MISO's Experiences with Congestion Management Enhancement

6/22/2015

Background

- Prior to February 1st 2012, MISO used Constraint Relaxation. This practice often produced inefficient shadow prices that distorted the associated LMPs and understated the reliability cost of violating a constraint.

- On February 1, 2012, per IMM recommendation, MISO discontinued the use of Constraint Relaxation on non-Market-to-Market Transmission constraints and started to use Marginal Value Limits (MVLs) to set LMPs when a transmission constraint was unmanageable. The default MVL depends on the type of constraint and the voltage level of the monitored elements of that constraint.

- Expected impacts of the single step MVL
  - Improved Real-Time congestion pricing and higher Real-Time congestion values
  - Improved Real-Time pricing performance and improved price convergence between the Day-Ahead and Real-Time markets by eliminating inefficient shadow prices

Background Continued…

- Between February 1st 2013 and November 2013, MISO used a single step MVL to price relief for non market-to-market constraints (non-M2M) for both Day-Ahead and Real-Time markets.

- Observations during the first months of the MVL implementation
  - Higher Real-Time congestion values were experienced with constraint relaxation turned off.
  - Discontinuing constraint relaxation exacerbated price spikes at impacted intervals
  - Reacting to high LMPs, customers managed net load by increasing behind-the-meter-generation and/or by the reduction of industrial load
  - In reaction to high LMPs, some market participants utilized "must run" generation in local constrained areas.
  - Reacting to very low LMPs on constraints previously managed solely by manual curtailment, market participants chose to self-curtail Intermittent (non-DIR) wind generation

Background Continued…

- After observing increase price volatility, the IMM recommended MISO to consider implementing a graduated marginal value limit, or a Transmission Constraint Demand Curve (TCDC) for transmission constraints.

- TCDC would not apply to Market to Market constraints (i.e. between MISO-PJM and MISO-SPP)

MISO's implemented TCDC

- Multi-step demand curves take into account different exceedance levels for transmission constraints
- For simplicity, two-step demand curves were implemented
  - Lower demand curve block for relatively small exceedances
  - Higher demand curve block for larger exceedances. This is the original single step MVL
- Applied TCDC for non market-to-market constraints only
- Applied to both Day ahead and Real time Markets
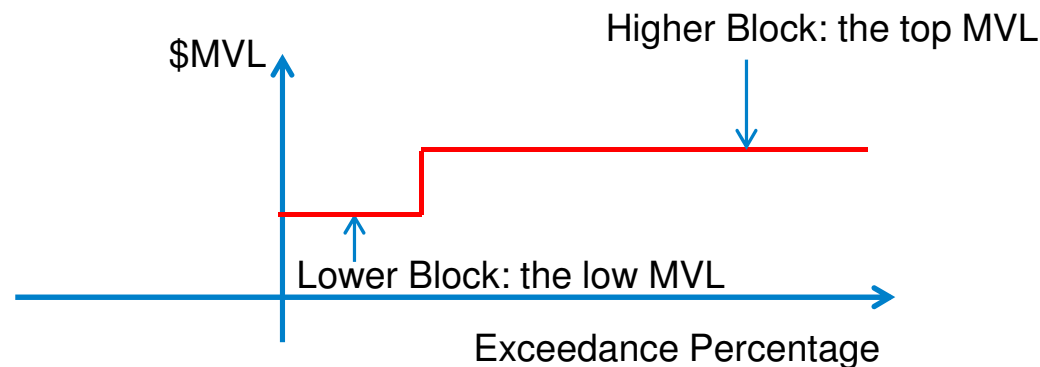
MISO's implemented TCDC (Group 1)

TCDC curves are percentage based with the exception of the TLR constraints. Due to the nature of transmission constraints associated with Transmission Loading Relief events, the constraint exceedance of the TLR TCDC is defined as the MW amount above the binding limit.

| Group 1		Type and Voltage (V)			
		V <= 100kV $/MWh	>100kV and <161kV $/MWh	>= 161kV $/MWh	IROL $/MWh
Binding Constraint Exceedance Percentage	>=102%	$500	$1,000	$2,000	$4,000
	>100% and <102%	$400	$700	$1,000	$3,000

Group 1		TLR $/MW
Constraint Exceedance MW	>= 10 MW	$2,000
	>0 MW and <10 MW	$1,000

MISO's implemented TCDC (Group 2)

Constraints that raise reliability concerns differing from other constraints in the same voltage class when their flows exceed their binding limits are managed through Group 2 TCDCs

Group 2		Type and Voltage (V)		
		V <= 100kV $/MWh	>100kV and <161kV $/MWh	V >= 161kV $/MWh
Binding Constraint Exceedance Percentage	>=102%	$1,000	$2,000	$3,000
	>100% and <102%	$700	$1,000	$2,000

Binding Constraint Levels
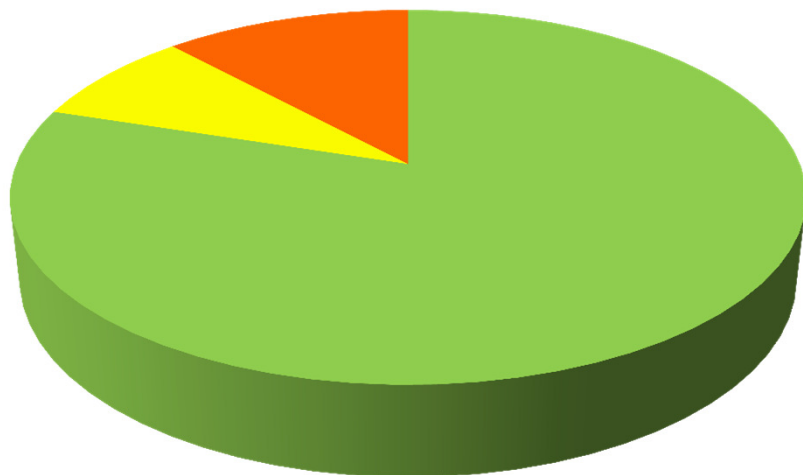
- ■ Manageable (Flow=100%)
- ■ TCDC Block 1 (100%<Flow<102%)
- ■ TCDC Block 2 (Flow>=102%)

Binding Constraint Flow	Interval Count	% of Total
Manageable (Flow=100%)	392,204	80.3%
TCDC Block 1 (100%<Flow<102%)	38,897	8.0%
TCDC Block 2 (Flow>=102%)	57,532	11.8%
Total	488,633	100%

Date Range: Dec 1 2013 - Feb 28 2015

MISO

Binding Constraint Breakdown

| Constraint Curve	Binding Intervals (Manageable)	TCDC Block 1 Intervals (Unmanageable)	TCDC Block 2 Intervals (Unmanageable)	Total Binding Intervals	Unmanageable % of Total
Group 1: <=100KV (%)	58,957	10,588	21,765	91,310	35.4%
Group 1: 100KV-161KV (%)	108,421	18,288	25,296	152,005	28.7%
Group 1: >=161KV (%)	185,030	6,494	5,942	197,466	6.3%
Group 2: <=100KV (%)	33,765	3,095	4,052	40,912	17.5%
Group 2: 100KV-161KV (%)	2,084	393	355	2,832	26.4%
Group 2: >=161KV (%)	3,719	26	13	3,758	1.0%
IROL Default (%)	123	3	90	216	43.1%
TLR Default (MW)	105	10	19	134	21.6%
Grand Total	**392,204**	**38,897**	**57,532**	**488,633**	**19.7%**

Date Range: Dec 1 2013 - Feb 28 2015

Congestion Reduction as a Result of TCDC Implementation

- Minor or transient exceedances are sent a more appropriate price signal
- Less volatility in pricing/generation by not chasing false signals
- Congestion reduction of $274 Million from 12/1/13 – 2/28/2015* compared to using a single MVL.

Constraint Curve	Congestion w/o TCDC	Congestion Reduction due to TCDC	Reduction % due to TCDC
Group 1: <=100KV (%)	$145,842,029	$1,994,730	1.4%
Group 1: 100KV-161KV (%)	$924,302,067	$72,987,020	7.9%
Group 1: >=161KV (%)	$1,214,529,695	$188,911,241	15.6%
Group 2: <=100KV (%)	$68,752,584	$3,513,735	5.1%
Group 2: 100KV-161KV (%)	$32,478,884	$5,931,847	18.3%
Group 2: >=161KV (%)	$8,671,265	$289,127	3.3%
IROL Default (%)	$6,220,689	$107,242	1.7%
TLR Default (MW)	$1,473,429	$290,102	19.7%
Grand Total	**$2,429,338,591**	**$274,046,069**	**11.3%**

*ELMP went into effect on 3/1/2015. Savings calculated with standard LMP
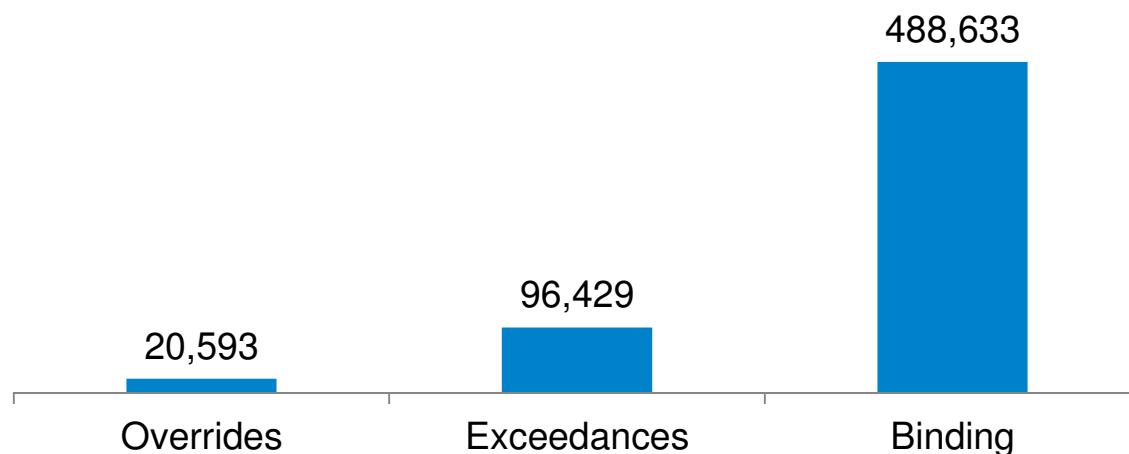
MISO

Combined View of TCDC Impact
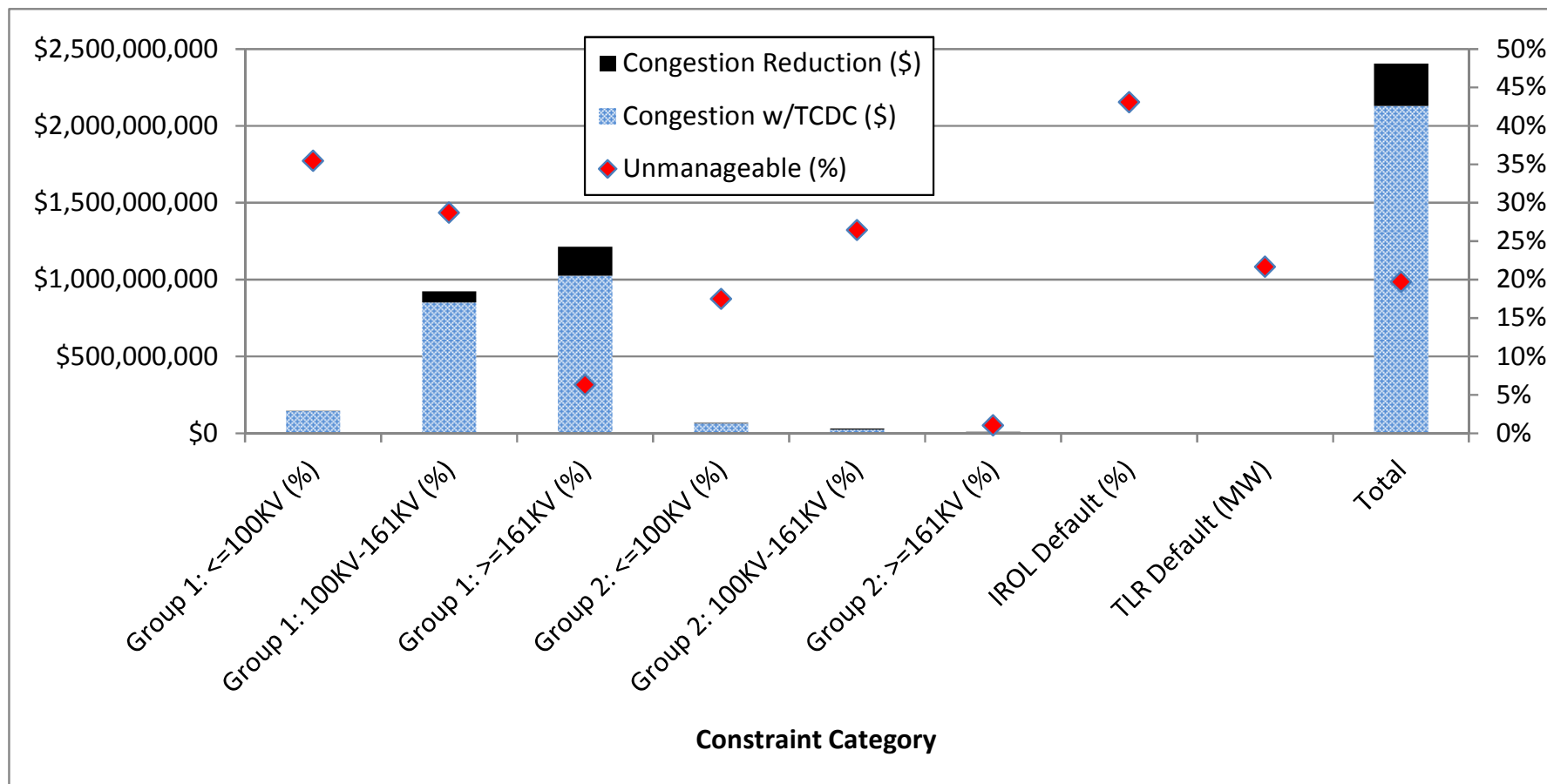
Override of TCDC Marginal Value Limits

- Marginal Value Limits (MVL) of TCDC can be temporarily overridden if the flow over a constraint is greater than or is expected to be greater than the binding limit in more than two intervals or if the constraint raises elevated reliability concerns.

- Data shows that the use of temporary overrides is not prevalent.

Count of Occurrences

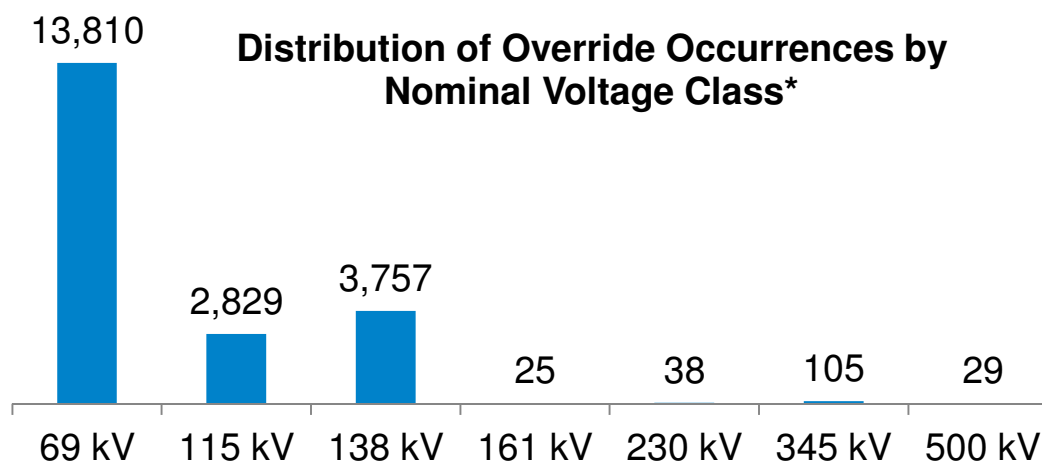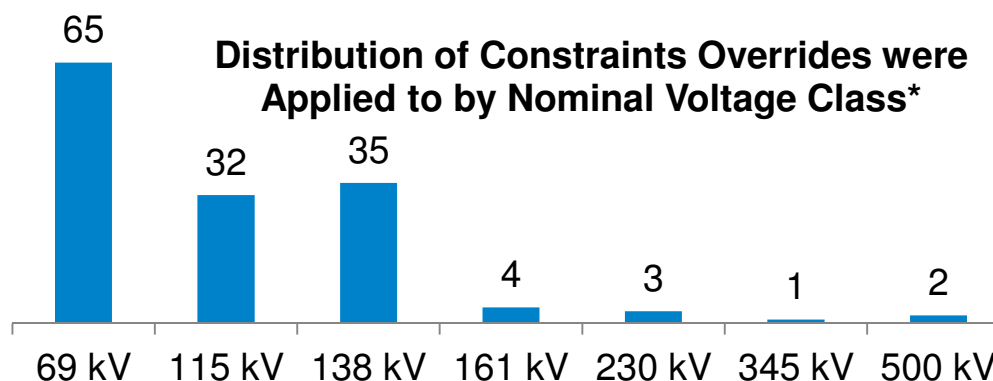|	20,593	96,429	488,633
	Overrides	Exceedances	Binding

Study Period: Dec. 2013 – Feb. 2015

Override of TCDC Marginal Value Limits

- Overrides were applied to only a small subset of MISO's constraints, almost entirely involving lower voltage constraints.

- Study period: Dec 2013 – Feb 2015

- Binding non Market-to-Market constraints: ~ 1800

- **Overrides applied to total of 142 constraints**

Distribution of Constraints Overrides were Applied to by Nominal Voltage Class*

69 kV	115 kV	138 kV	161 kV	230 kV	345 kV	500 kV
65	32	35	4	3	1	2

Distribution of Override Occurrences by Nominal Voltage Class*

69 kV	115 kV	138 kV	161 kV	230 kV	345 kV	500 kV
13,810	2,829	3,757	25	38	105	29

* Voltage on low side of transformers used

MISO

Summary

- **The TCDCs that are in use at MISO are performing as designed**

- **The impact of the newly implemented Extended LMP (ELMP) on the constraint shadow prices will need to be studied to determine if any adjustments will be needed to the TCDCs.**

- **The impact of wind on constraints in the northwest area of MISO has resulted in several constraints moving from group 1 to group 2**

Appendix

Wind and TCDCs

- No need to change the current TCDC specifically for wind-impacted transmission constraints

  - Manual overrides were applied for only handful of days for those wind impacted constraints. When override occurred, it usually occurred for a long period -- several consecutive days .

  - The constraints with high number of overrides could be managed well in group 2

  - A procedure is needed to reassign wind-impacted constraints to group 1 or 2.

Constraint Name	# of days having override	Daily Max # of 5-min override intervals	Binding (%) under group1	Binding(%) under group2
ALW16X26_WAPELLO_TR91_TR91	15	262	24%	2%
DPC16006_ADAMS_I_TR2_TR2	20	212	21%	1%
ALW16065_ARORAHTS_ARORAKLLG69_1_1	8	239	32%	28%
ALW16085_ARORAHTS_ARORAJASPE69_1_1	10	275	38%	7%
ALW16066_HIAWATA_TR1_TR1	3	194	23%	0%
NIP13098_HONEYC_T_69103_C	8	139	78%	12%
ALW16015_KNOXVIL_KNOXVLUCAS69_1_1	4	116	9%	0%
HE34X05_DRESSER_DRESS08ALE13_2_1	4	182	27%	18%
ALW16077_WAPELLO_TR92_TR92	5	117	15%	11%
NSPALE01_GLENMNT_GLENMREDRO11_1_1	5	177	2%	0%

Constraints with Manual Override Needed

CONSTRAINT		BINDING	OVERRIDE COUNT	VOLTAGE(kV)			
DPC16006_ADAMS_I_TR2_TR2		7317	1540	69			

SP Interval		≤400	(400,500]	(500,700]	(700,1000]	(1000,1500]	(1500,2000]	(2000,2500]	>2500
SP Distribution	Binding	4806	949	420	1062	36	44	0	0
	Percentage	65.68%	12.97%	5.74%	14.51%	0.49%	0.60%	0.00%	0.00%
Override	0	3974	888	307	608	0	0	0	0
	1	832	61	113	454	36	44	0	0

- The group 2 TCDC managed the constraint for nearly 99% bindings. However, on May 1st ,2014, the Shadow Price (SP's) of the constraint was beyond $1000/MWh for an extended period of time, from 7:50 to 10:10 and on May 31st,2014 , the SP's were kept at 2000$/MWh from 16:25 to 19:30. Manual overrides were necessary during the period.

CONSTRAINT		BINDING	OVERRIDE COUNT	VOLTAGE(kV)			
ALW16065_ARORAHTS_ARORAKLLG69_1_1		2442	977	69			

SP Interval		≤400	(400,500]	(500,700]	(700,1000]	(1000,1500]	(1500,2000]	(2000,2500]	>2500
SP Distribution	Binding	679	980	28	74	609	20	52	0
	Percentage	27.81%	40.13%	1.15%	3.03%	24.94%	0.82%	2.13%	0.00%
Override	0	488	977	0	0	0	0	0	0
	1	191	3	28	74	609	20	52	0

- During 11/16/2013-06/30/2014, the SP's of the constraint went beyond $1000/MWh with a high frequency. On May 1st,2014, from 11:50-13:00, the SP's were kept at $2000/MWh, and from 13:05-17:20, the SP's were kept at $2500/MWh. Increasing MVL were necessary during the period for the constraint.

MVL higher than $2500/MW is not necessary

Rerun UDS cases by increasing/decreasing MVLs by $500/MW or $1000/MW, to find out the flow change and the impact to the congestion relief.

Case	MKT HOUR	CONSTRAINT	MVL at base case	Flow at base case	MVL ↓ $500/MWh		MVL ↓ $1000/MWh	
					FLOW	VARIAT ION	FLOW	VARIAT ION
1	5/1/2014 13:05 EST	ALW16065_ARORAHTS_ARORAKLLG69_1_1	2500	59.4	60.2	1.4%	61.3	3.3%
2	4/23/2014 20:05 EST	Fancy_Point_500_230_AT1_Xmfr_ftlo_Webre__Bayou_L	3000	1702.5	1702.7	0.0%	1703.1	0.0%
3	1/7/2014 18:50 EST	CIN34027_BLOOMTON_TR3_TR3	3000	628.7	631.1	0.4%	631.1	0.4%
		TVA50023_MCCRACKE_MCCRA5MCCR16_1_1	3000	342.6	342.6	0.0%	342.6	0.0%
4	1/14/2014 09:50 EST	EATVA003_FISHR2_FISHR2_NEWPRT5_A	3000	276.6	276.6	0.0%	276.6	0.0%
5	1/14/2014 07:35 EST	Reverse_ORCA_1_Interface	3000	892.4	893.3	0.1%	895.2	0.3%
6	6/25/2014 17:05 EST	NIP13098_HONEYC_T_69103_C	3000	55.5	56.1	1.1%	56.2	1.3%

- UDS case rerun results indicate that the MVL higher than $2,500 /MWh provides very little congestion relief as compared to $2,500/MWh setting.
- The manual override MVL up to $2500/MWh should be high enough for economical congestion relief, otherwise manual dispatch should be applied.

Questions?

Contact names

- Tom Welch - twelch@misoenergy.org

- Chuck Hansen – chansen@misoenergy.org

- Oluwaseyi Akinbode – oakinbode@misoenergy.org