screening analyses of potential solutions
- Leverage the above to finalize a portfolio of projects that could be considered for recommendation via pathways described on slide 30

Concluding Remarks

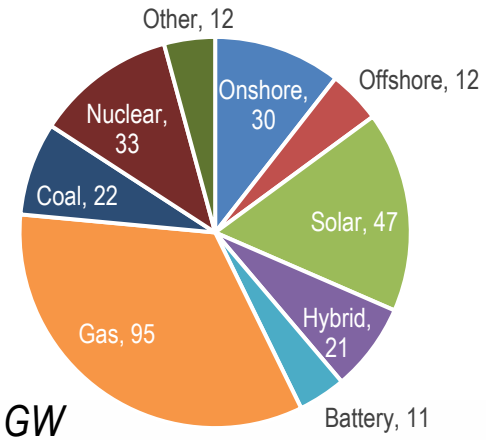
- PJM and MISO conducted an innovative transfer capability study
  - Multi-pronged analysis identifying reliability and economic needs
  - Use of common model with realistic long-term assumptions, including accounting of policies
- The two RTOs identified several transfer limiting facilities along the seam overlapping with reliability and economic needs
- PJM and MISO will collaborate with states and stakeholders to continue evaluating the proposed solution concepts from MISO's conceptual window and investigate pathways (discussed on slide 30) to advance solutions to the ITCS needs
  - Next update to IPSAC in will be Q4 2025

Appendix:

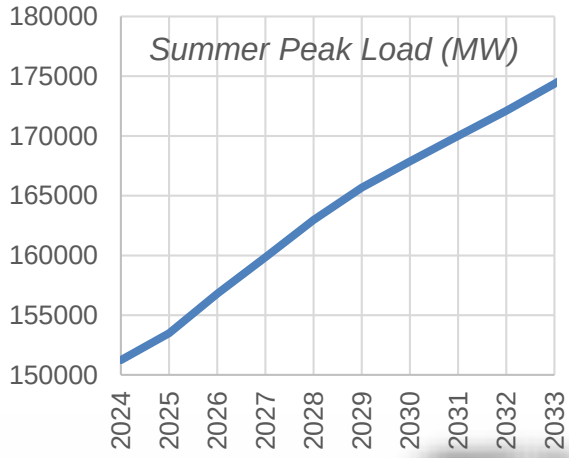
Blended Model Assumptions at a Glance

PJM Footprint:

- PJM's 2024 Load Forecast
- PJM Independent State Agency Committee (ISAC) Policy Workbook
  - Policy-driven retirements (state & federal 25 GW)
  - New generation policies (98 GW renewable/ storage *added*, 7 GW of thermal based on queue)
- 2024 RTEP topology

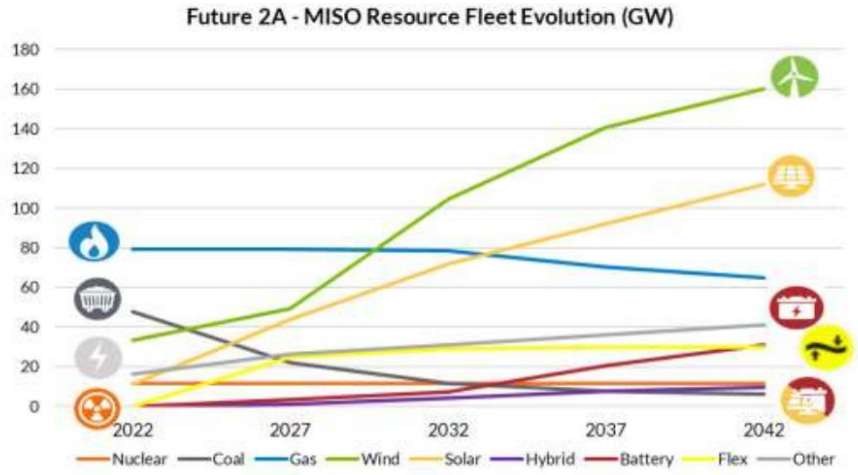


Tot. 282 GW



MISO Footprint:

- MISO LRTP Future 2A 2032 (without Tranche 2.1 Solutions)
  - 93GW of additional renewable generation and 15.5GW of new thermals
  - 57 GW of retirements
  - Load Shapes, Peak Load, and Annual energy based on the modified 2019 Merged Load Forecast developed in the Series 1A F2A Futures
- Additional details on Future Assumptions: Series1A Futures Report



Nine Bi-directional Transfers

Transfer Short Name	Interface Name	Transfer Full Name	Transfer No.	Source	Sink
Michigan Exports To The South	Michigan Southern Interface	Michigan Exports To The South Over The Michigan Southern Interface	1a	LRZ7	LRZ6 & PJM West (minus ComEd)
Michigan Imports From The South		Michigan Imports From The South Over The Michigan Southern Interface	1b	LRZ6 & PJM West (minus ComEd)	LRZ7
Wisconsin Exports To Northern Illinois	Wisconsin Interface w/ Northern Illinois	Wisconsin Exports To Northern Illinois Over The Wisconsin Interface With Northern Illinois	2a	LRZ2	ComEd
Wisconsin Imports From Northern Illinois		Wisconsin Imports From Northern Illinois Over The Wisconsin Interface With Northern Illinois	2b	ComEd	LRZ2
Iowa & Southern Illinois Exports To Northern Illinois	Iowa/Illinois Interface w/ Northern Illinois	Iowa & Southern Illinois Exports To Northern Illinois Over The Iowa/Southern Illinois Interface With Northern Illinois	3a	LRZ3 & LRZ4	ComEd
Iowa & Southern Illinois Imports From Northern Illinois		Iowa & Southern Illinois Imports From Northern Illinois Over The Iowa/Southern Illinois Interface With Northern Illinois	3b	ComEd	LRZ3 & LRZ4
Indiana Exports To Northern Illinois	Indiana Interface w/ Northern Illinois	Indiana Exports To Northern Illinois Over The Indiana Interface With Northern Illinois	4a	LRZ6	ComEd
Indiana Imports From Northern Illinois		Indiana Imports From Northern Illinois Over The Indiana Interface With Northern Illinois	4b	ComEd	LRZ6
Indiana Exports To The East	Indiana Interface w/ Ohio & Kentucky	Indiana Exports To The East Over The Indiana Interface With Ohio	5a	LRZ6	PJM West (minus ComEd)
Indiana Imports From The East		Indiana Imports From The East Over The Indiana Interface With Ohio	5b	PJM West (minus ComEd)	LRZ6

Interfaces considered for transfer analysis

NERC ITCS Transfers Between MISO & PJM (see next slide)
E12: MISO West <-> PJM West
E16: MISO Central <-> PJM West
E22: MISO East <-> PJM West

General Transfers Between MISO & PJM
MISO Classic <-> PJM

Reliability Analysis

- MISO:
  - Focus on MISO Classic region (East/Central/West)
  - Reliability tests:
    - Single initiating (*N-1*) event contingency analysis
    - Summer Peak, Winter Peak, and Light Load
- PJM: near-full reliability analysis
  - Focus on PJM West
  - Reliability tests
    - Summer, Winter, and Light Load
    - *N*-1, *N*-2 (345*kV* and above), Generation Deliverability, Load Deliverability for ComEd

Economic Event File Assumptions

- MISO's LRTP Series1A F2A events
- Subset of 2024 PJM Market Efficiency monitored flowgates (115kV and above near the seam, 230kV+ in the rest of PJM WEST, 345kV+ in PJM East and PJM South)
- Subset of PJM Generation Deliverability critical flowgates (115kV and above near the seam, 230kV+ in the rest of PJM WEST, 345kV+ in PJM East and PJM South)
- MISO-PJM Tie Lines
- PJM Interfaces modified consistent with PJM assumptions