ASSESSMENT OF HISTORICAL TRANSMISSION SCHEDULES AND FLOWS IN THE EASTERN INTERCONNECTION

PREPARED FOR LAWRENCE BERKELEY NATIONAL LABORATORY

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1. Introduction

Understanding and analyzing scheduled and actual flows of electricity on the transmission grid can provide insight into how traditional utilities, power marketers and others use the system. It can indicate where and when the system is heavily or consistently used, and how schedules align with actual use.

There are limited sources of data that provide information on scheduled and actual electricity transfers in the Eastern Interconnection of the United States.[1] To address this gap, the U.S. Department of Energy, through the Lawrence Berkeley National Laboratory, issued a contract to Open Access Technology International, Inc. (OATI) to identify and aggregate data describing scheduled transactions and actual flows in the Eastern Interconnection for the year 2010. OATI was directed to aggregate the schedules and actual flows according to the sub-regions within the Eastern Interconnection that had been defined by the Eastern Interconnection Planning Collaborative (EIPC).

This report documents OATI's data collection and aggregation, and presents the data. Section 2 describes the sources for the data collected by OATI, and the means that they were aggregated. It introduces the EIPC sub-regions and provides detailed descriptions for how data collection and aggregation were implemented for each sub-region. Section 3 presents the data representing scheduled and actual flows between the EIPC sub-regions OATI's analysis. It first describes the transmission system utilization metrics among the sub regions and presents the results of these metrics in section 3.1. Section 3.2 then presents the loading of the paths between sub regions, organized as 'load duration curves'.

[1] The Western Electricity Coordinating Council's Transmission Expansion Planning and Policy Committee routinely prepares a study of historic transmission system utilization within the Western Interconnection.

2. Transmission Utilization Data Sources and Analysis Methods

This section describes the sources for the data collected by OATI and the means by which the data was aggregated for analysis. Section 2.1 introduces the Eastern Interconnection Planning Collaborative (EIPC) sub-regions that were used to aggregate the data. Section 2.2 describes how the institutional boundaries among these sub-regions affected the data collection process; and, for each sub-region, how the data collection and aggregation process was implemented.

2.1 EIPC Sub-Regions

In early 2009, a group of planning authorities in the east formed the EIPC with the goal of improving joint planning of interregional grid development. EIPC is the first planning collaboration ever undertaken for the eastern interconnection, and membership now totals 26 planning coordinators.[4]

In 2010, EIPC initiated an interconnection-wide planning study that relied on an integrated suite of macroeconomic and generation dispatch/expansion modeling tools.[5] These generation tools represent the eastern interconnection as a set of 26 sub-regions (sometimes called "bubbles") connected to one another through a network of transmission (sometimes called "pipes"). Transmission lines connecting one sub-region to another sub-region are represented by a single pipe. Of course, most sub-regions are connected to multiple sub-regions so there are multiple pipes associated with most bubbles. Sub-regions and pipes from the EIPC Study are represented in Figure 1 below.

[4] EIPC website link: http://www.eipconline.com/

[5] Eastern Interconnection Planning Council, "Phase 1 Report: Formation of Stakeholder Process, Regional Plan Integration and Macroeconomic Analysis." DOE Award Project DE-OE0000343, December 2011. http://www.eipconline.com/uploads/Phase_1_Report_Final_12-15-2011.pdf

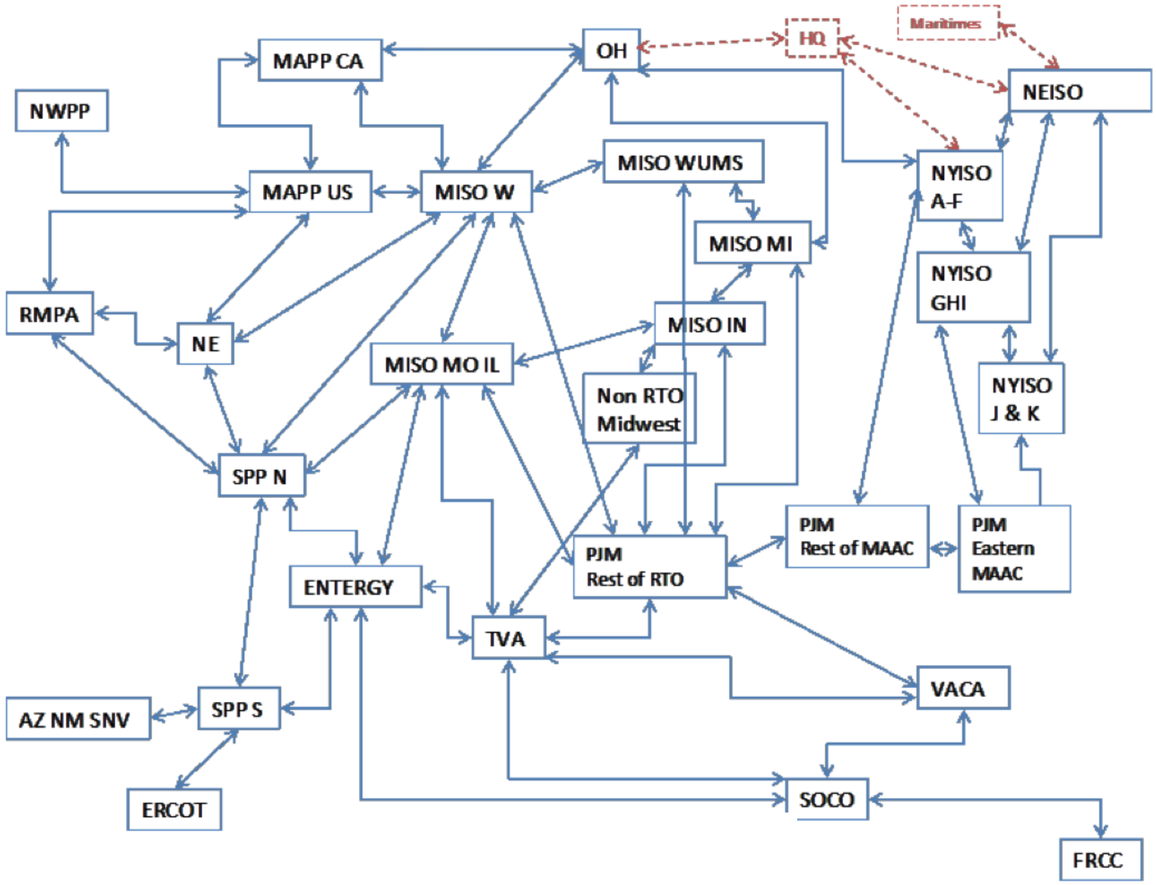

Figure 1: Sub-Regions and Pipes from EIPC Study

EIPC Sub-region Consideration

As detailed in Section 2.2, EIPC pipes represent a variety of interconnections. The scheduling challenge comes with accurately analyzing schedules on EIPC pipes where at least one end of the pipe terminates within a Balancing Authority (BA) containing more than one sub-region. In these instances, schedule information is maintained at the BA (and not at the sub-region with the BA); therefore schedule information does not exist with sub-region granularity.

To accurately analyze schedule and actual flows on these specific types of EIPC pipes, OATI analyzed congestion at the BA and not at the sub-region contained within the BA. Areas defined by dotted lines in Figure 2 below shows where OATI analyzed actual and schedule information by BA; and where, therefore, multiple EIPC pipes were analyzed together. The total of these pipes between Regional Transmission Operators (RTOs)/Independent System Operators (ISOs) and other sub regions is represented by the blue pipes in Figure 2; and as further defined in Section 2.2.

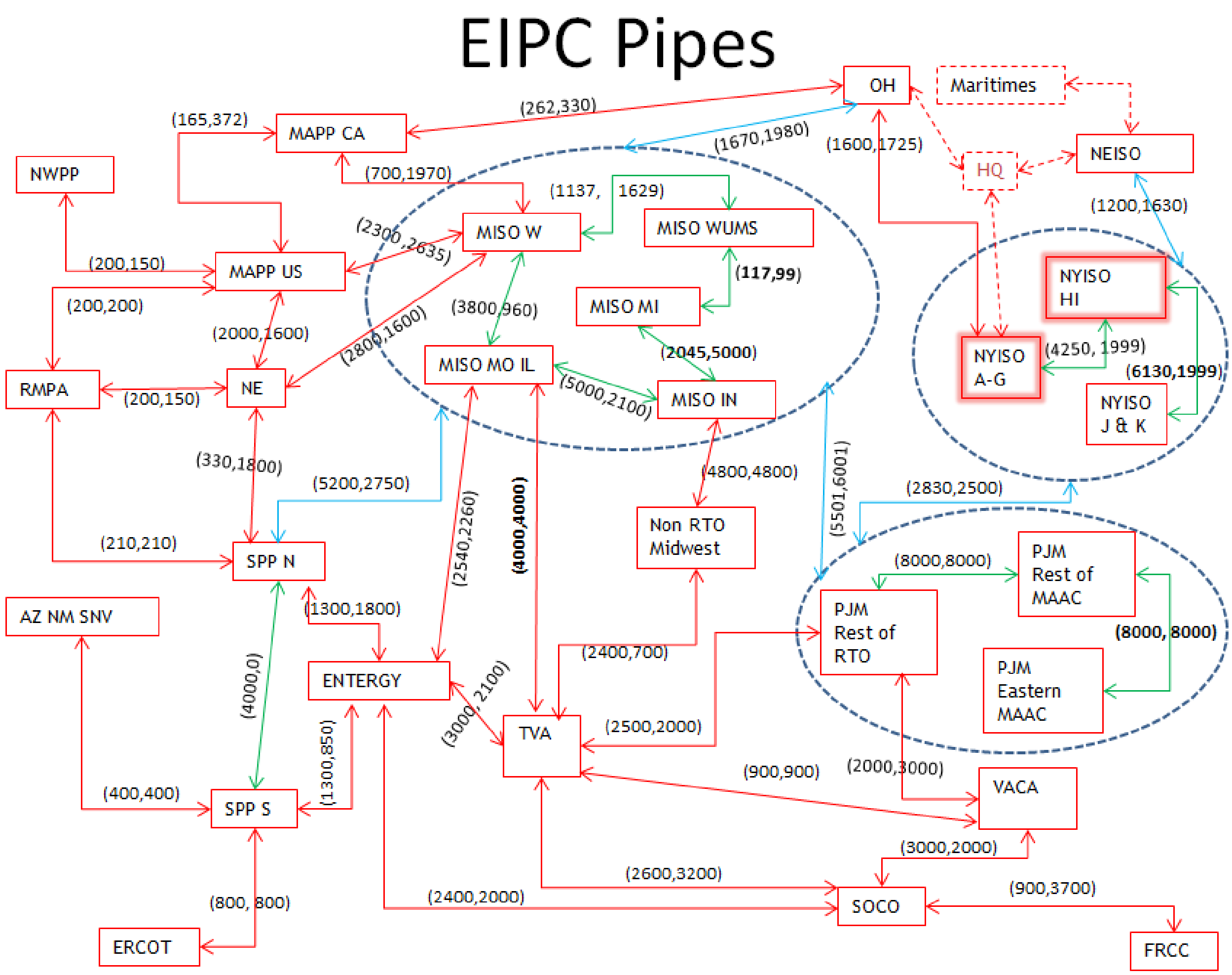

Figure 2: Sub-Regions and Pipes from EIPC Study Used for Analysis

Note: NYISO sub-region A-F was modified to A-G and sub-region GHI was modified to HI to align with the 2010 operation monitoring and available flowgate data. Also the data for all except MAPP_CA to OH and MISO_MI to MISO_WUMS was available for the study.

2.2 Data Sources for Scheduled and Actual Flows across EIPC Pipes

The number of sub-regions and pipes was determined through prior studies conducted by the contractor supporting the EIPC. In some instances, the boundaries (and the pipes) between sub-regions correspond exactly or closely with existing institutional boundaries among transmission operating entities within the interconnection. In other instances, they did not. The extent pipes corresponded to existing institutional boundaries affected both the sources for and types of information that were collected for this study.

The basic institutional construct for the operation of the transmission system of the eastern interconnection is called the BA. A BA is responsible for maintaining the balance between load and generation within their area including interchange with neighboring BAs.

As described in Section 2.1, the analysis of schedule and actual flows was dependent on the availability of schedule and actual information across pipes connecting EIPC sub-regions. Following is an explanation of 1) the data sources for this analysis, and 2) how EIPC pipes were categorized by pipe type.

Scheduled Flow Data (e-Tags)

The North American Electric Reliability Corporation (NERC) requires that BAs identify (or "e-Tag") and report each planned (or "scheduled") flow from the source (generation) to the sink (load). Each e-Tag (schedule) not only identifies the generating and load BA, but also identifies any of the in between (Wheeling) BAs impacted by the schedule. The schedule from one BA to another BA also identifies the Point of Receipt (POR) and Point of Delivery (POD) to provide additional granularity for processing schedules.

E-Tags, therefore, were used as the source for scheduled data. Since e-Tags are delineated by BA/POR/POD, e-Tag "schedule" information is not available for EIPC sub-regions where multiple EIPC sub-regions exist in the same BA. For this reason, EIPC pipes terminating between sub-regions sharing the same BA are evaluated at the BA and not at the specific sub-region (as shown by blue pipes connecting dotted areas in Figure 2 above).

Actual Flow Data (Metered Data)

NERC also requires BAs to monitor the actual flows that pass from one BA to another. The metered actual flows on the BA to BA interconnections are monitored and recorded for true up and settlement of flows. The use of the actual metered flow data are used for calculating the actual flows on the EIPC identified pipes.

Metered data, therefore, was used as the source of actual data. This metered data was provided by the BAs owning the metered equipment on the EIPC pipe.

Congestion Management Data (IDC Historical Data)

To manage congestion within the Eastern Interconnection, NERC requires the transmission operators to monitor a set of electrical equipment, known as flowgates, for overloads. NERC utilizes Interchange Distribution Calculator (IDC) applications to calculate the impact of each schedule on these monitored flowgates. In real-time operations transmission operators use the IDC to, or responds to TLRs by, curtailing schedules or redispatching the system. Operators may either curtail these tags or use the market re-dispatch to relieve overloads. IDC stores information that can recreate historical schedules and approximate actual flow on the monitored flowgates. This study used the IDC historical data for calculating schedules and actual flows on EIPC pipes that are entirely within MISO, PJM or SPP and could be associated with one or more monitored flowgates.[6] This flowgate association was coordinated through the operator of that BA.

Categorization of EIPC Pipes into Pipe Types

In considering the mapping between BAs and EIPC sub-regions, it is important to distinguish between the sub-regions of the eastern interconnection where transmission is scheduled bi-laterally among BAs and the sub-regions where transmission is scheduled through organized wholesale markets (the RTO/ISOs) within a single BA.

In the sub-regions where transmission is scheduled bi-laterally, the BAs in the eastern interconnection generally map neatly into a single EIPC sub-region. An EIPC sub-region may consist of either a single BA or a group of BAs.

In the sub-regions where transmission is scheduled through organized or centralized wholesale markets, the wholesale market operators (RTO/ISO's) are themselves each a single BA. However, each RTO/ISO is represented by more than one EIPC sub-region; that is, there is more than one sub-region within a single BA.

[6] Metered flow data were obtained from NYISO on those internal interfaces.

Hence, the analysis of scheduled and actual flows required EIPC pipes to be categorized into one of the following three pipe types (represented as a red, green, or blue pipe in Figure 1 and Figure 2):

RED, Type 1 - Pipes between a sub-region that is not within an RTO/ISO are either a) another sub-region that is also not within an RTO/ISO, or b) a single sub-region that is within an RTO/ISO.[7]

These pipes correspond directly to the schedules and flows between a single or a group of BAs and another single or group of BAs. Developing schedule and flow information is straight-forward in these instances because, as described, the BAs collect and maintain this information according to the BA boundaries. It should be noted that some of the BA boundaries may have been different at the time of study vs. the time of historical data collection as there has been movement of some BAs in and out of centralized markets.

GREEN, Type 2 - Pipes between two sub-regions both within the same RTO/ISO.

These pipes correspond to sub-regions that are both within a single BA. Developing schedule and flow information is more challenging in these instances because the sub-regions used by EIPC may or may not correspond to internal boundaries that are already recognized by the RTO/ISOs (hence are already used by the RTO/ISO to collect and aggregate information on internal schedules and flows). OATI worked with each RTO/ISO individually to establish a means for partitioning information already collected by the RTO/ISO to best approximate the boundaries of these EIPC sub-regions.

BLUE, Type 3 - Pipes between a) a sub-region that is not an RTO/ISO to more than one RTO/ISO sub-regions, or b) more than one RTO/ISO sub-regions and other RTO/ISO sub-regions. These pipes are represented as blue pipes on Figure 1. As mentioned above, generating historical schedule data for these blue pipes is not feasible due to the limited e-tag information available; therefore the total of these pipes between RTO/ISO and other sub regions is represented by the blue pipes on Figure 2.

[7] A dashed red pipe is used to represent pipes involving some of the sub-regions in Canada.

These blue pipes on Figure 2 represent "sums of EIPC pipes" that link a single or group of BAs to a sub-region that is within a single BA (the RTO/ISO). Developing individual pipe schedule and flow information was not feasible because it could not be determined which, or to what extent, any given sub-region within the RTO/ISO footprint was either the POR or the POD for the schedule or flow with the adjacent regions. In the absence of more definitive individual pipe information, the analysis of this "blue" pipe information was developed on schedule and actual information evaluated at the BA (and not evaluated at the sub-region).

Table 1 and Table 2 list the EIPC sub-regions and the type of pipe linking them such that:

- EIPC sub-regions are listed in row/column format creating a matrix of EIPC sub-regions spanning Table 1 and Table 2.
- The color of each row/column intersection reflects the type of pipe (type 1, type 2, or type 3) linking the corresponding EIPC sub-regions. Again, type 3 pipes (blue) reflect the sum of more than one EIPC pipe.
- Flow is from the sub-region identified in the "row" to the sub-region identified in the "column."
- A blank indicates that there is no pipe linking the two sub-regions.

	ENTERGY	HQ	MAPP CA	MAPP US	MISO (total)	NE	NEISO	NON RTO MIDWEST	NYISO (total)	OH	PJM (total)	SPP N	TVA	VACA
ENTERGY					■									
HQ									■					
MAPP CA					■									
MAPP US					■									
MISO (total)	■		■	■		■		■		■	■	■	■	
NE					■									
NEISO									■					
NON RTO MIDWEST					■									
NYISO (total)		■					■			■	■			
OH					■				■					
PJM (total)					■				■				■	■
SPP N					■									
TVA					■						■			
VACA											■			

Table 1: Blue Pipe Types connecting EIPC Sub-Regions

	AZ NM SNV	ENTERGY	ERCOT	FRCC	HQ	MAPP CA	MAPP US	MARITIMES	MISO IN	MISO MI	MISO MO IL	MISO W	MISO WUMS	NE	NEISO	NON RTO MIDWEST	NWPP	NYISO A-G	NYISO HI	NYISO J&K	OH	PJM EASTERN MAAC	PJM REST OF MAAC	PJM REST OF RTO	RMPA	SOCO	SPP N	SPP S	TVA	VACA
AZ NM SNV																												Red		
ENTERGY																										Red	Red	Red	Red	
ERCOT																												Red		
FRCC																										Red				
HQ															Red						Red									
MAPP CA							Red														Red									
MAPP US						Red								Red			Red								Red					
MARITIMES															Red															
MISO IN										Green	Green																			
MISO MI									Green				Green																	
MISO MO IL									Green			Green																		
MISO W											Green		Green																	
MISO WUMS										Green		Green																		
NE							Red																		Red		Red			
NEISO					Red			Red																						
NON RTO MIDWEST																													Red	
NWPP							Red																							
NYISO A-G																			Green											
NYISO HI																		Green		Green										
NYISO J&K																			Green											
OH					Red	Red																								
PJM EASTERN MAAC																							Green							
PJM REST OF MAAC																						Green		Green						
PJM REST OF RTO																							Green							
RMPA							Red							Red													Red			
SOCO		Red		Red																									Red	Red
SPP N		Red												Red											Red			Red		
SPP S	Red	Red	Red																								Red			
TVA		Red														Red										Red				Red
VACA																										Red			Red	

Table 2: Red and Green Pipe Types connecting EIPC Sub-Regions

The analysis of scheduled and actual flows was performed by pipe type as described below:

<u>RED, Type 1 Pipes</u> - Schedules for Type 1 pipes were developed by aggregating NERC tags between the regions connected by each pipe. Actual flows for Type 1 pipes were developed by aggregating metered flows on the direct ties between the regions connected by each pipe. Schedules measured in this way represent the interchanges

between regions, with resulting actual flow that may flow directly between the regions or indirectly through other regions before reaching its scheduled destination. Because of this, schedules and actual flows as aggregated here, may trend in the same direction but should not be viewed as measure of comparable quantities. Also, as noted in the "RED, Type 1" pipe explanation above, some of the region boundaries changed between the time the EIPC was done (2010) and when the historical data were collected because of movement of some BAs into or out of centralized markets.

GREEN, Type 2 Pipes – MISO, PJM and NYISO identified surrogate IDC (NERC Interchange Distribution Calculator) flowgates that could be used for approximation of schedules on these pipes.

For MISO and PJM schedules on Type 2 pipes, IDC calculations were re-performed to calculate the schedules on the surrogate flowgates. IDC flowgate schedules were computed as hour ahead and real-time schedules.

For PJM the actual flow on Type 2 pipes was computed as real-time schedules on the surrogate flowgates, which included the schedule adjustments due to curtailments.

For MISO actual flow on the Type 2 pipes was developed by using the net Actual Interchange (NAI) for the Load Balancing Areas (LBAs), and the metered flows to other BAs. Appendix A has the calculation details for actual flow calculations for MISO Type 2 pipes.

NYISO posts real-time and hour-ahead flow results from the Security Constrained Economic Dispatch (SCED); therefore for NYISO, the hour before SCED results were used for schedules on Type 2 pipes and real-time SCED results were used for actuals on Type 2 pipes.

The Type 2 pipes are an approximation as these are not specific scheduling paths and the flows on these pipes do not represent the true system usage between the sub-regions. It should be noted that the comparison between the EIPC study and the historical analysis for 2010 may be difficult to make due to the following reasons:

- Sub regions modeled within RTOs by the EIPC study do not represent how the system is scheduled and operated; therefore, any estimation of schedule and actual flows for Type 2 pipes do not represent the usage as expected by the EIPC study.

- The actual flow for PJM Type 2 pipes are based on the real-time flow on the associated IDC flowgates.
- The actual flow on the Type 2 MISO pipes is based on the net metered flow calculations for entities (LBAs) within each sub-region. However, the historical data in 2010 may not represent these entities accurately as there have been changes to the LBAs that joined MISO since the EIPC study was performed.

Appendix A provides details for the flowgates as well as some of the interfaces.

BLUE, Type 3 Pipes – Since Type 3 pipes represent multiple pipes between an RTO (BA) and other BAs, the schedule and actual information was obtained from the BAs (which represent the sum of the schedules between the BAs and actuals across the multiple tie-lines connecting the given BAs. Schedules for Type 3 pipes were developed by aggregating NERC tags between the regions connected by each pipe. Actual flows for Type 3 pipes were developed by aggregating metered flows on the direct ties between the regions connected by each pipe. Schedules measured in this way represent the interchanges between regions, with resulting actual flow that may flow directly between the regions or indirectly through other regions before reaching its scheduled destination. Because of this, schedules and actual flows as aggregated here, may trend in the same direction but should not be viewed as measure of comparable quantities.

The results in the following sections present both schedules and actual nets for each pipe (colored by pipe type). The schedules are the expected interchanges or trades between the adjoined regions before real-time; however, the actual flows are based on the real-time power flows. The schedules and actuals are not expected to match due to the loop flows, inadvertent flows, dynamic schedules, and pseudo ties.[8]

[8] Dynamic Schedules and pseudo ties concepts are used to transfer power from one BA to another in real-time, without creating a regular schedule (eTag)

3. Transmission Utilization in the Eastern Interconnection in 2010

This section presents the findings from the OATI analysis of transmission utilization in the Eastern Interconnection in 2010. Two formats for representing hourly scheduled and actual flows for pipes connecting sub-regions are used. The first is transmission utilization metrics that compare scheduled and actual flow to the EIPC study limits and is presented in section 3.1. The second is "flow-duration" curves that show directional schedules, net schedules, and actual flow, sorted by magnitude over the study year. The flow duration curve results are presented in section 3.2.

The inter-regional transfer limits used by EIPC in their analysis were non-simultaneous transfer limits used for capacity expansion, and may be significantly different than the actual 2010 operating limits. Therefore these results should be reviewed considering the difference in the operating limits and the EIPC study limits.

The following three entities in the EIPC Model were in regions other than MISO, however during 2010, these entities had joined MISO and are part of MISO BA. This study assumes these three entities to be part of MISO region. A complete list of the Region/Entity/BA associations used in the OATI utilization analysis is in Appendix B:

Entity	Region at time of EIPC Study	Region at Time of OATI Utilization Analysis
MPCN	MAPP US	MISO
MRES	MAPP US	MISO
BREC	Non - RTO Midwest	MISO

In addition to the above regional changes, the sub regions within NYISO were also changed to match with the operating criteria for 2010. The sub region AF was changed to AG and GI to HI.

3.1 Transmission Utilization Metrics

Two transmission utilization metrics are calculated for each direction of flow (compared to the "positive" and "negative" flow-limits, respectively) for both scheduled and actual flows. The first metric, U75, represents the percentage of time the flow is greater than 75 percent of the flow-limit. The second metric, U90, represents the percentage of time the flow is greater than 90 percent of the flow-limit.

In the EIPC model, the flow-limit represents the maximum amount of power that can be transmitted across the interface between two sub-regions. EIPC flow-limits form the basis for the calculation of transmission utilization metrics. The metrics express the percentage of time that a transmission schedule or actual flow exceeds a pre-specified amount. The pre-specified amounts are calculated as fractions of the EIPC flow-limits.[9] The EIPC model is based on the 2020 planning study; therefore the limits are the planning expectation of 2020 on these pipes. There has been recommendation from the industry advisors, especially for the Type 2 pipes, that the EIPC 2020 planning limits may be significantly different from the actual operating limits on these pipes during 2010. RTOs expect historical operating limits to be significantly different from the EIPC study limits and therefore, these results should be reviewed in light of this fact.

The transmission utilization metrics are presented in four tables where each table follows the format of Table 1/Table 2 in Section 2 (i.e. EIPC pipes reflected as a matrix of EIPC sub-regions) such that:

- EIPC sub-regions are listed in row/column format creating a matrix of EIPC sub-regions.
- Each row/column intersection reflects the transmission metrics for either scheduled or actual flows.
- Tables 3 and 4 and tables 5 and 6 contain the transmission metrics for scheduled flows for U75 and U90 respectively.
- Tables 7 and 8 and tables 9 and 10 contain the transmission metrics for actual flows for U75 and U90 respectively.
- Flow is from the sub-region identified in the “row” to the sub-region identified in the “column.”
- A blank row/column simply indicates no pipe linking the two sub-regions; and therefore, no analysis possible.

[9] These metrics are calculated based on 2010 operating limits, not EIPC flow-limits, for connections between NYISO and other regions, and within NYISO.

U75 Schedule	AZ_NM_SNV	ENTERGY	ERCOT	FRCC	HQ	MAPPCA	MAPPUS	Maritimes	MISO_IN	MISO_MI	MISO_MO_IL	MISO_W	MISO_WUMS	NE	NEISO	Non_RTO_Midwest	NWPP	NYISO A G	NYISO_HI	NYISO_J&K	OH	PJM_Eastern_MAAC	PJM_REST_OF_MAAC	PJM_Rest_OF_RTO	RMPA	SOCO	SPP_N	SPP_S	TVA	VACA
AZ_NM_SNV																												0		
ENTERGY																										5	0	11	0	
ERCOT																												<1		
FRCC																										<1				
HQ															No Limit						44									
MAPPCA							0														No Data									
MAPPUS						0								0			2								17					
Maritimes															No Limit															
MISO_IN										0	0																			
MISO_MI									3				No Data																	
MISO_MO_IL									<1			<1																		
MISO_W											0		49																	
MISO_WUMS										No Data		60																		
NE							0																		0		0			
NEISO					No Limit			No Limit																						
Non_RTO_Midwest																													0	
NWPP							0																							
NYISO A G																			36											
NYISO_HI																		No Data		56										
NYISO_J&K																			No Limit											
OH					26	No Data																								
PJM_Eastern_MAAC																							99							
PJM_REST_OF_MAAC																						40		89						
PJM_Rest_OF_RTO																							8							
RMPA							11							0													0			
SOCO		0		<1																									<1	<1
SPP_N		0												0											0			0		
SPP_S	0	69	18																								No Limit			
TVA		37														0										0				<1
VACA																										0			0	

Table 3: Percent of the time schedules on pipe are over 75% of the EIPC limit

** NYISO limits are the 2010 operational limits.*

U 75 Schedule	ENTERGY	HQ	MAPP CA	MAPP US	MISO (total)	NE	NEISO	NON RTO MIDWEST	NYISO (total)	OH	PJM (total)	SPP N	TVA	VACA
ENTERGY					0									
HQ									36					
MAPP CA					46									
MAPP US					<1									
MISO (total)	0		4	0		0		0		3	0	0	0	
NE					0									
NEISO									No Limit					
NON RTO MIDWEST					0									
NYISO (total)		12					2			0	No Limit			
OH					18				<1					
PJM (total)					18				39				<1	<1
SPP N					0									
TVA					0						2			
VACA											1			

Table 4: Percent of the time schedules on pipe are over 75% of the EIPC limit

** NYISO limits are the 2010 operational limits.*

U90 Schedule	AZ_NM_SNV	ENTERGY	ERCOT	FRCC	HQ	MAPPCA	MAPPUS	Maritimes	MISO_IN	MISO_MI	MISO_MO_IL	MISO_W	MISO_WUMS	NE	NEISO	Non_RTO_Midwest	NWPP	NYISO AG	NYISO_HI	NYISO_J&K	OH	PJM_Eastern_MAAC	PJM_REST_OF_MAAC	PJM_Rest_OF_RTO	RMPA	SOCO	SPP_N	SPP_S	TVA	VACA
AZ_NM_SNV																												0		
ENTERGY																										1	0	7	0	
ERCOT																												<1		
FRCC																										<1				
HQ															No Limit						22									
MAPPCA							0														No Data									
MAPPUS						0								0			<1								11					
Maritimes															No Limit															
MISO_IN										0	0																			
MISO_MI									<1				No Data																	
MISO_MO_IL									<1			0																		
MISO_W											0		9																	
MISO_WUMS										No Data		25																		
NE							0																		0		0			
NEISO					No Limit			No Limit																						
Non_RTO_Midwest																													0	
NWPP							0																							
NYISO AG																			14											
NYISO_HI																		No Data		24										
NYISO_J&K																			No Limit											
OH					20	No Data																								
PJM_Eastern_MAAC																							87							
PJM_REST_OF_MAAC																						16		55						
PJM_Rest_OF_RTO																							<1							
RMPA							6							0													0			
SOCO		0		0																									<1	<1
SPP_N		0												0											0			0		
SPP_S	0	50	7																								No Limit			
TVA		21														0										0				<1
VACA																										0			0	

Table 5: Percent of the time schedules on pipe are over 90% of the EIPC limit

** NYISO limits are the 2010 operational limits.*

U 90 Schedule	ENTERGY	HQ	MAPP CA	MAPP US	MISO (total)	NE	NEISO	NON RTO MIDWEST	NYISO (total)	OH	PJM (total)	SPP N	TVA	VACA
ENTERGY					0									
HQ									25					
MAPP CA					24									
MAPP US					0									
MISO (total)	0		2	0		0		0		<1	0	0	0	
NE					0									
NEISO									No Limit					
NON RTO MIDWEST					0									
NYISO (total)		10					<1			0	No Limit			
OH					10				<1					
PJM (total)					7				18				<1	<1
SPP N					0									
TVA					0						1			
VACA											<1			

Table 6: Percent of the time schedules on pipe are over 90% of the EIPC limit

** NYISO limits are the 2010 operational limits.*

U75 Actual	AZ_NM_SNV	ENTERGY	ERCOT	FRCC	HQ	MAPPCA	MAPPUS	Maritimes	MISO_IN	MISO_MI	MISO_MO_IL	MISO_W	MISO_WUMS	NE	NEISO	Non_RTO_Midwest	NWPP	NYISO AG	NYISO_HI	NYISO_J&K	OH	PJM_Eastern_MAAC	PJM_REST_OF_MAAC	PJM_Rest_OF_RTO	RMPA	SOCO	SPP_N	SPP_S	TVA	VACA
AZ_NM_SNV																												<1		
ENTERGY																										0	0	0	0	
ERCOT																												<1		
FRCC																										0				
HQ															No Limit						No Data									
MAPPCA							4														No Data									
MAPPUS						<1								0			<1								0					
Maritimes															No Limit															
MISO_IN										0	0																			
MISO_MI									0				No Data																	
MISO_MO_IL									0			0																		
MISO_W											0		0																	
MISO_WUMS										No Data		0																		
NE							<1																		0		0			
NEISO					No Limit			No Limit																						
Non_RTO_Midwest																													0	
NWPP							25																							
NYISO AG																			22											
NYISO_HI																		No Data		46										
NYISO_J&K																			No Limit											
OH					No Data	No Data																								
PJM_Eastern_MAAC																							0							
PJM_REST_OF_MAAC																						0		0						
PJM_Rest_OF_RTO																							0							
RMPA							16							0													0			
SOCO		0		29																									<1	<1
SPP_N		0												0											0			0		
SPP_S	0	0	13																								No Limit			
TVA		0														0										0				<1
VACA																										0			0	

Table 7: Percent of the time Actual Flow on pipe is over 75% of the EIPC limit

** NYISO limits are the 2010 operational limits.*

U 75 Actuals	ENTERGY	HQ	MAPP CA	MAPP US	MISO (total)	NE	NEISO	NON RTO MIDWEST	NYISO (total)	OH	PJM (total)	SPP N	TVA	VACA
ENTERGY					0									
HQ									0					
MAPP CA					33									
MAPP US					0									
MISO (total)	0		1	0		0		0		0	0	0	0	
NE					0									
NEISO									0					
NON RTO MIDWEST					0									
NYISO (total)		42					0			<1	No Limit			
OH					<1				<1					
PJM (total)					<1				13				<1	<1
SPP N					0									
TVA					0						1			
VACA											<1			

Table 8: Percent of the time Actual Flow on pipe is over 75% of the EIPC limit

** NYISO limits are the 2010 operational limits.*

U90 Actual	AZ_NM_SNV	ENTERGY	ERCOT	FRCC	HQ	MAPPCA	MAPPUS	Maritimes	MISO_IN	MISO_MI	MISO_MO_IL	MISO_W	MISO_WUMS	NE	NEISO	Non_RTO_Midwest	NWPP	NYISO AG	NYISO_HI	NYISO_J&K	OH	PJM_Eastern_MAAC	PJM_REST_OF_MAAC	PJM_Rest_OF_RTO	RMPA	SOCO	SPP_N	SPP_S	TVA	VACA
AZ_NM_SNV																												0		
ENTERGY																										0	0	0	0	
ERCOT																												0		
FRCC																										0				
HQ															No Limit						No Data									
MAPPCA							<1														No Data									
MAPPUS						<1								0			0								0					
Maritimes															No Limit															
MISO_IN										0	0																			
MISO_MI									0				No Data																	
MISO_MO_IL									0			0																		
MISO_W											0		0																	
MISO_WUMS										No Data		0																		
NE							0																		0		0			
NEISO					No Limit			No Limit																						
Non_RTO_Midwest																													0	
NWPP							18																							
NYISO AG																			6											
NYISO_HI																		No Data		16										
NYISO_J&K																			No Limit											
OH					No Data	No Data																								
PJM_Eastern_MAAC																							0							
PJM_REST_OF_MAAC																						0		0						
PJM_Rest_OF_RTO																							0							
RMPA							10							0													0			
SOCO		0		12																									0	<1
SPP_N		0												0											0			0		
SPP_S	0	0	7																								0			
TVA		0														0										0				<1
VACA																										0			0	

Table 9: Percent of the time Actual Flow on pipe is over 90% of the EIPC limit

** NYISO limits are the 2010 operational limits.*

U 90 Actuals	ENTERGY	HQ	MAPP CA	MAPP US	MISO (total)	NE	NEISO	NON RTO MIDWEST	NYISO (total)	OH	PJM (total)	SPP N	TVA	VACA
ENTERGY					0									
HQ									0					
MAPP CA					11									
MAPP US					0									
MISO (total)	0		<1	0		0		0		0	0	0	0	
NE					0									
NEISO									0					
NON RTO MIDWEST					0									
NYISO (total)		37					0			<1	No Limit			
OH					0				<1					
PJM (total)					<1				6				<1	<1
SPP N					0									
TVA					0						<1			
VACA											<1			

Table 10: Percent of the time Actual Flow on pipe is over 90% of the EIPC limit

** NYISO limits are the 2010 operational limits.*

3.2 Transmission Flow-Duration Curves

All hourly schedules and actual flows between sub-regions are aggregated to net values which either source from or sink to an individual sub-region (see Table 1 and 2 in Section 2).

The hourly information is then graphed in "flow-duration" curves further quantified as follows:

- A sign convention is used to designate one sub-region as the overall sink and the other sub-region as the overall source. Positive hourly values (scheduled or actual) reflect flow into the sink; and negative hourly values reflect reverse flow "back" into the source. This sign convention is reflected in the order of regions in the title of each chart: the source is the first region, the sink is the second region. Again, this was merely a sign-convention arbitrarily assigned to designate source and sink.

- Directional schedules are consistent with the definition of source and sink indicated by the order of region names. Directional schedules are sorted by rank order and graphed.
- Net schedules are calculated as the hourly difference between direction schedules, source to sink minus sink to source. The difference is taken on the chronological directional schedules before they are sorted by rank order for graphing. These net schedules are then sorted in rank order for graphing.
- Actual schedules are measured directly, not calculated, and sorted in rank order for graphing.
- Rank ordering of all hourly directional schedules, and net schedule and actual flows from positive to negative (left to right) is used to show both scheduled and actual flows on a single chart. Rank ordering suppresses the chronology of the individual flow; therefore, the hour of the year at which a particular scheduled flow is observed does not necessarily correspond to the actual flow for that same hour. This includes the directional and net schedules: each directional schedule was identified or aggregated, and each net schedule was calculated based on chronological directional schedules, but then each was sorted separately by magnitude for plotting on the charts, so the schedules represented on the graph may not line up chronologically.

The transmission flow-duration curves are presented for each interface identified in Table 1 and Table 2 in the following figures. Table 1 and Table 2 are repeated here with the figure number to the schedule flow duration curves (Figures). An asterisk (*) indicates data was not available for that pipe.

Figure Number Reference	AZ NM SNV	ENTERGY	ERCOT	FRCC	HQ	MAPP CA	MAPP US	MARITIMES	MISO IN	MISO MI	MISO MO IL	MISO W	MISO WUMS	NE	NEISO	NON RTO MIDWEST	NWPP	NYISO AG	NYISO HI	NYISO J&K	OH	PJM EASTERN MAAC	PJM REST OF MAAC	PJM REST OF RTO	RMPA	SOCO	SPP N	SPP S	TVA	VACA
AZ NM SNV																												3		
ENTERGY																										5	6	7	8	
ERCOT																												9		
FRCC																										10				
HQ															11						13									
MAPP CA							15														*									
MAPP US						15								17			19								18					
MARITIMES															46															
MISO IN										21	24																			
MISO MI									21				*																	
MISO MO IL									24			25																		
MISO W											25		26																	
MISO WUMS										*		26																		
NE							17																		29		31			
NEISO					11			46																						
NON RTO MIDWEST																													47	
NWPP							19																							
NYISO AG																			39											
NYISO HI																		39		40										
NYISO J&K																			40											
OH					13	*																								
PJM EASTERN MAAC																							44							
PJM REST OF MAAC																						44		45						
PJM REST OF RTO																							45							
RMPA							18							29													38			
SOCO		5		10																									30	35

Table 11: Links to the loading level graphs for EIPC Pipes

- *Indicates data does not exists for that pipe therefore no corresponding chart*

Figure Number Reference	AZ NM SNV	ENTERGY	ERCOT	FRCC	HQ	MAPP CA	MAPP US	MARITIMES	MISO IN	MISO MI	MISO MO IL	MISO W	MISO WUMS	NE	NEISO	NON RTO MIDWEST	NWPP	NYISO AG	NYISO HI	NYISO J&K	OH	PJM EASTERN MAAC	PJM REST OF MAAC	PJM REST OF RTO	RMPA	SOCO	SPP N	SPP S	TVA	VACA
SPP N		6												31											38			32		
SPP S	3	7	9																								32			
TVA		8														47										30				34
VACA																										35			34	

Table 11: (continuation) Links to the loading level graphs for EIPC Pipes

Figure Number Reference	ENTERGY	HQ	MAPP CA	MAPP US	MISO (total)	NE	NEISO	NON RTO MIDWEST	NYISO (total)	OH	PJM (total)	SPP N	TVA	VACA
ENTERGY					4									
HQ									12					
MAPP CA					14									
MAPP US					16									
MISO (total)	4		14	16		28		22		23	20	27	33	
NE					28									
NEISO									41					
NON RTO MIDWEST					22									
NYISO (total)		12					41			42	43			
OH					23				42					
PJM (total)					20				43				36	37
SPP N					27									
TVA					33						36			
VACA											37			

Table 12: Links to the loading level graphs for EIPC Pipes

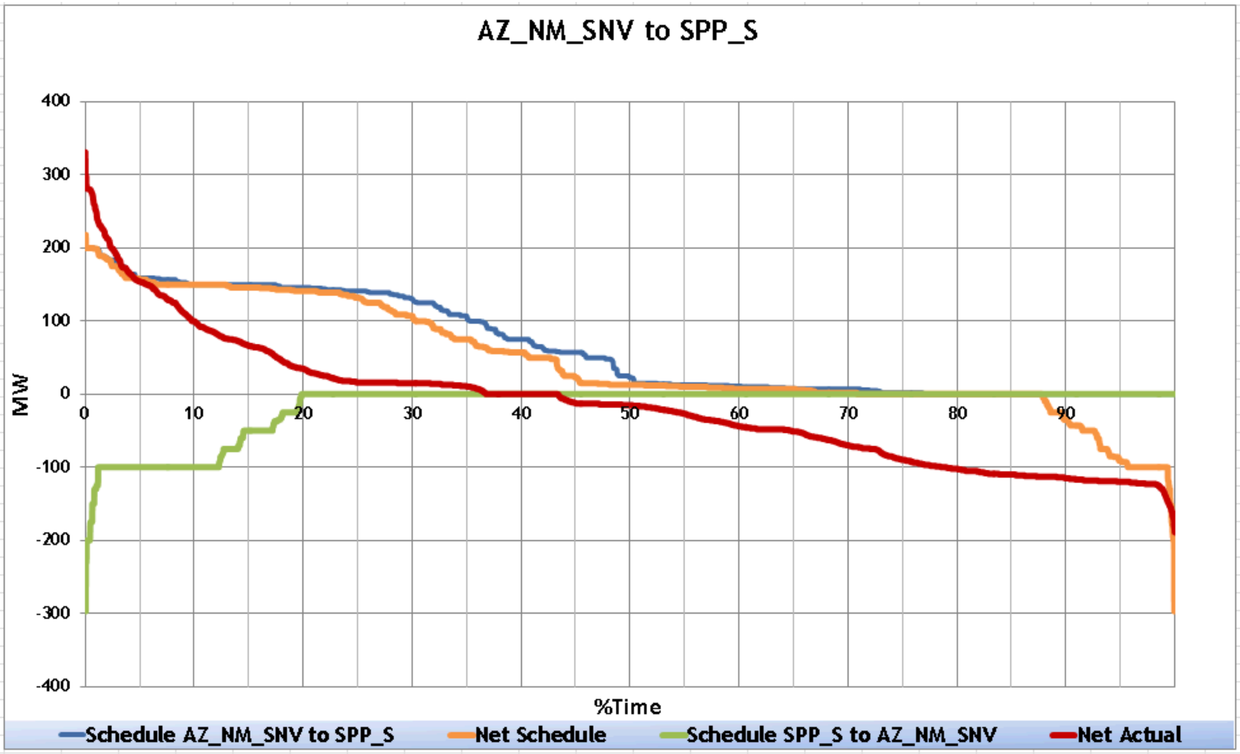

Figure 3: Load for AZ_NM_SNV to SPP_S

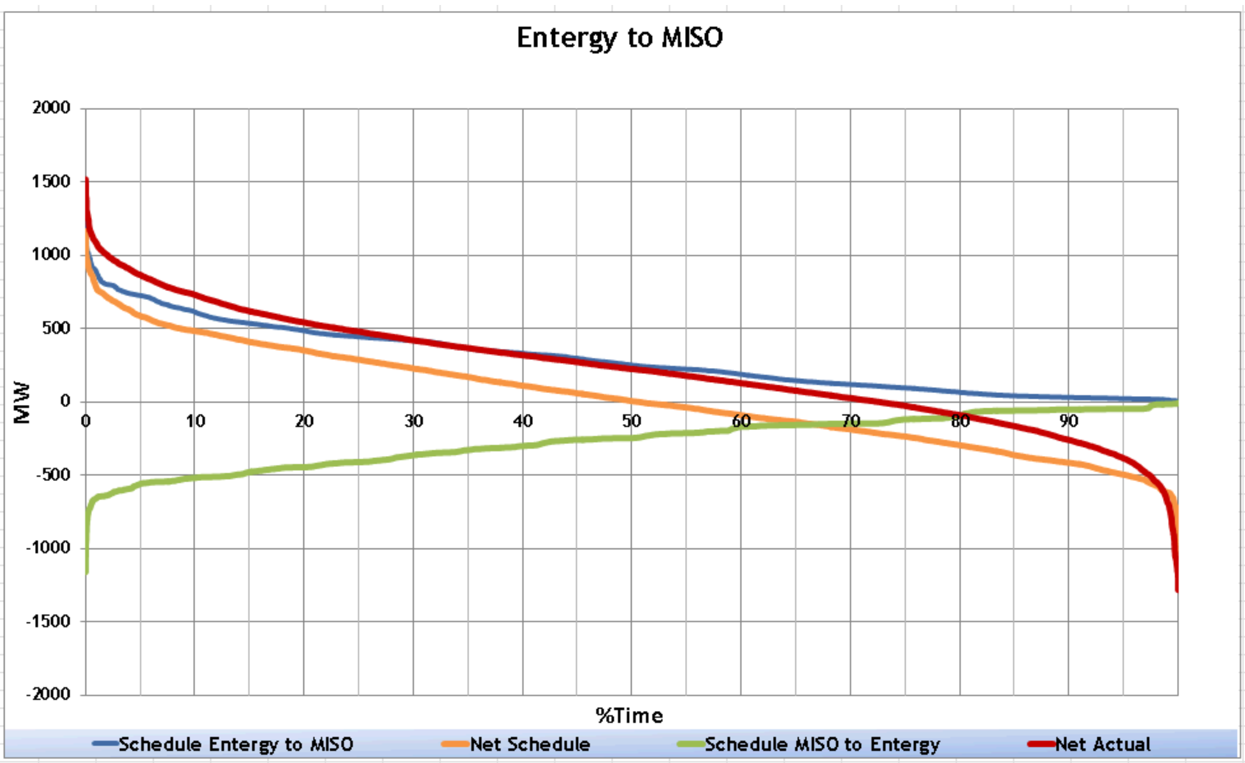

Figure 4: Load for Entergy to MISO

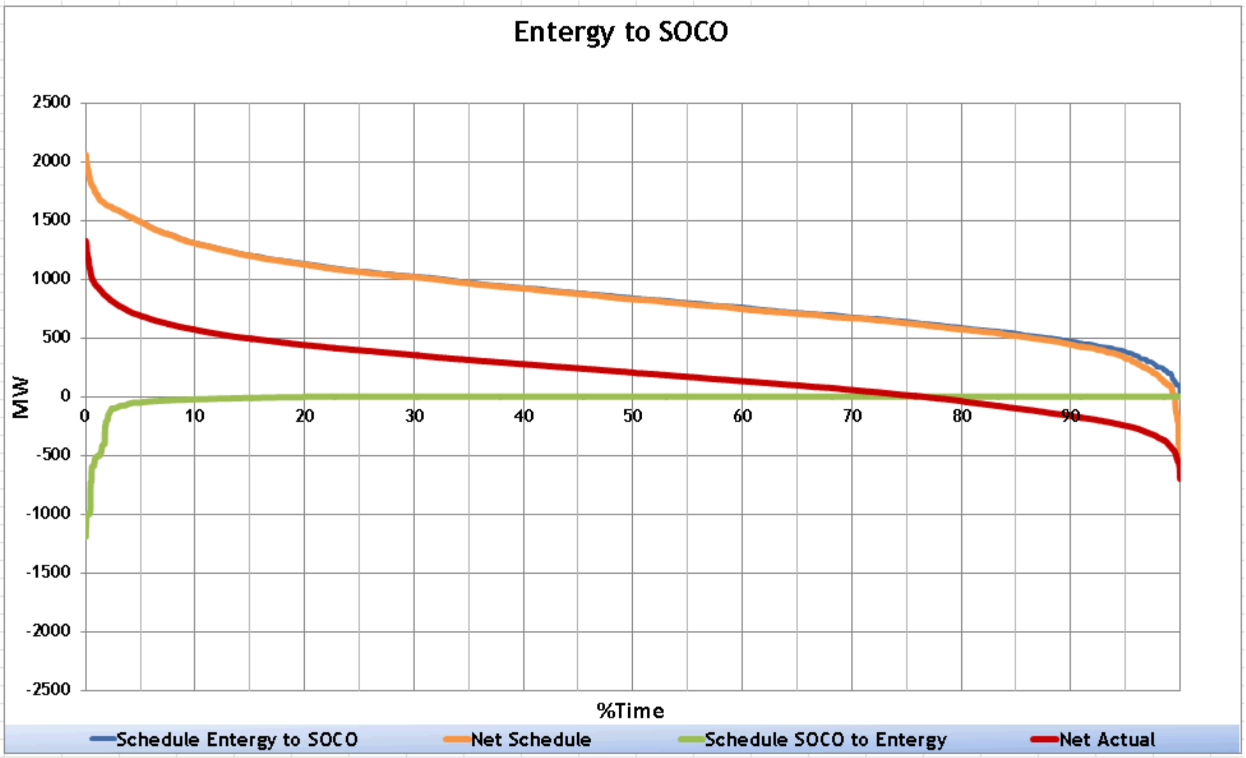

Figure 5: Load for Entergy to SOCO

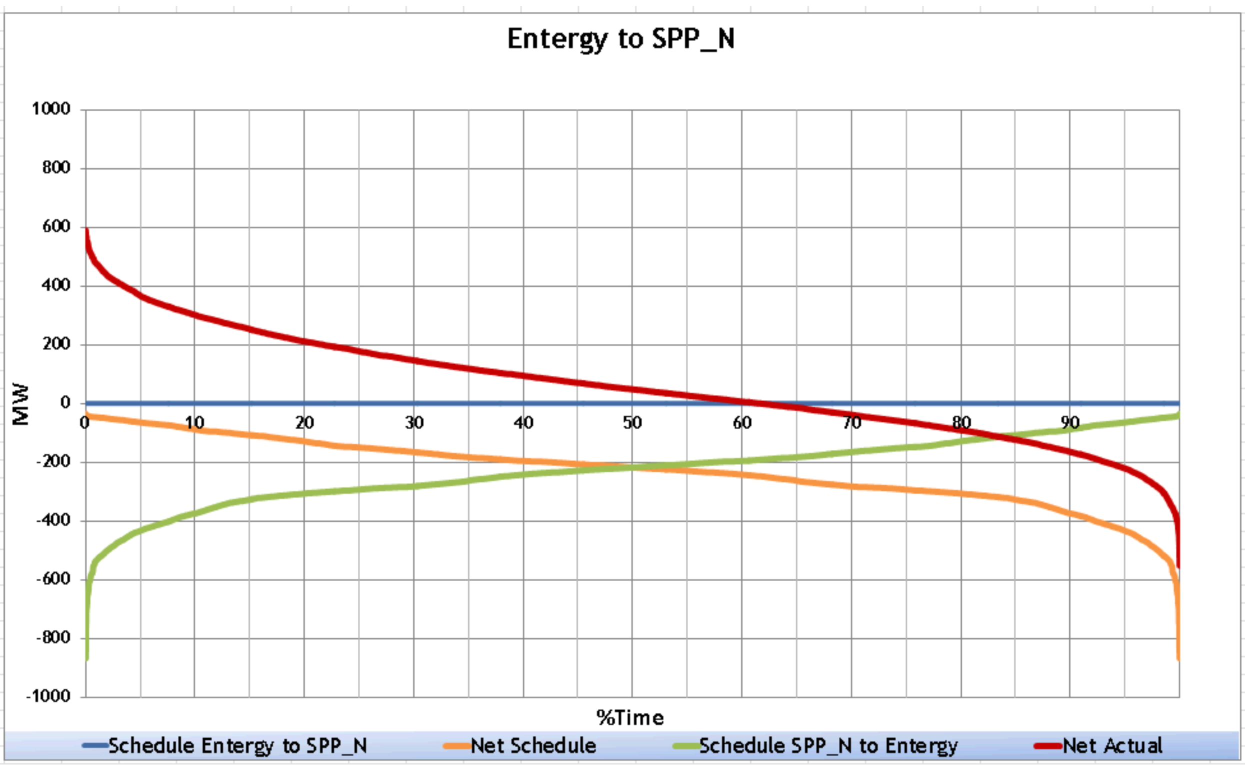

Figure 6: Load for Entergy to SPP_N

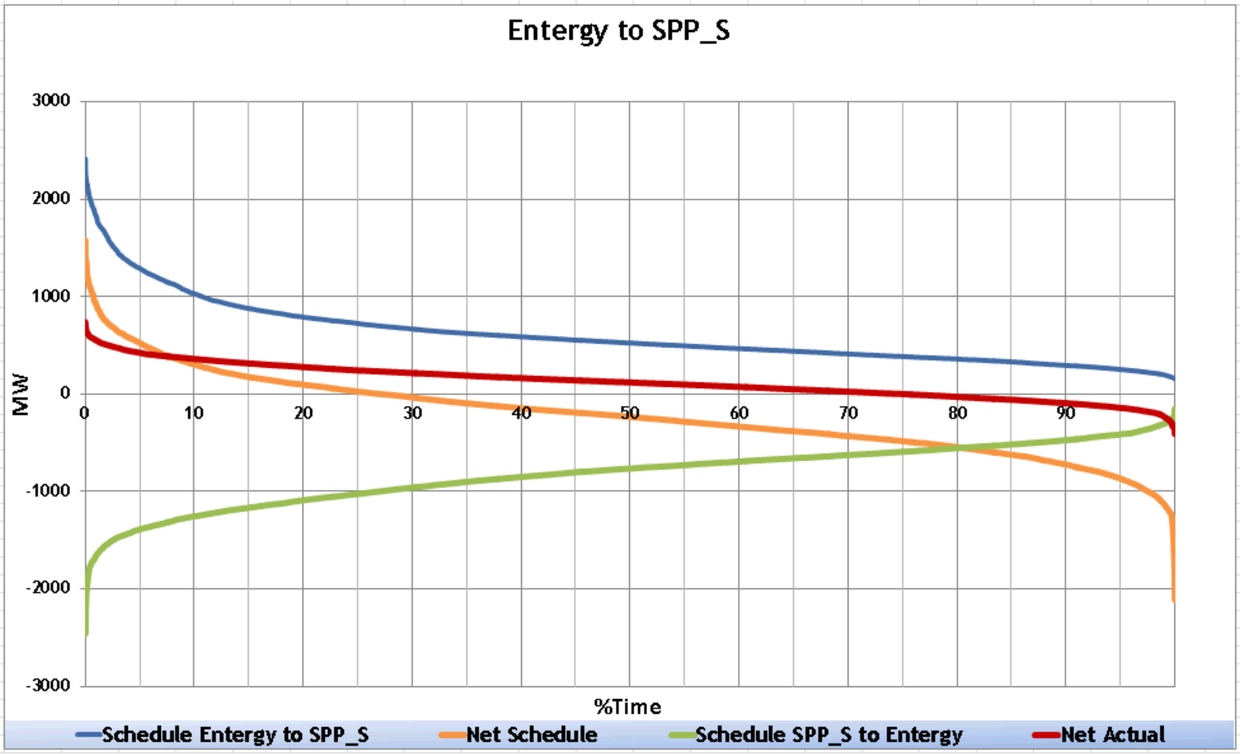

Figure 7: Load for Entergy to SPP_S

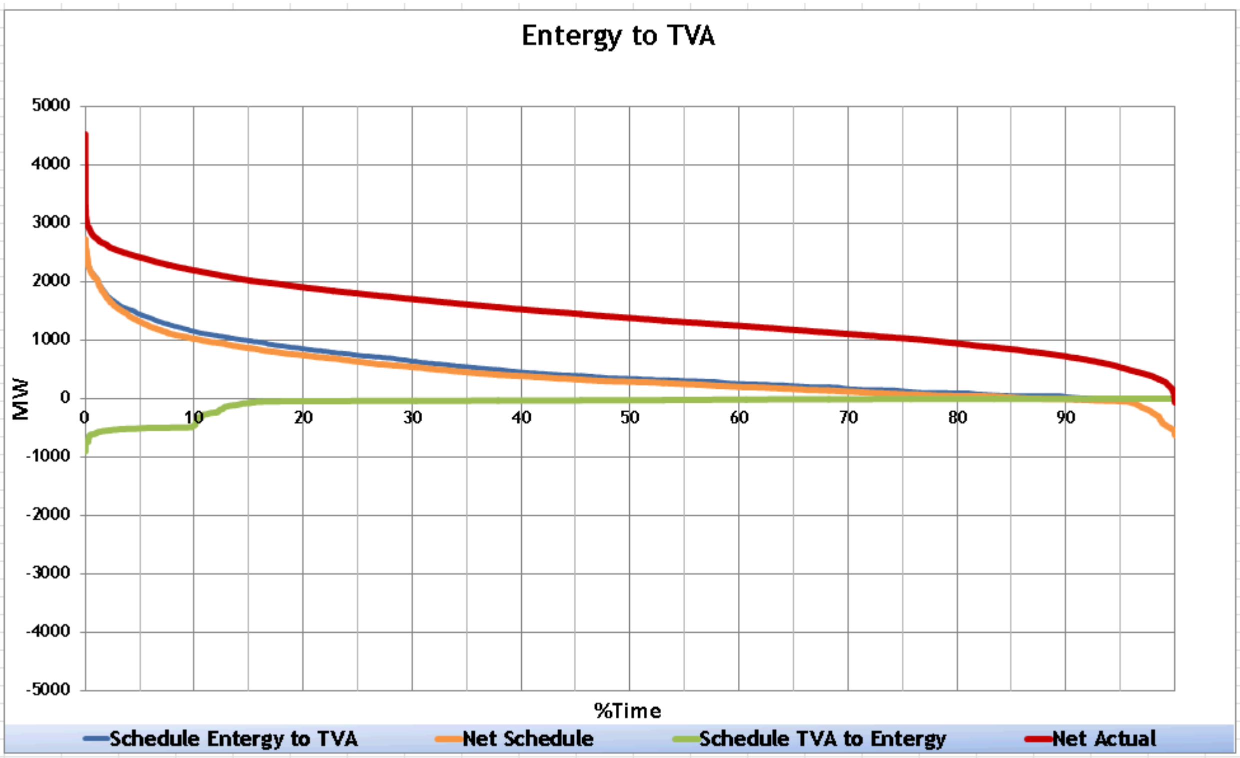

Figure 8: Load for Entergy to TVA

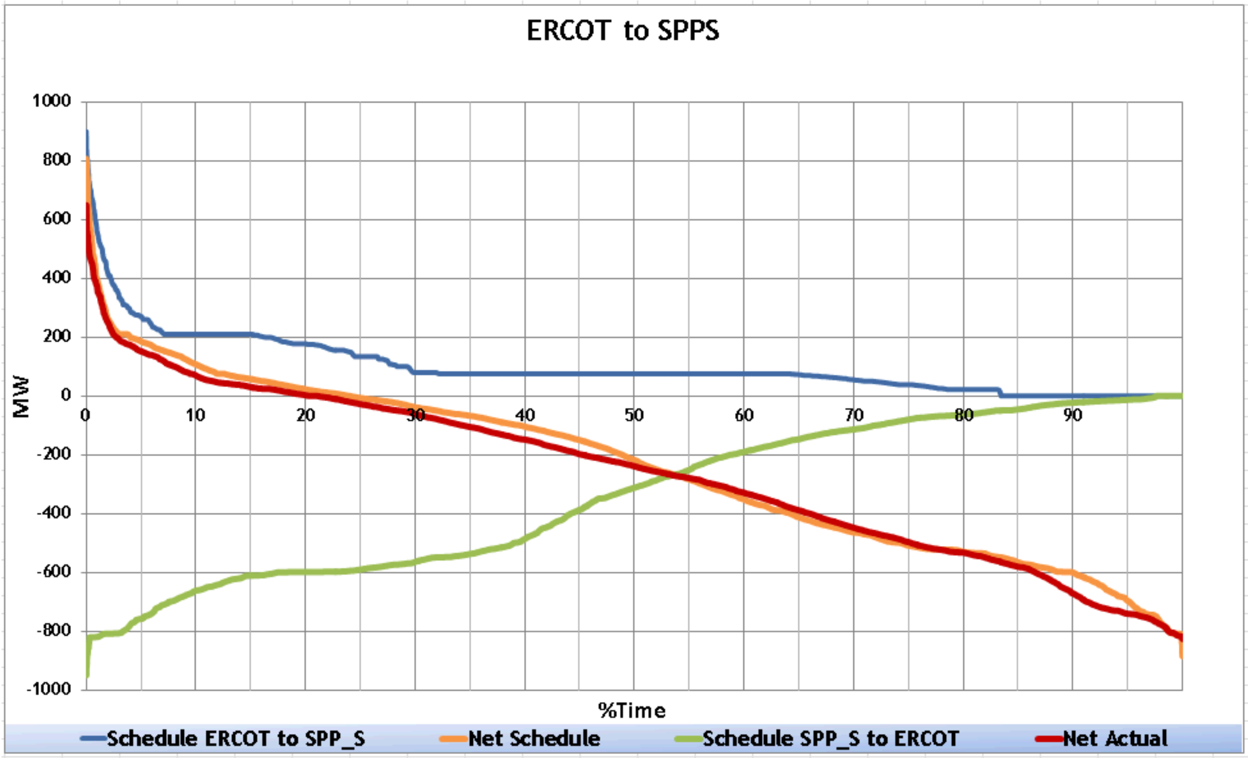

Figure 9: Load for ERCOT to SPPS

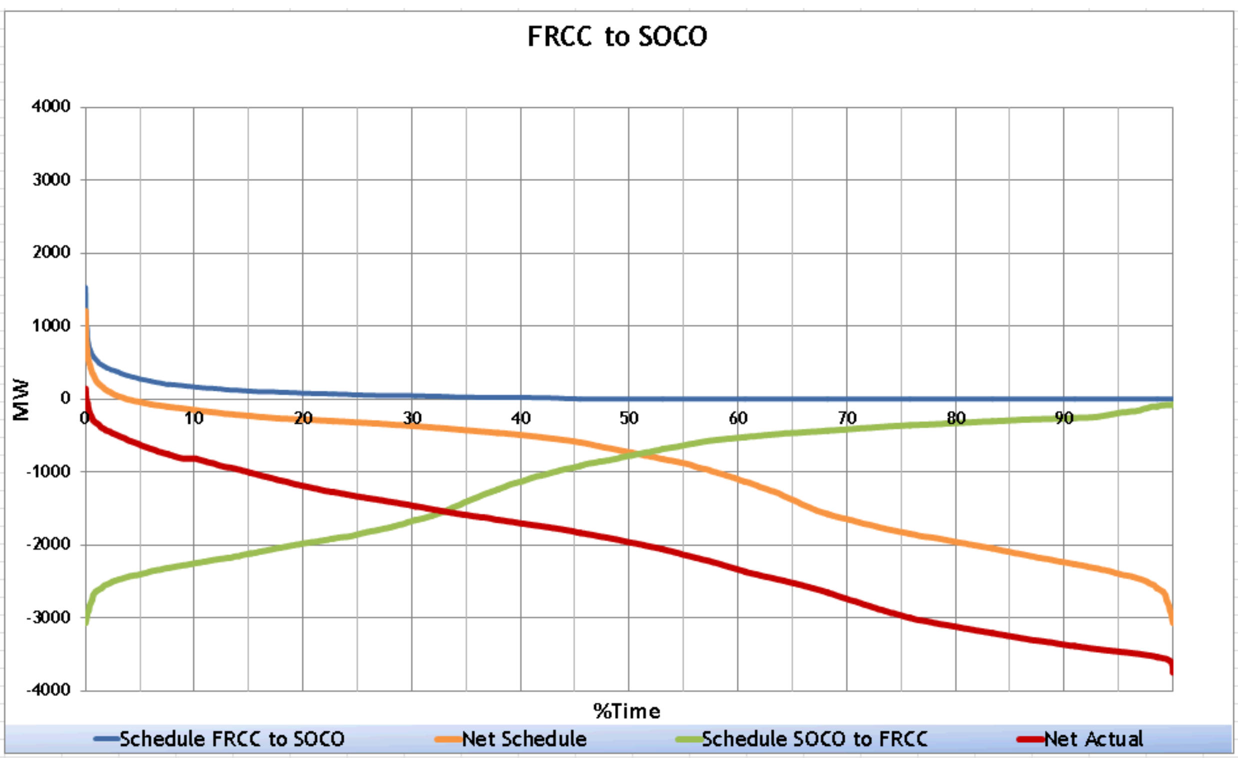

Figure 10: Load for FRCC to SOCO

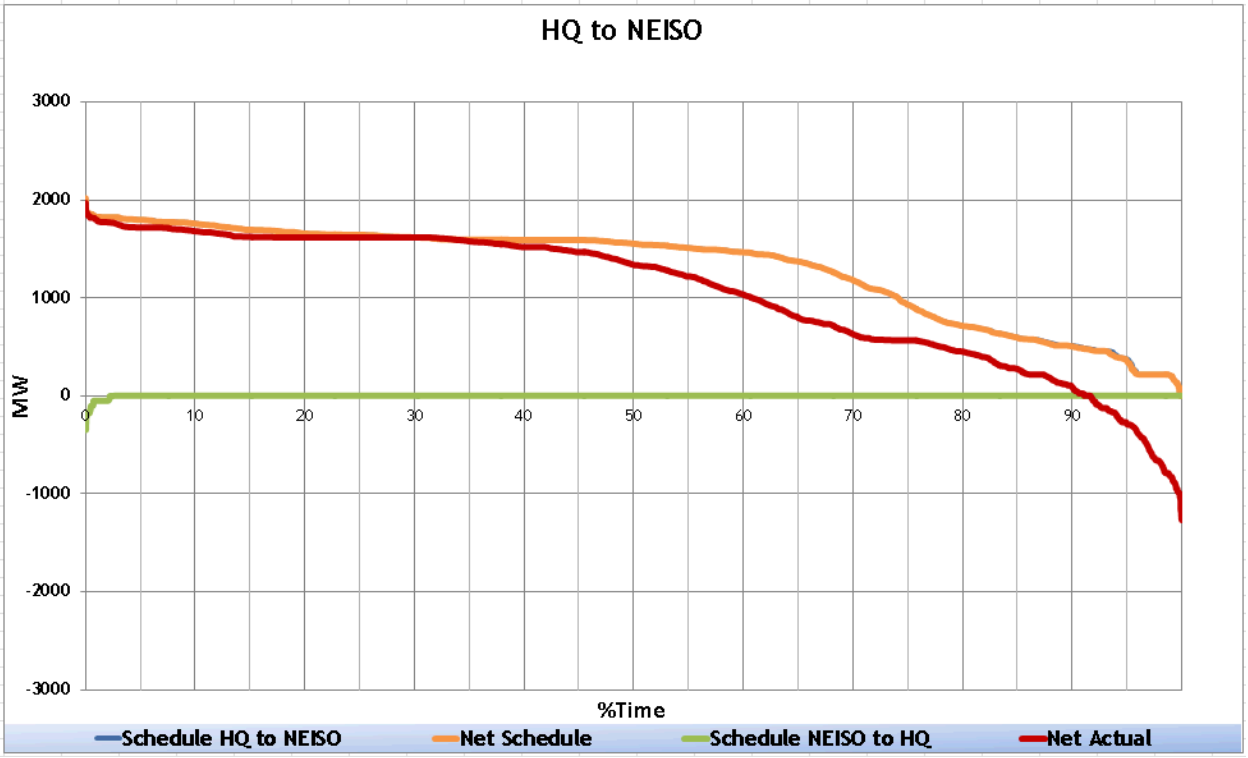

Figure 11: Load for HQ to NEISO

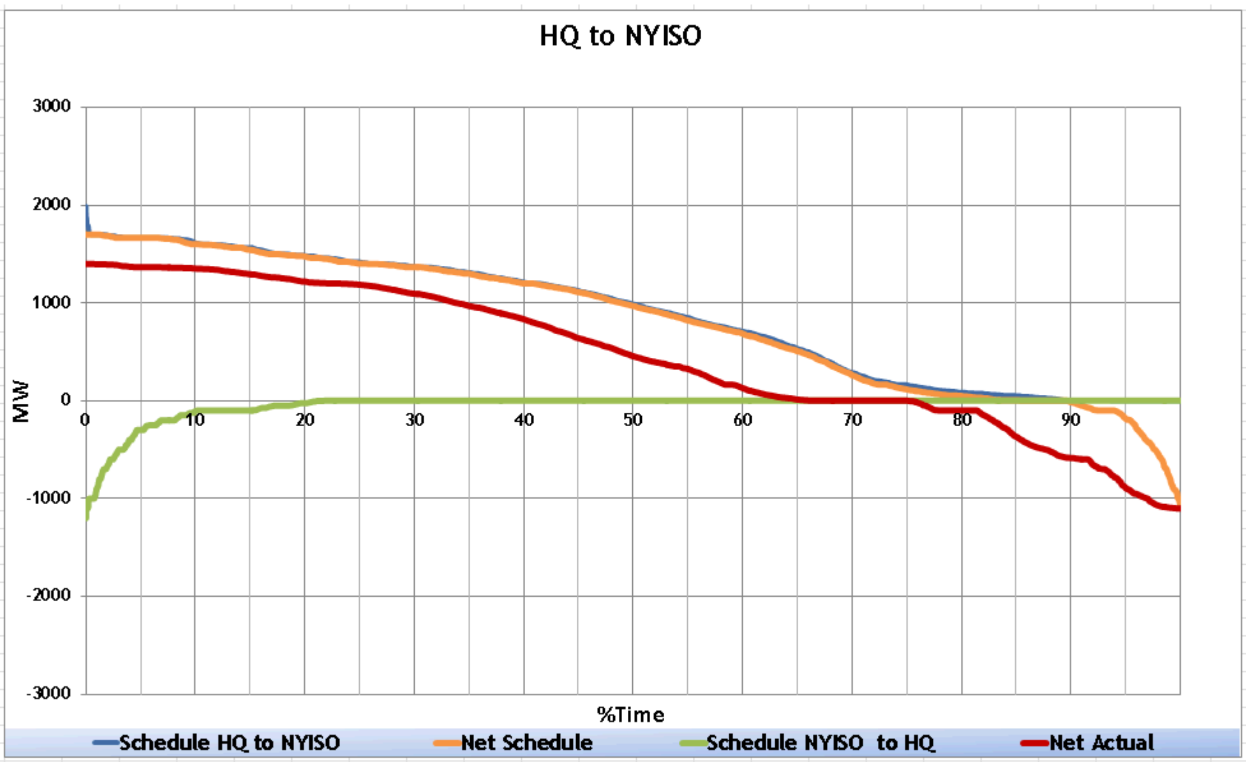

Figure12: Load for HQ to NYISO

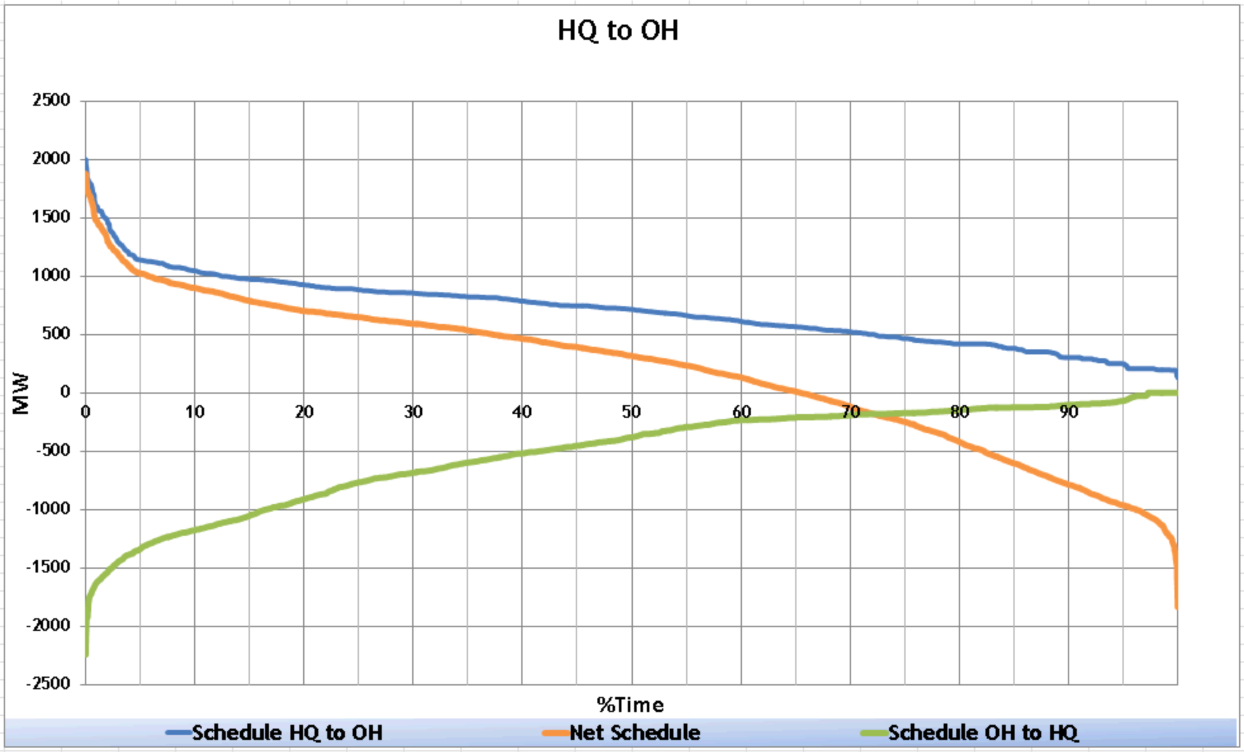

Figure 13: Schedules for HQ to OH

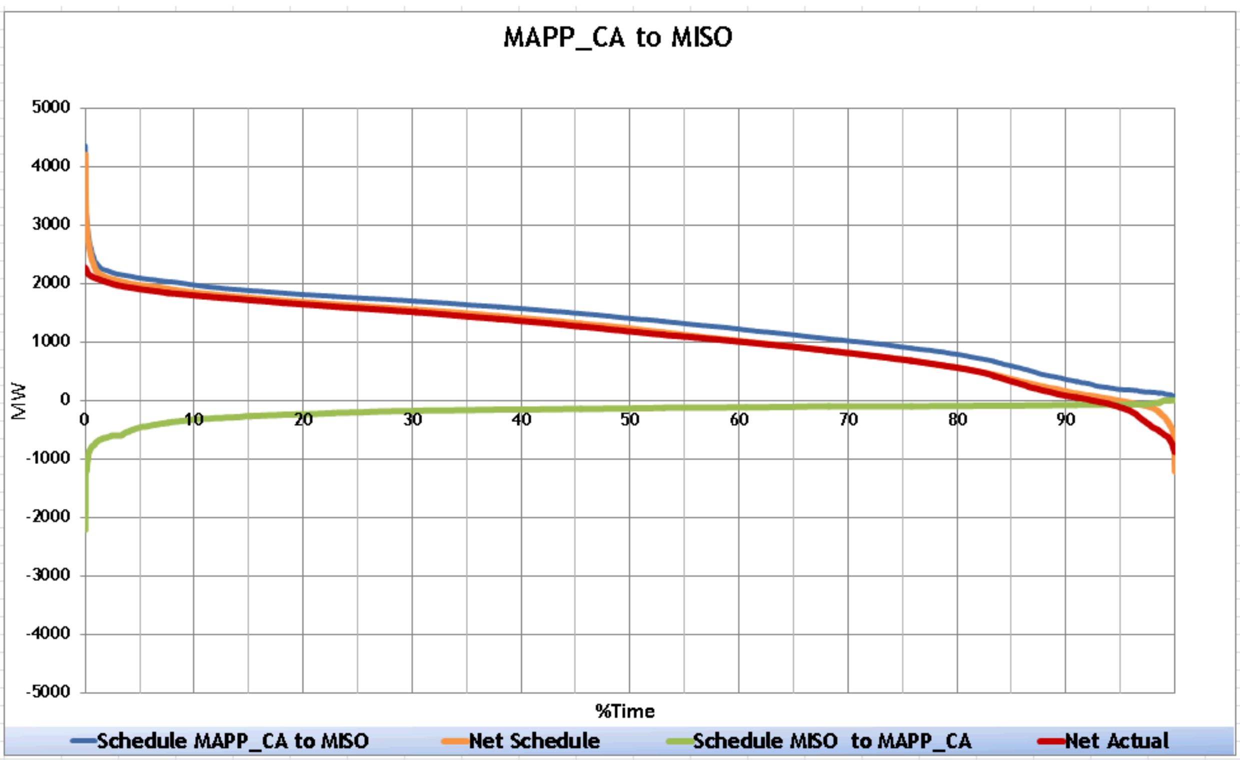

Figure 14: Load for MAPP CA to MISO

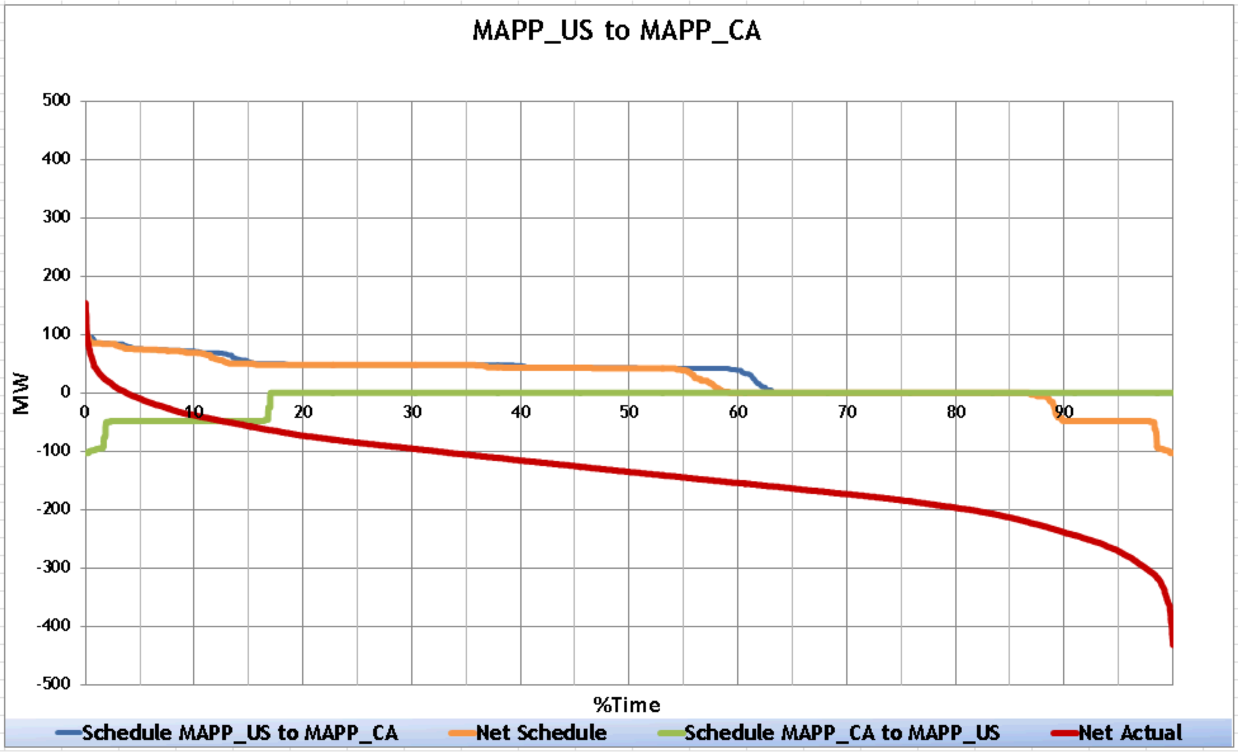

Figure 15: Load for MAPP US to MAPP CA

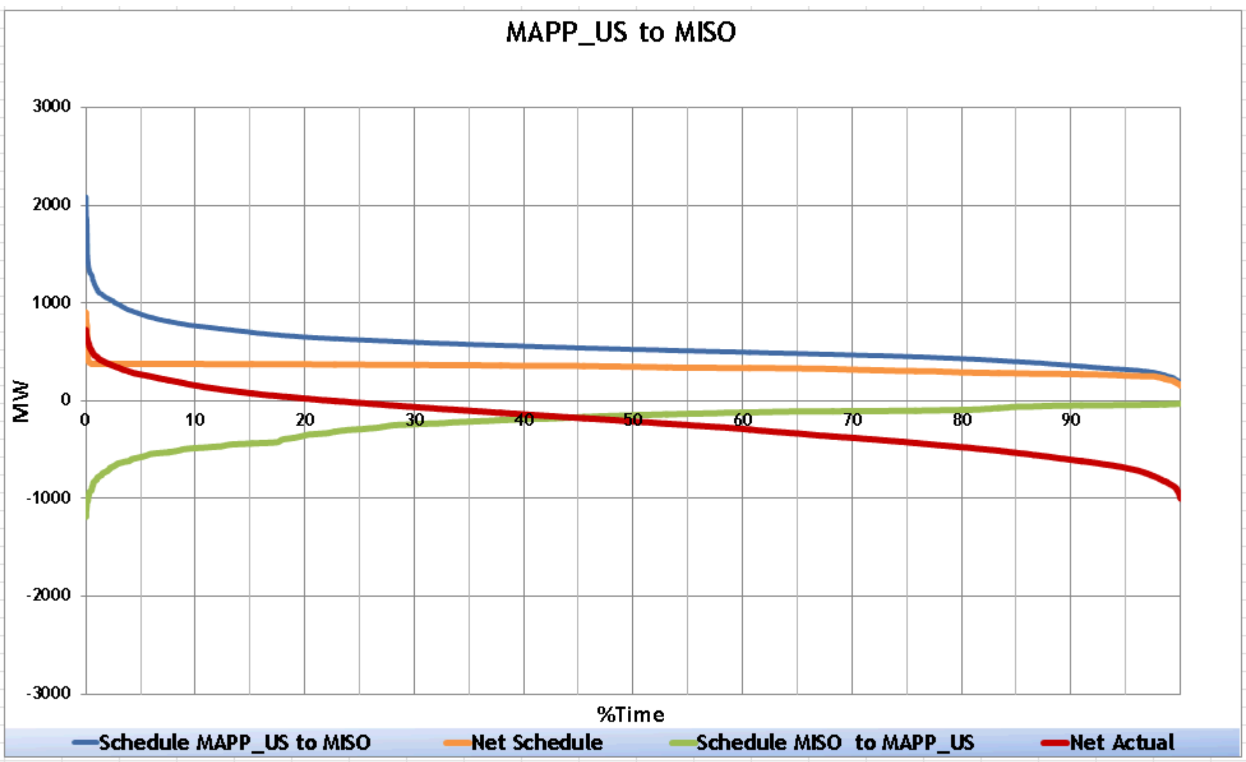

Figure 16: Load for MAPP US to MISO

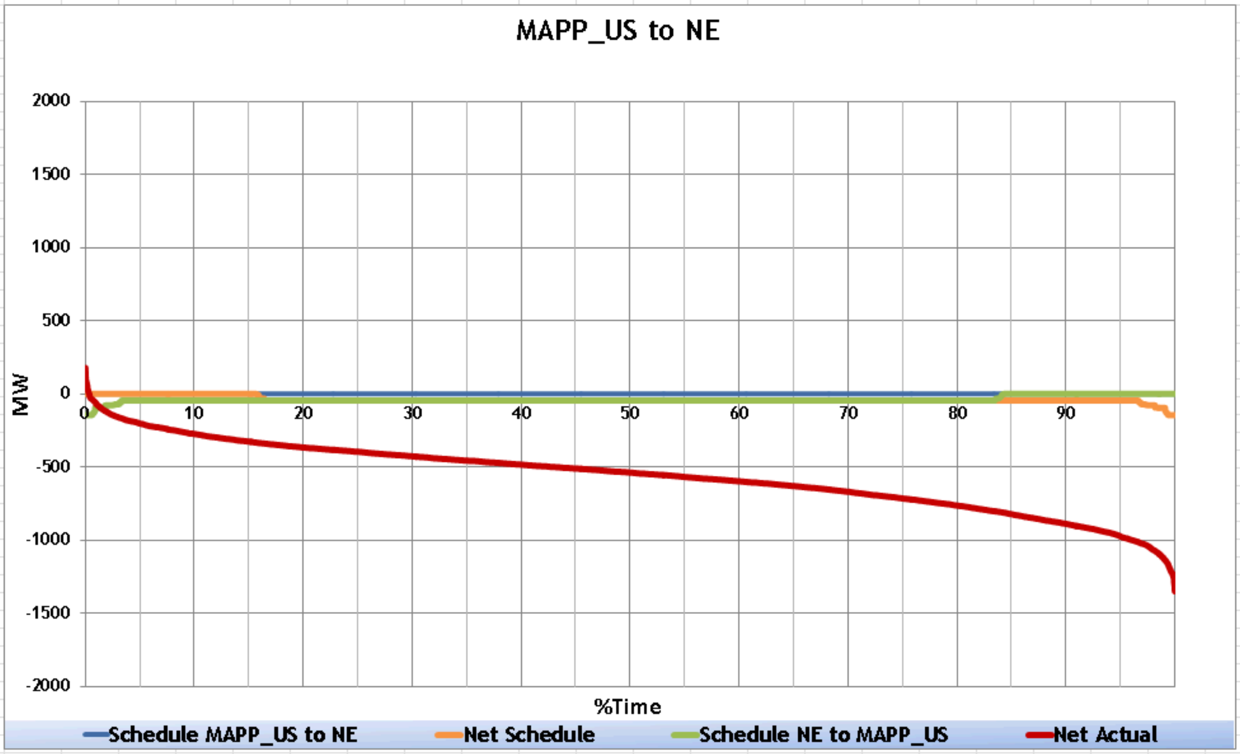

Figure 17: Load for MAPP US to NE

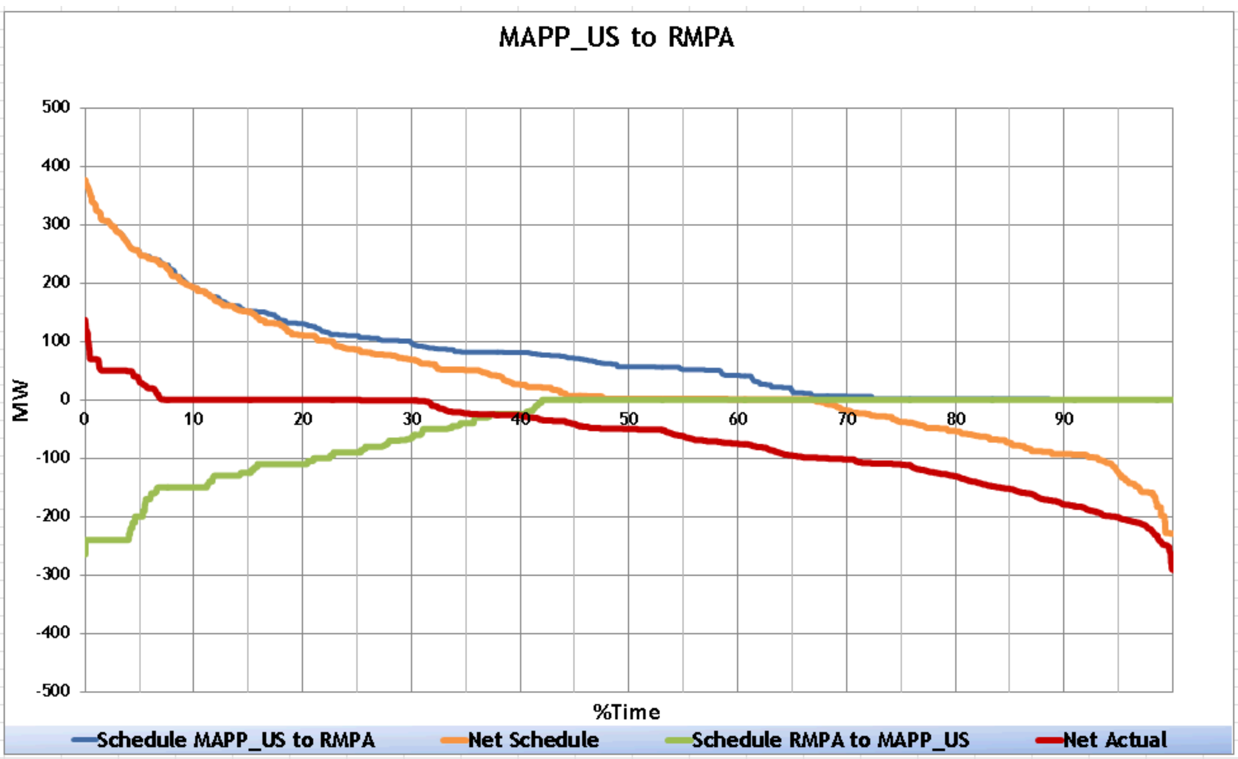

Figure 18: Load for MAPP US to RMPA

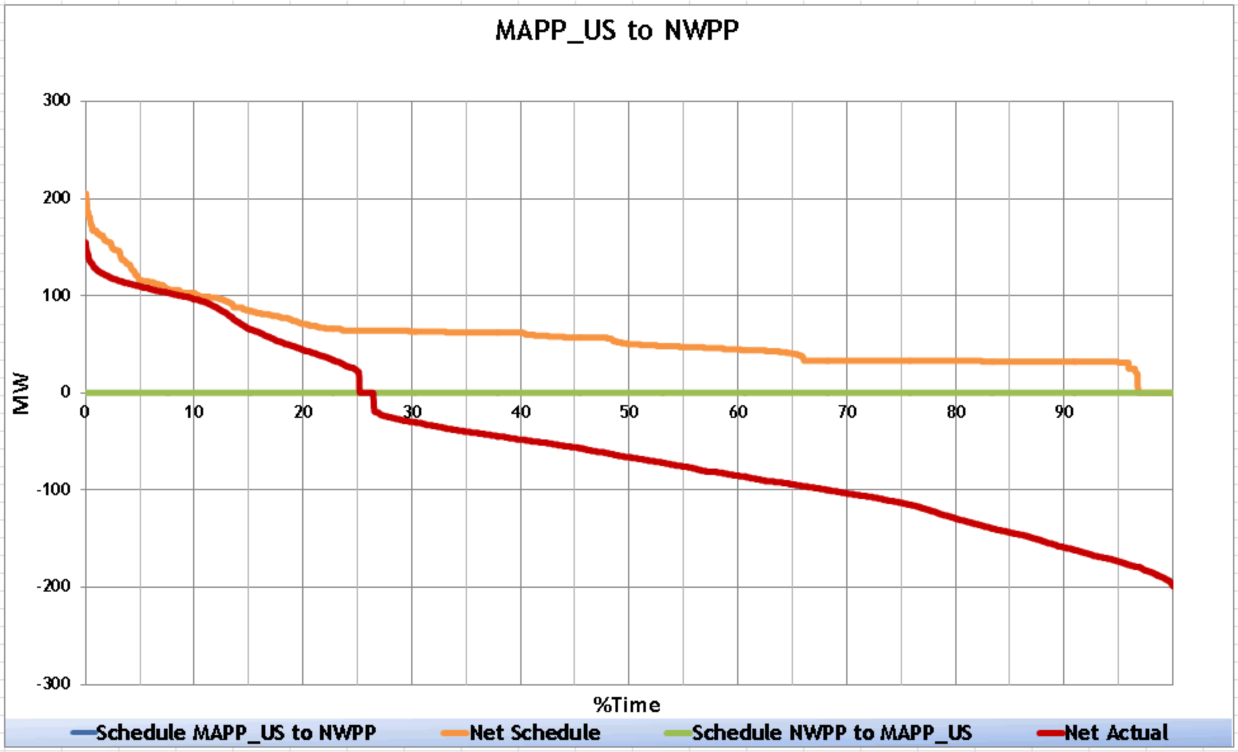

Figure 19: Load for MAPP US to NWPP

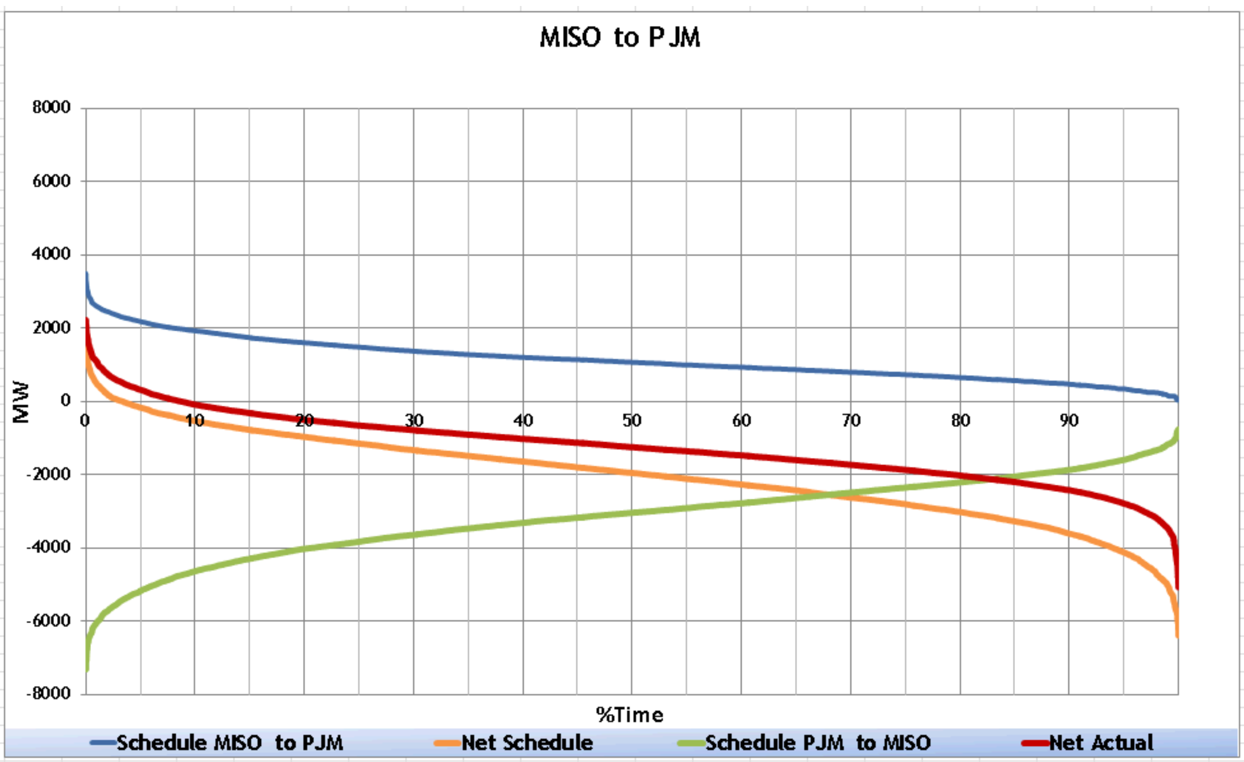

Figure 20: Load for MISO to PJM

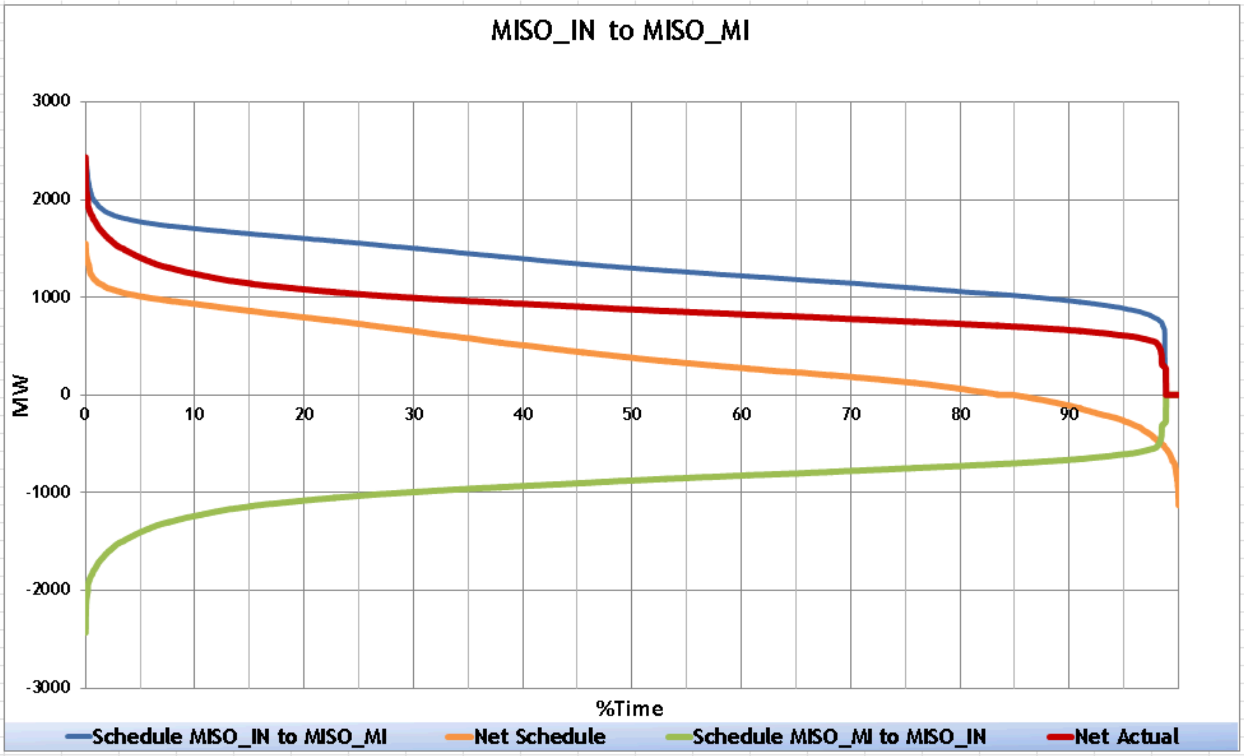

Figure 21: Load for MISO IN to MISO MI

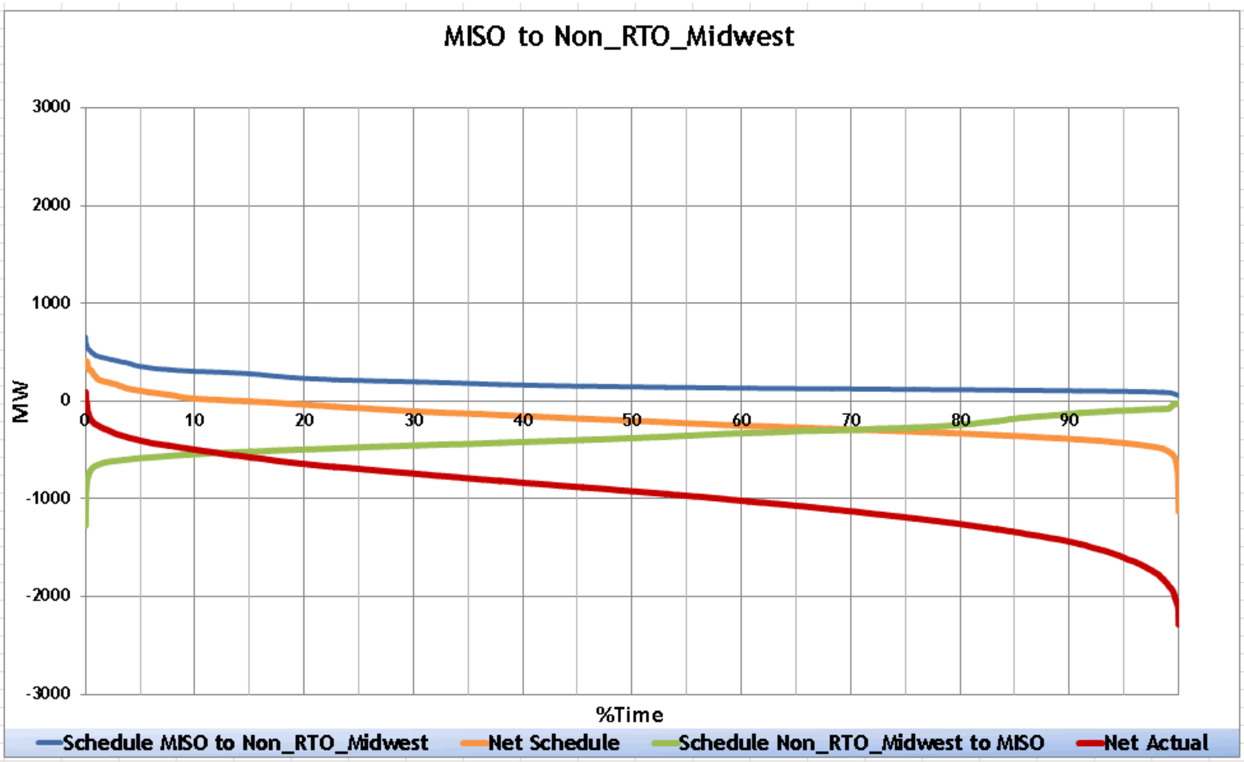

Figure 22: Load for MISO to Non_RTO_Midwest

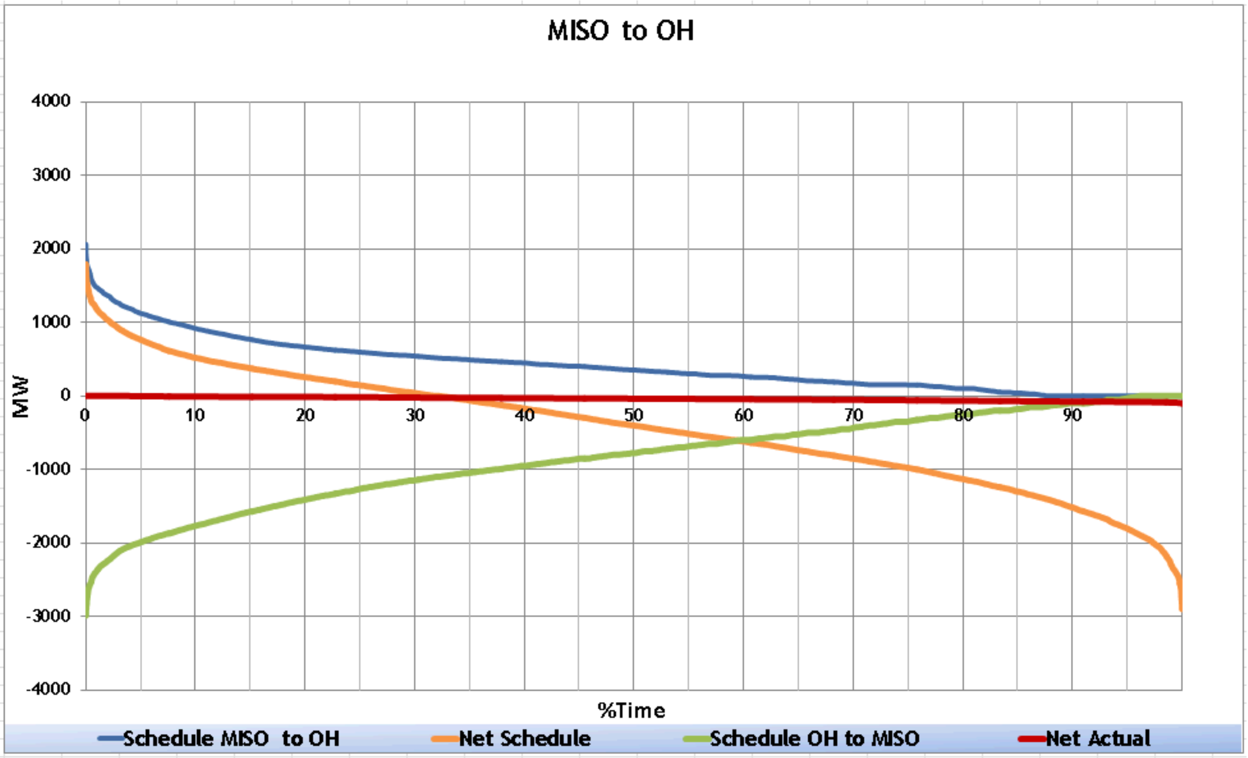

Figure 23: Load for MISO to OH

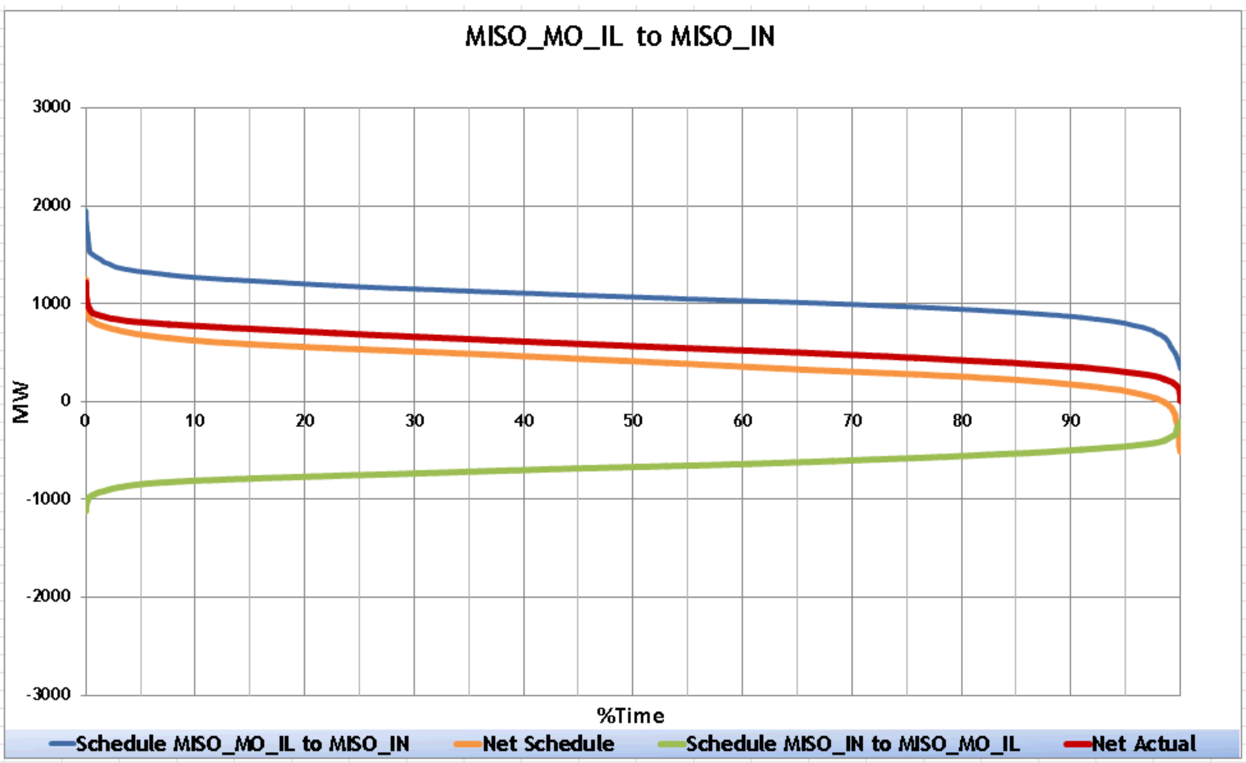

Figure 24: Load for MISO MO IL to MISO IN

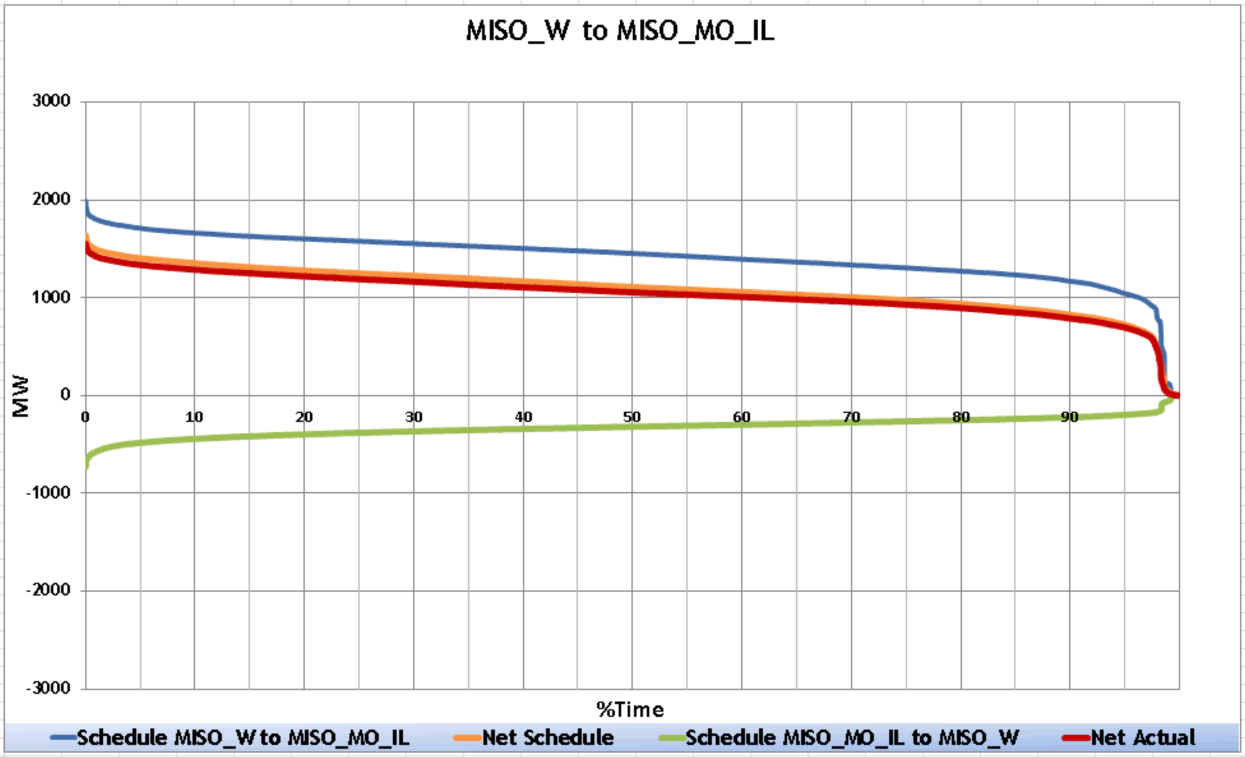

Figure 25: Load for MISO W to MISO MO IL

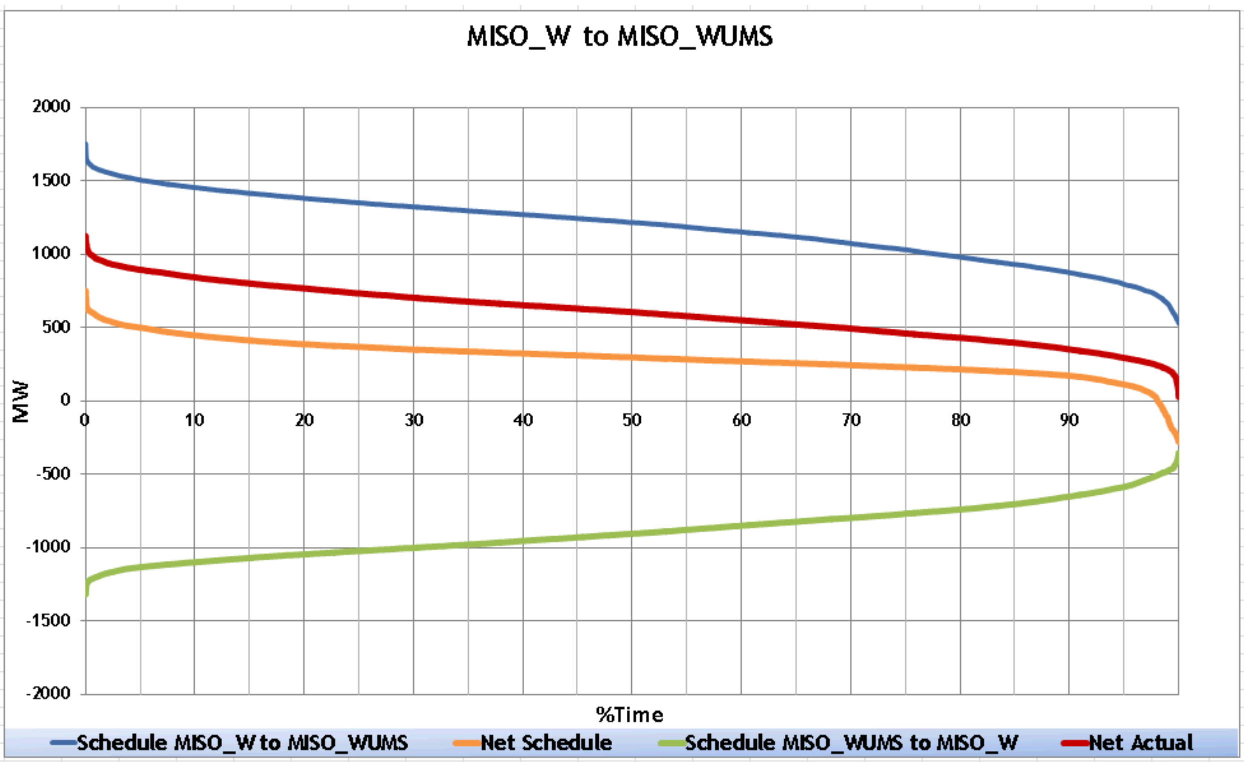

Figure 26: Load for MISO W to MISO WUMS

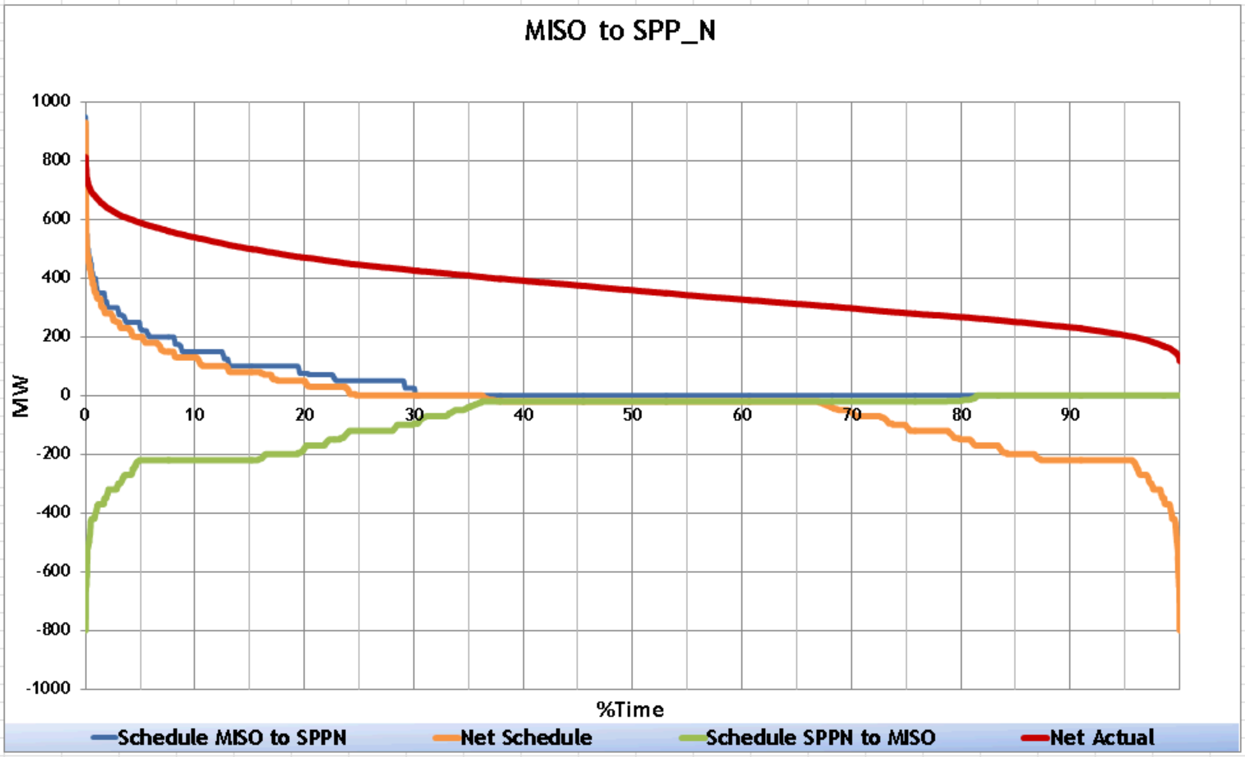

Figure 27: Load for MISO to SPP N

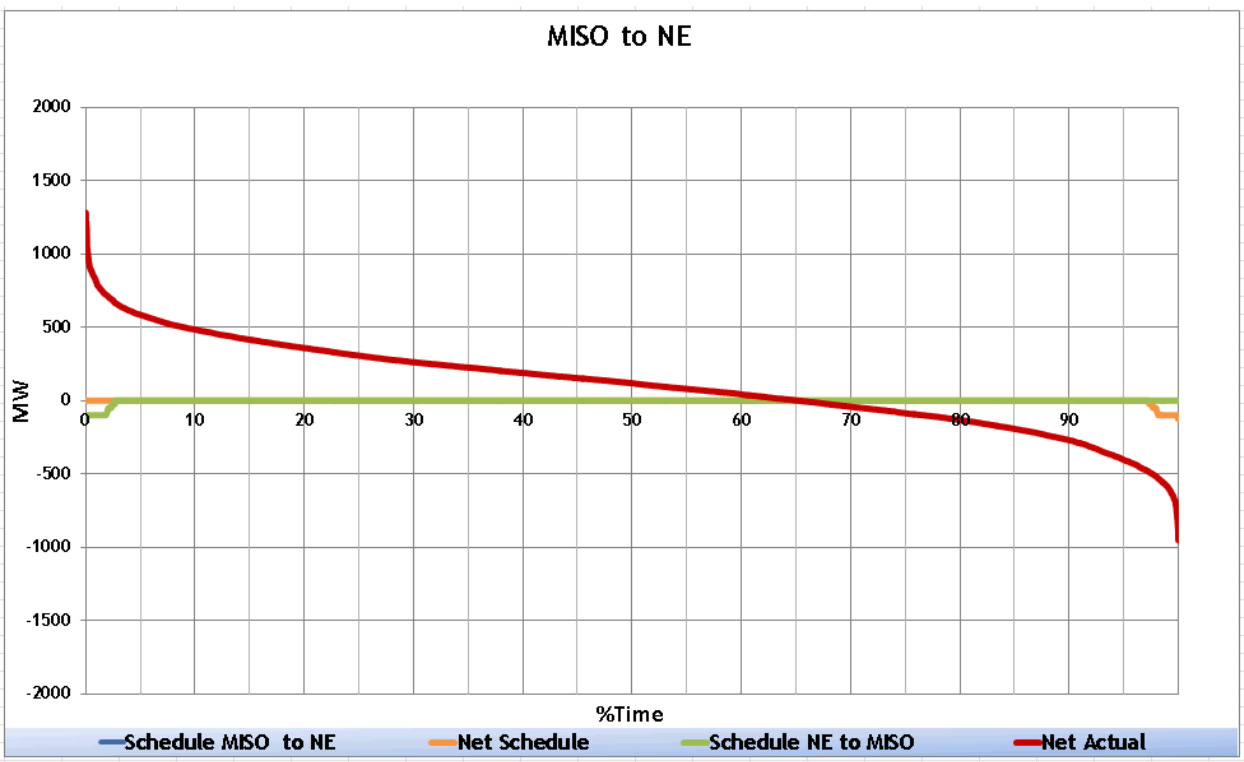

Figure 28: Load for MISO W to NE

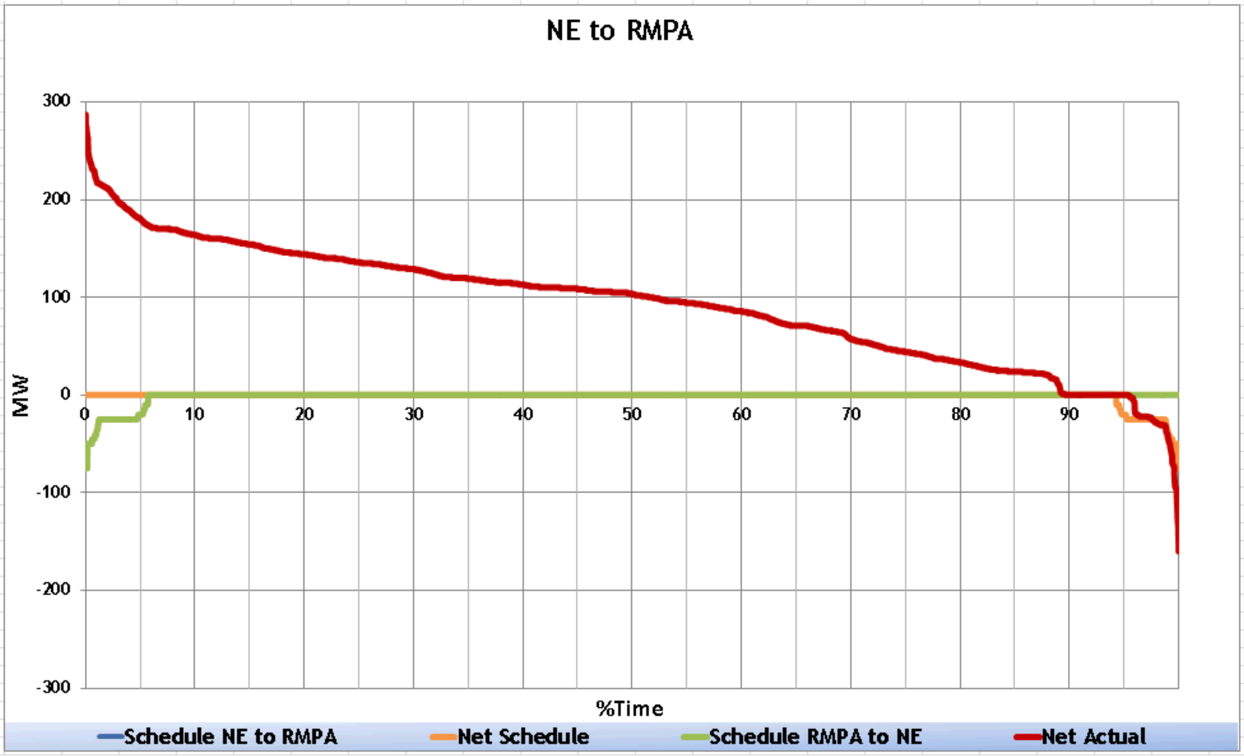

Figure 29: Load for NE to RMPA

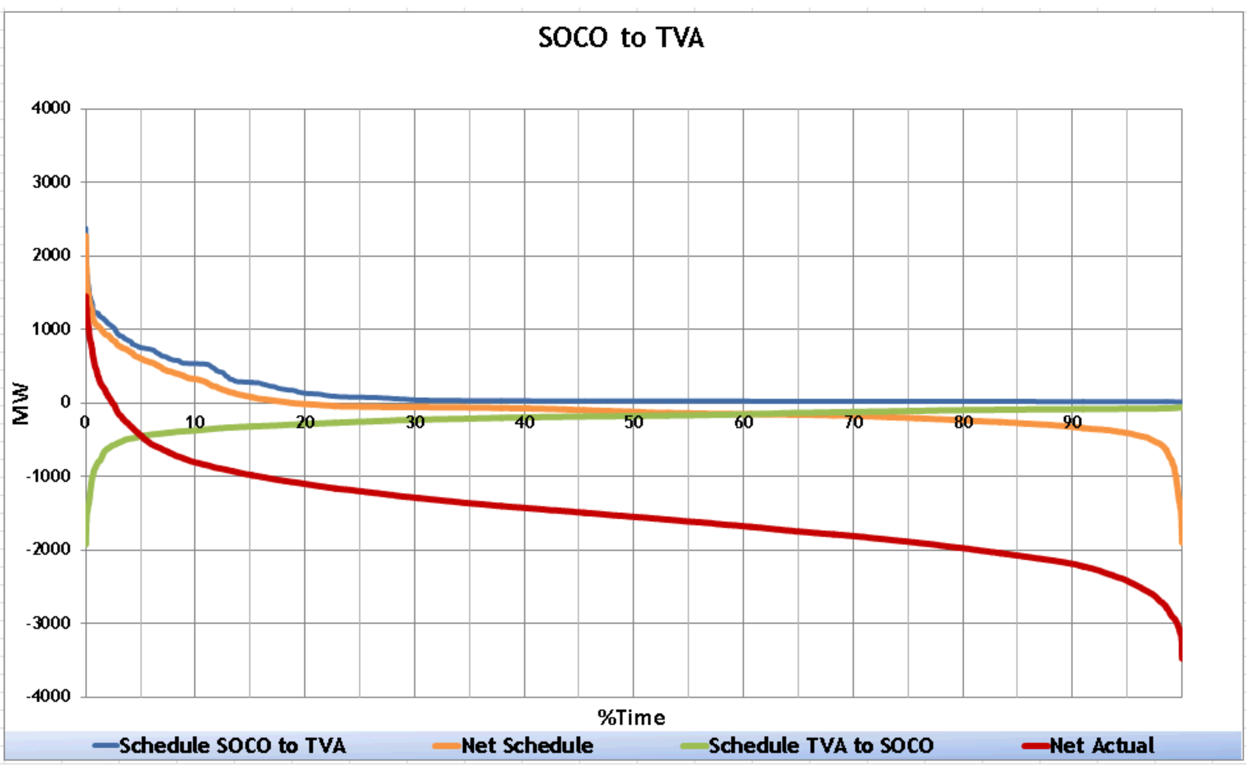

Figure 30: Load for SOCO to TVA

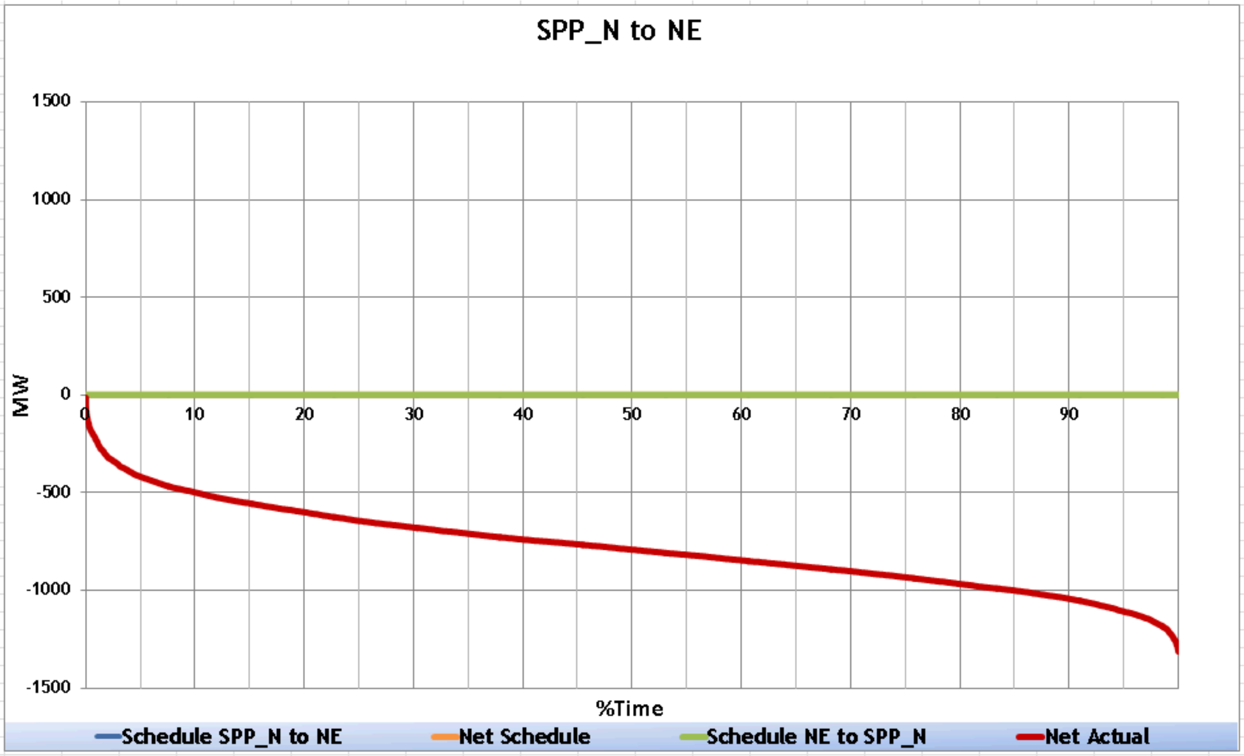

Figure 31: Load for SPP_N to NE

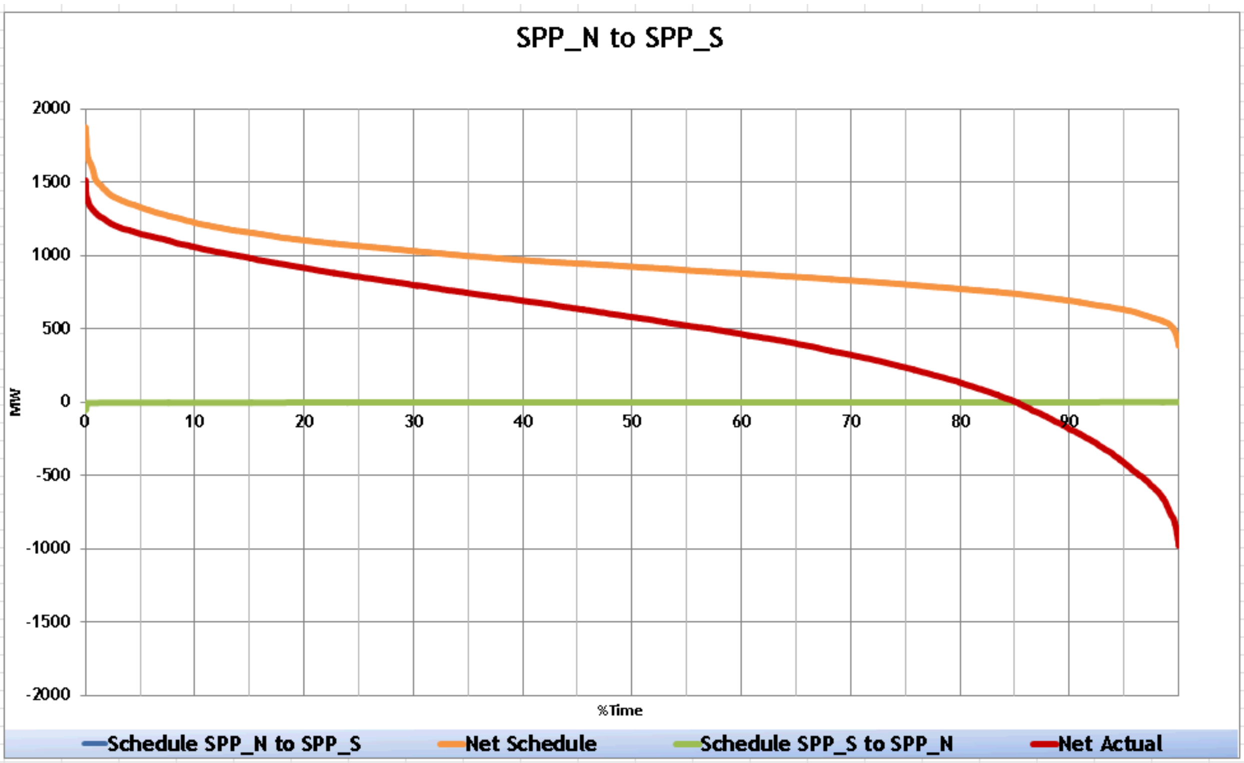

Figure 32: Load for SPP_N to SPP_S

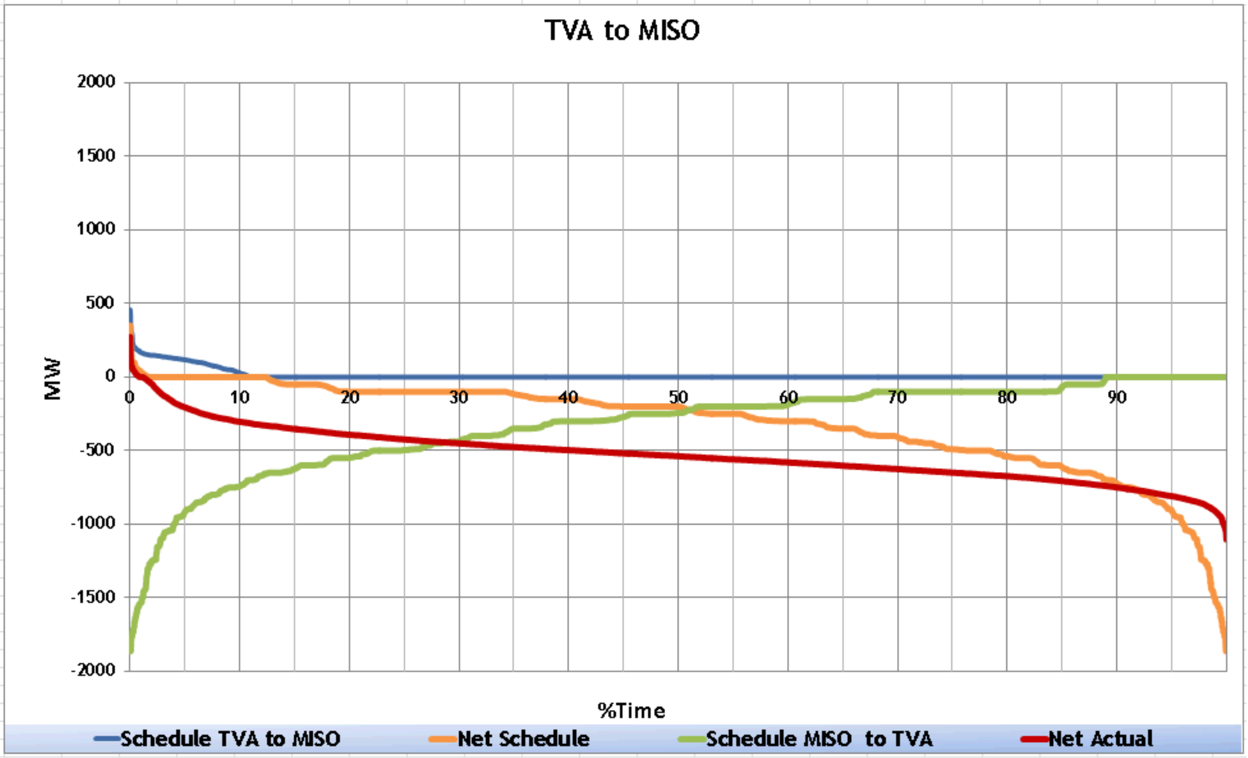

Figure 33: Load for TVA to MISO

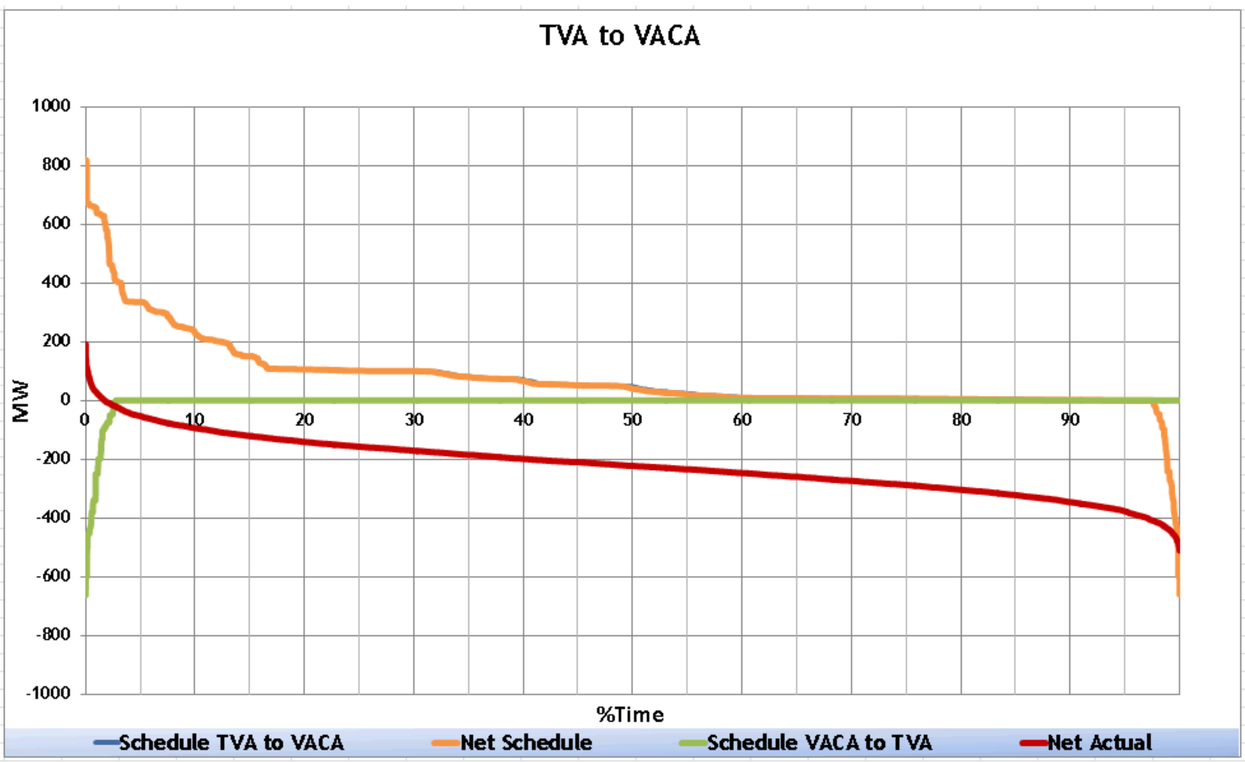

Figure 34: Load for TVA to VACA

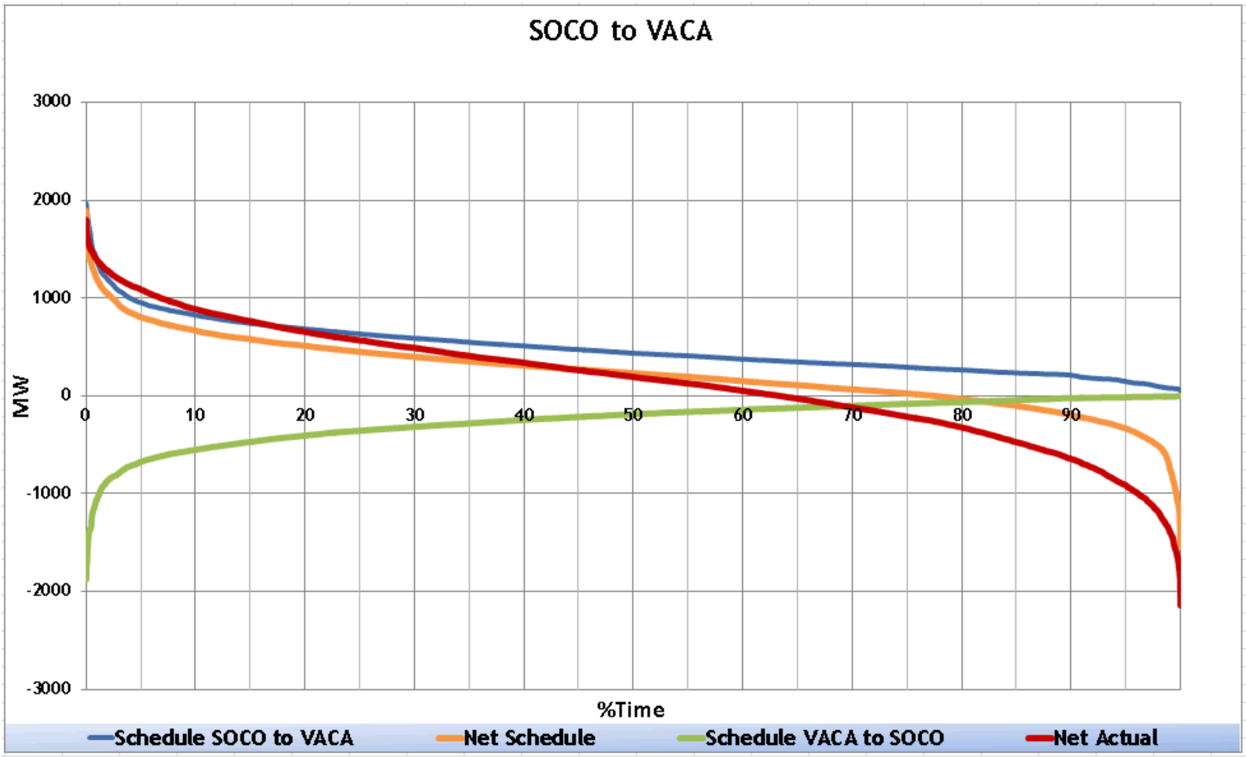

Figure 35: Load for SOCO to VACA

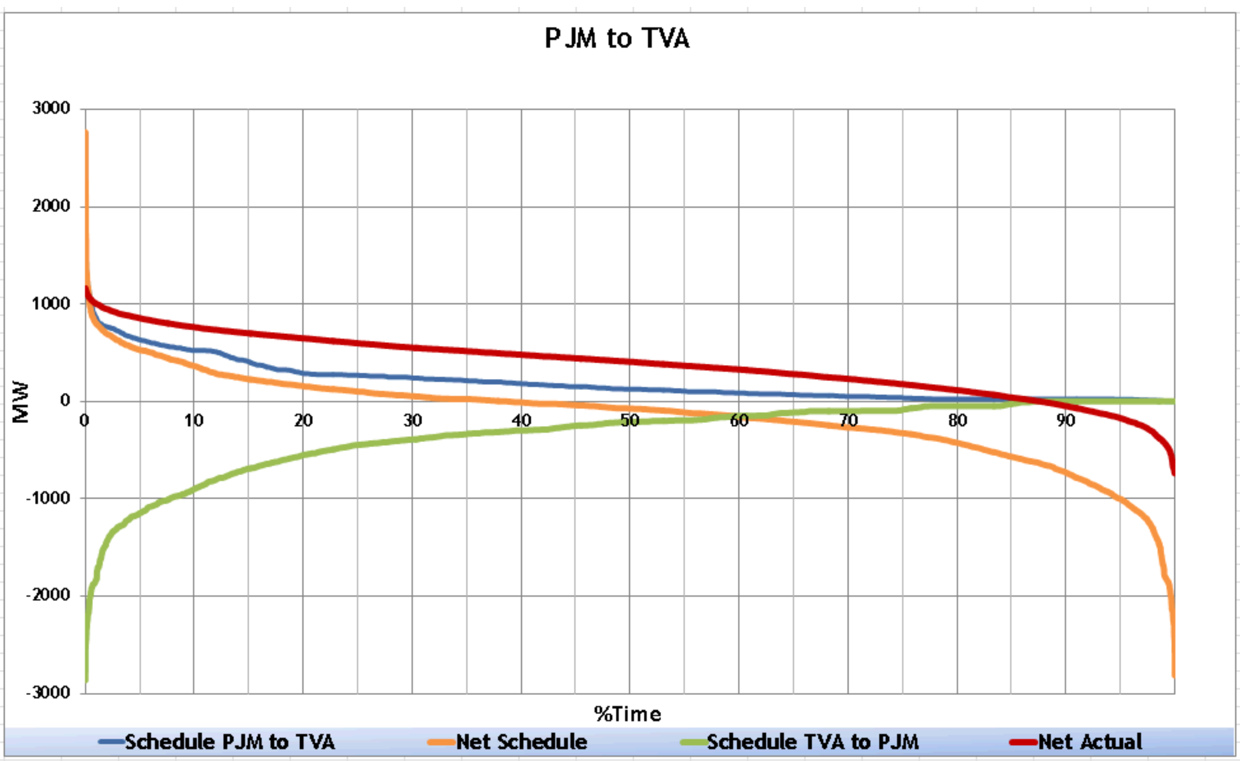

Figure 36: Load for PJM to TVA

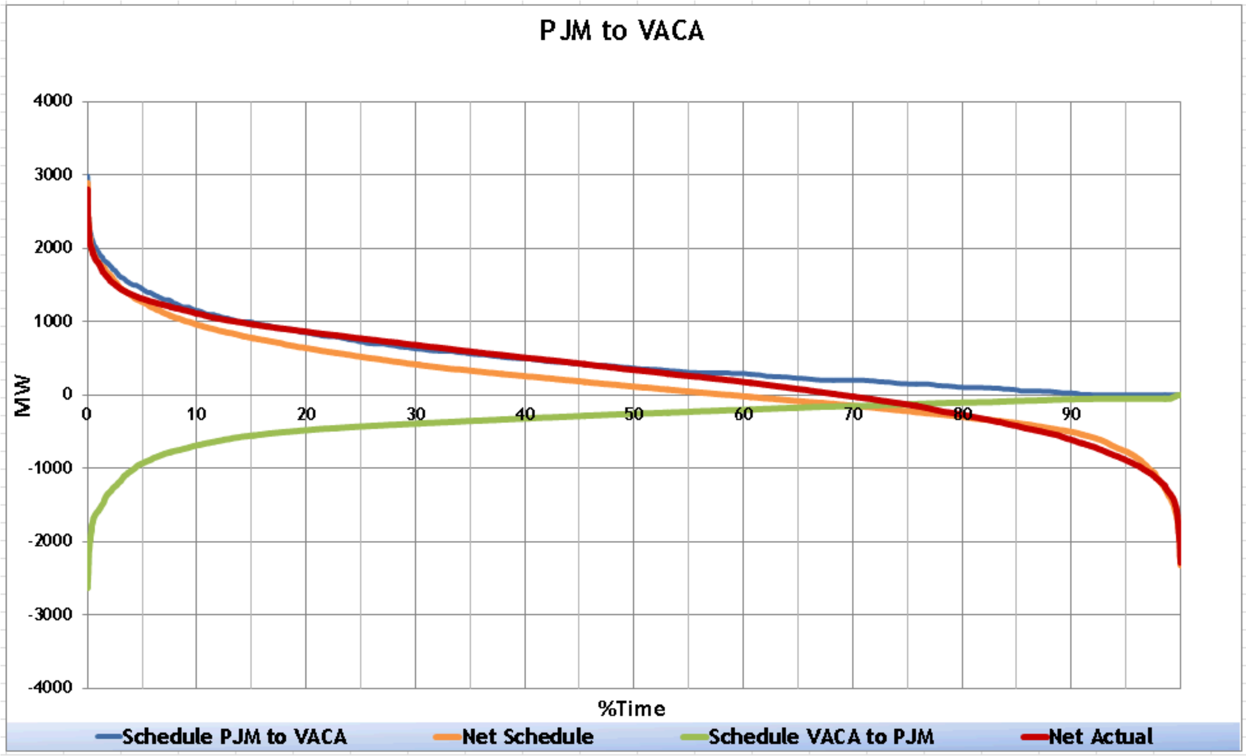

Figure 37: Load for PJM to VACA

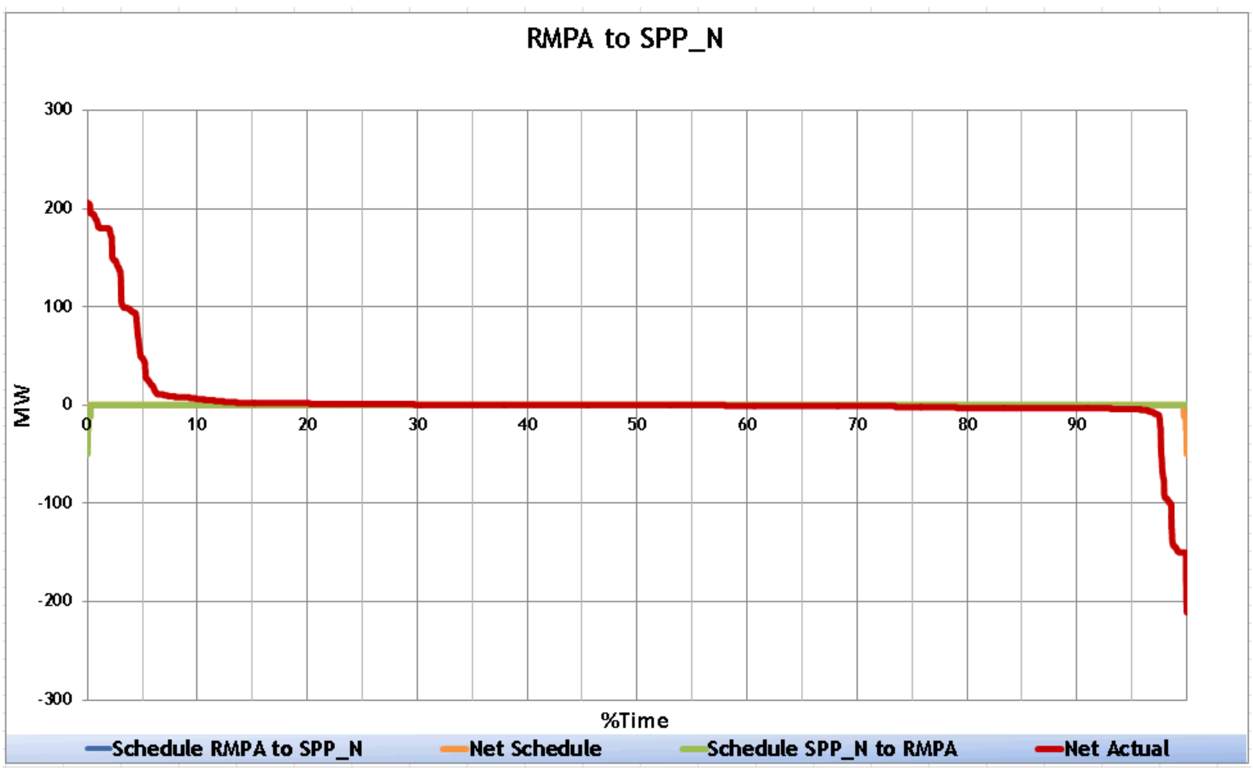

Figure 38: RMPA to SPP_N

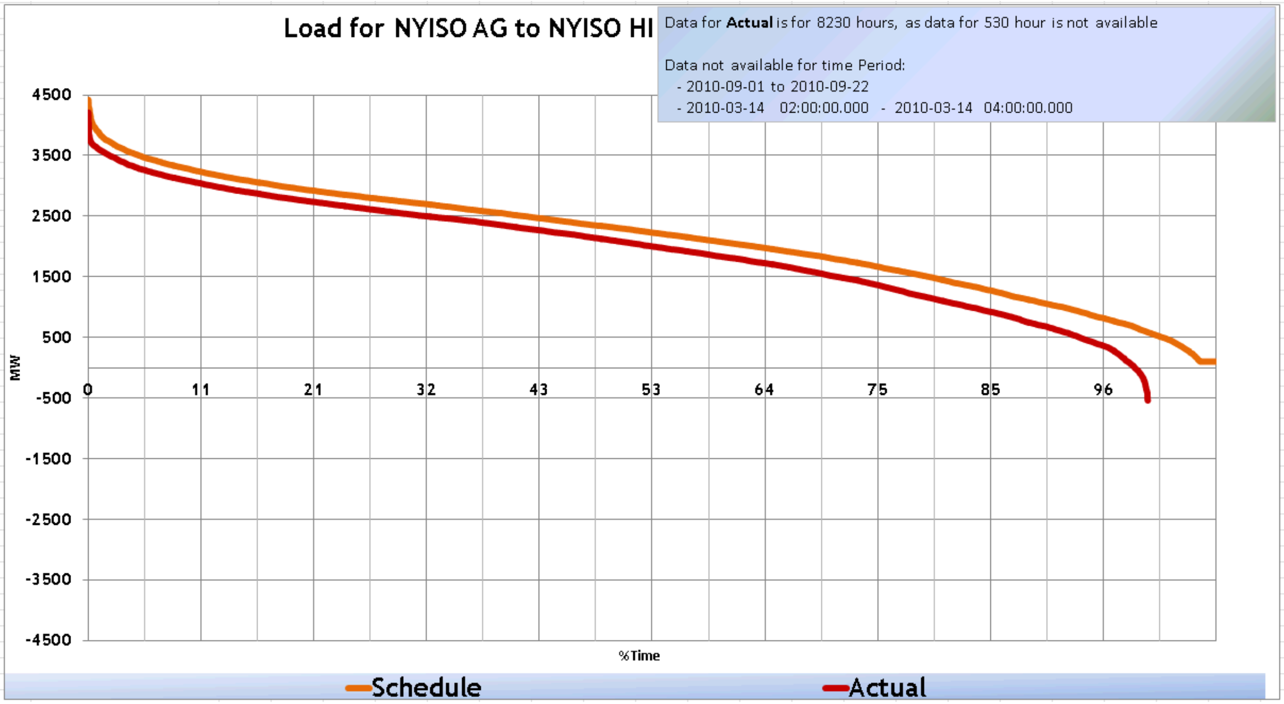

Figure 39: Load for NYISO AG to NYISO HI

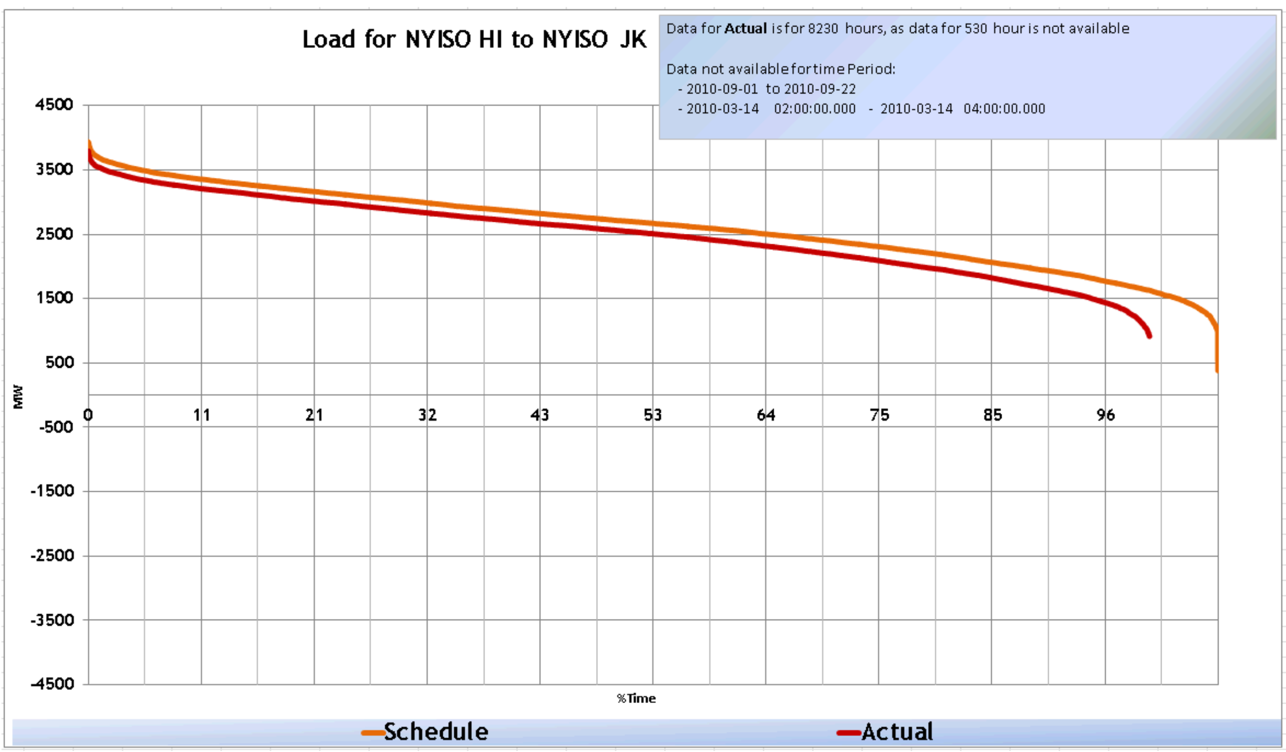

Figure 40: Load for NYISO HI to NYISO JK

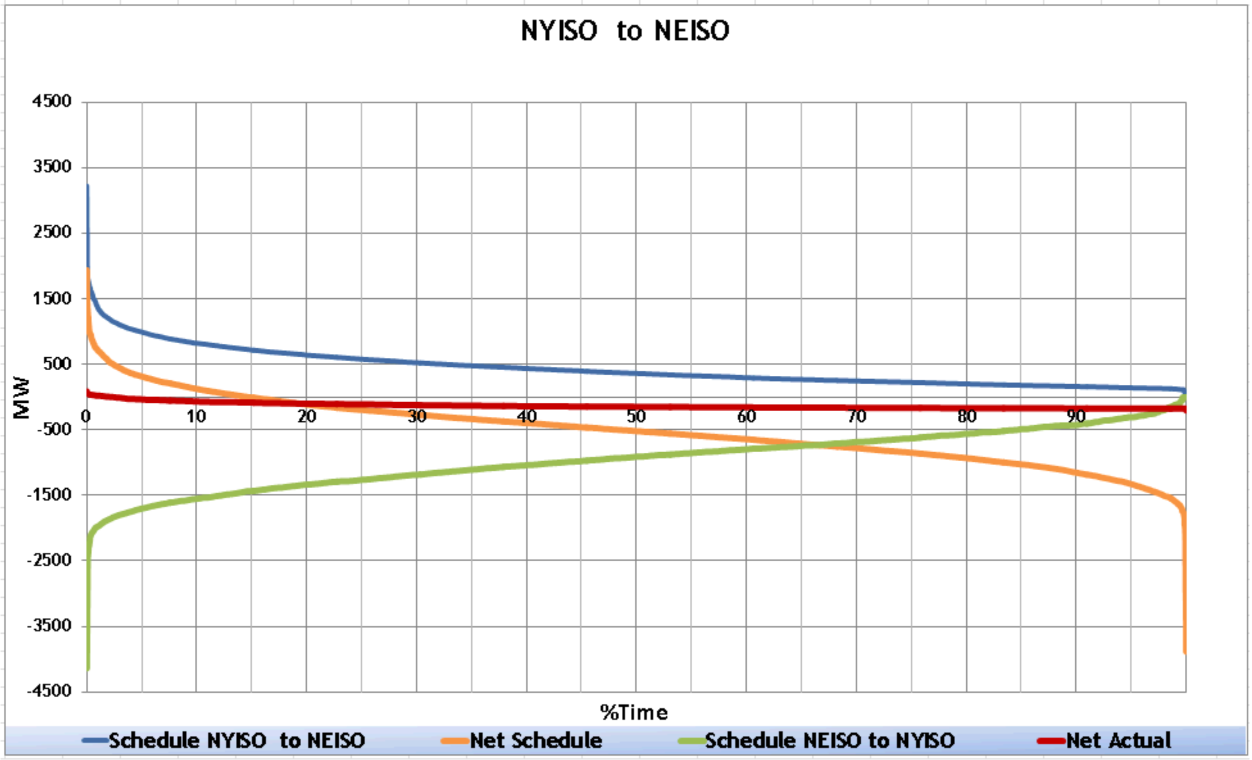

Figure 41: Load for NYISO to NEISO

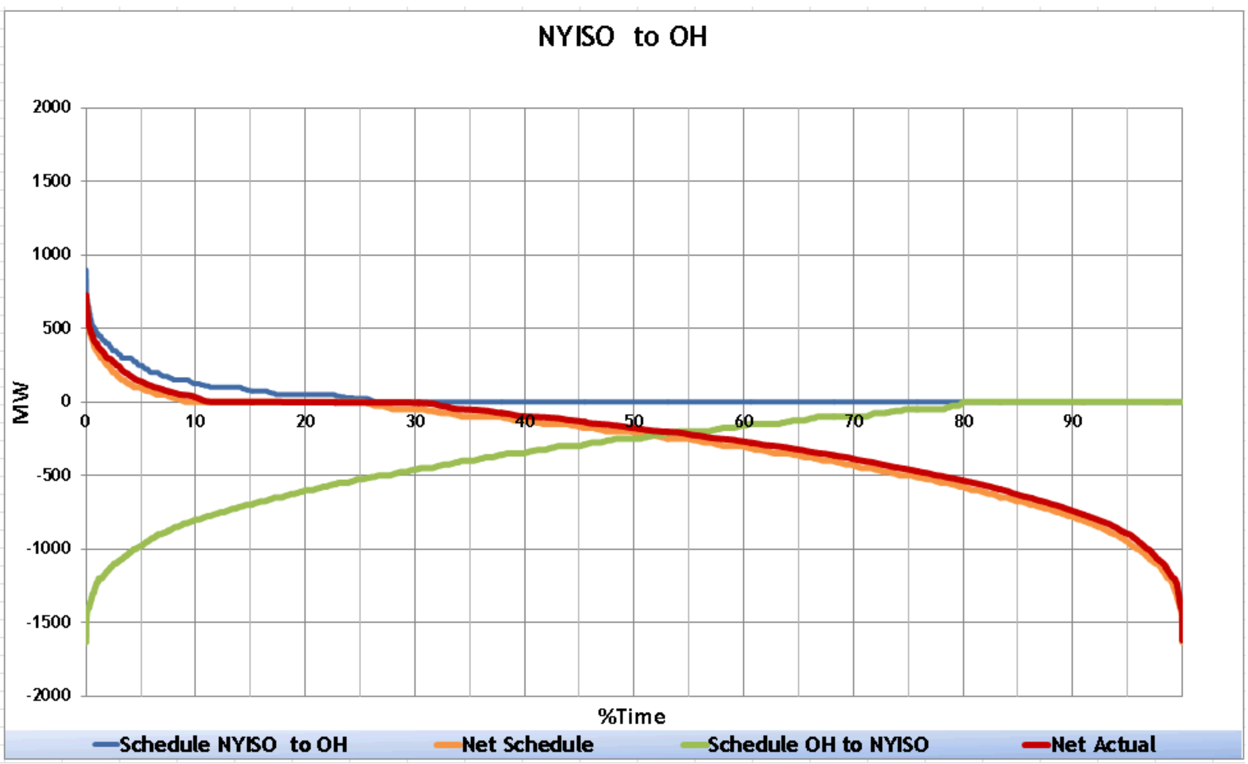

Figure 42: Load for NYISO to OH

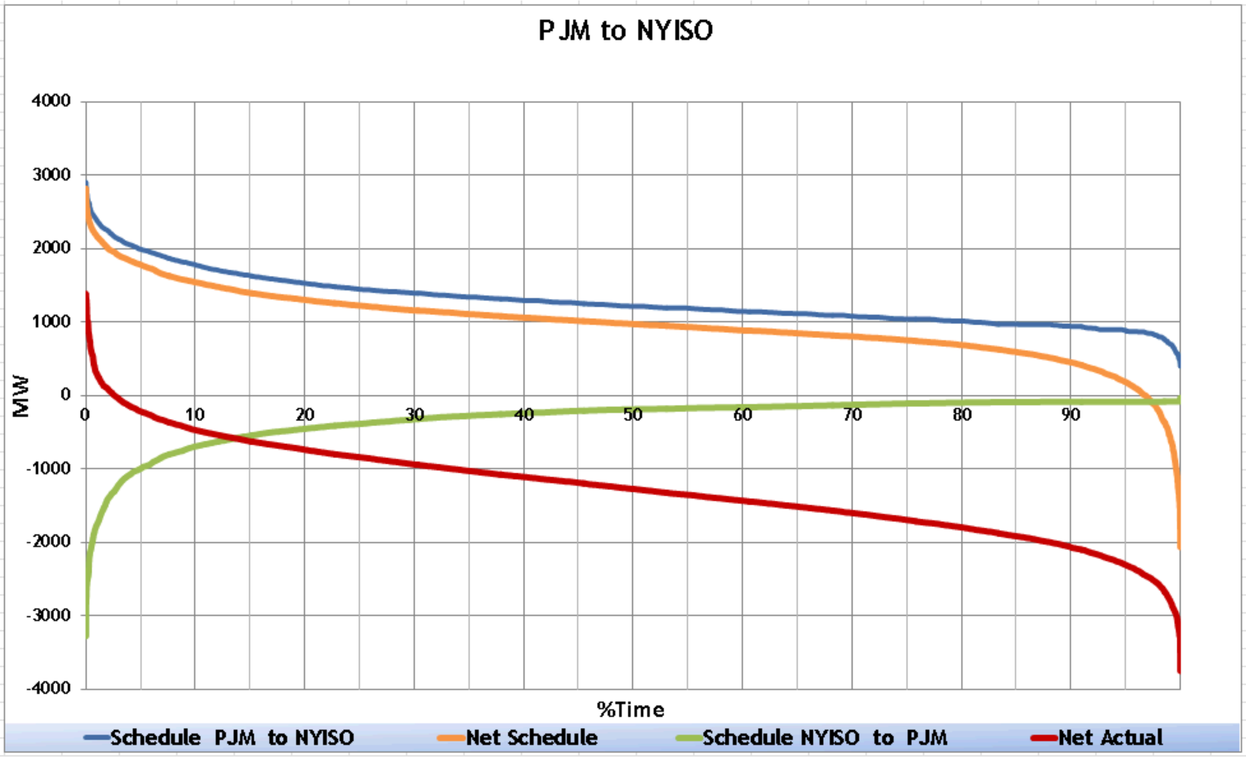

Figure 43: Load for PJM to NYISO

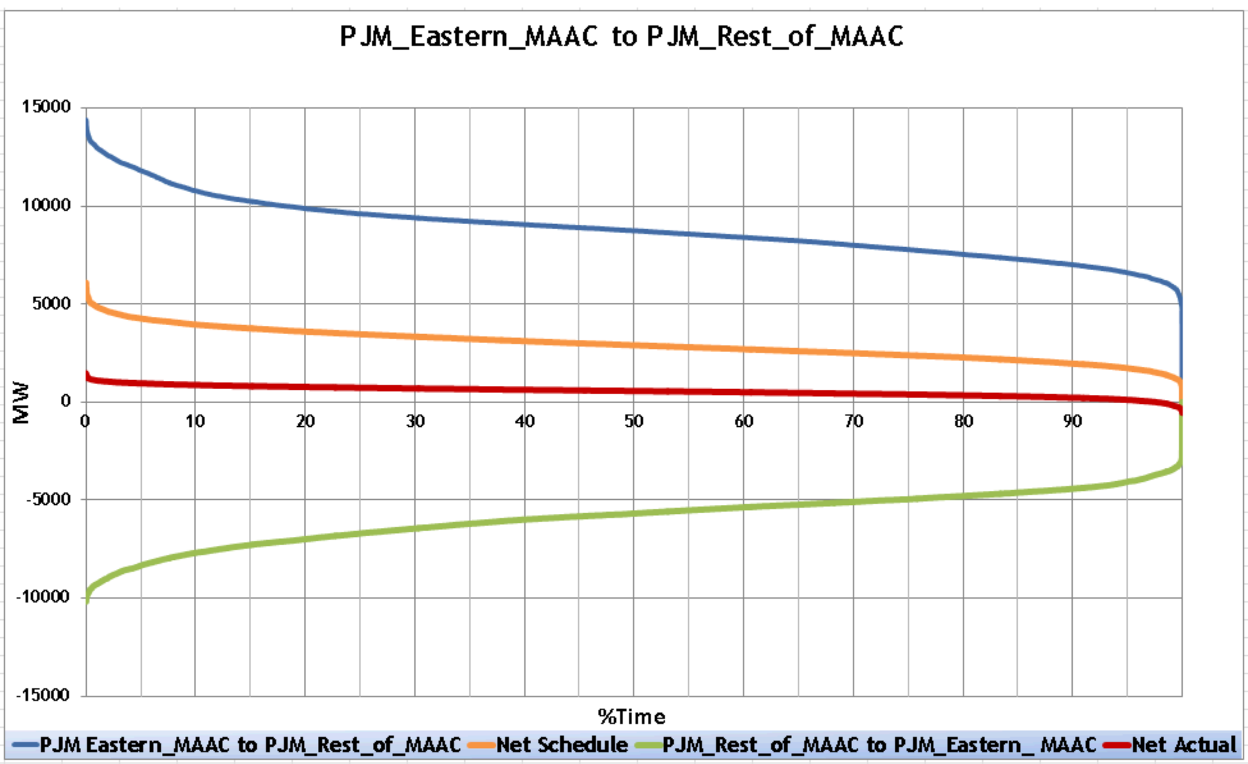

Figure 44: Load for PJM_Eastern_MAAC to PJM_Rest_of_MAAC

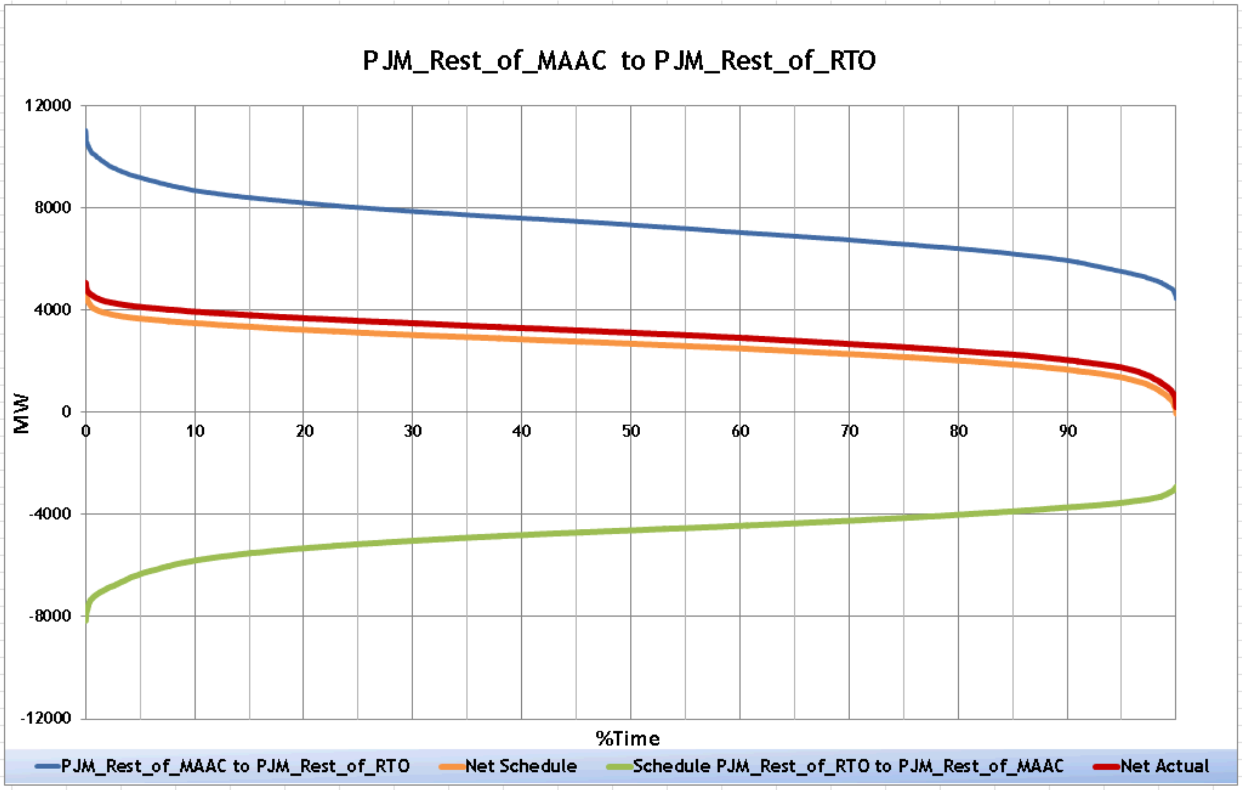

Figure 45: Load for PJM_Rest of MAAC to PJM Rest of RTO

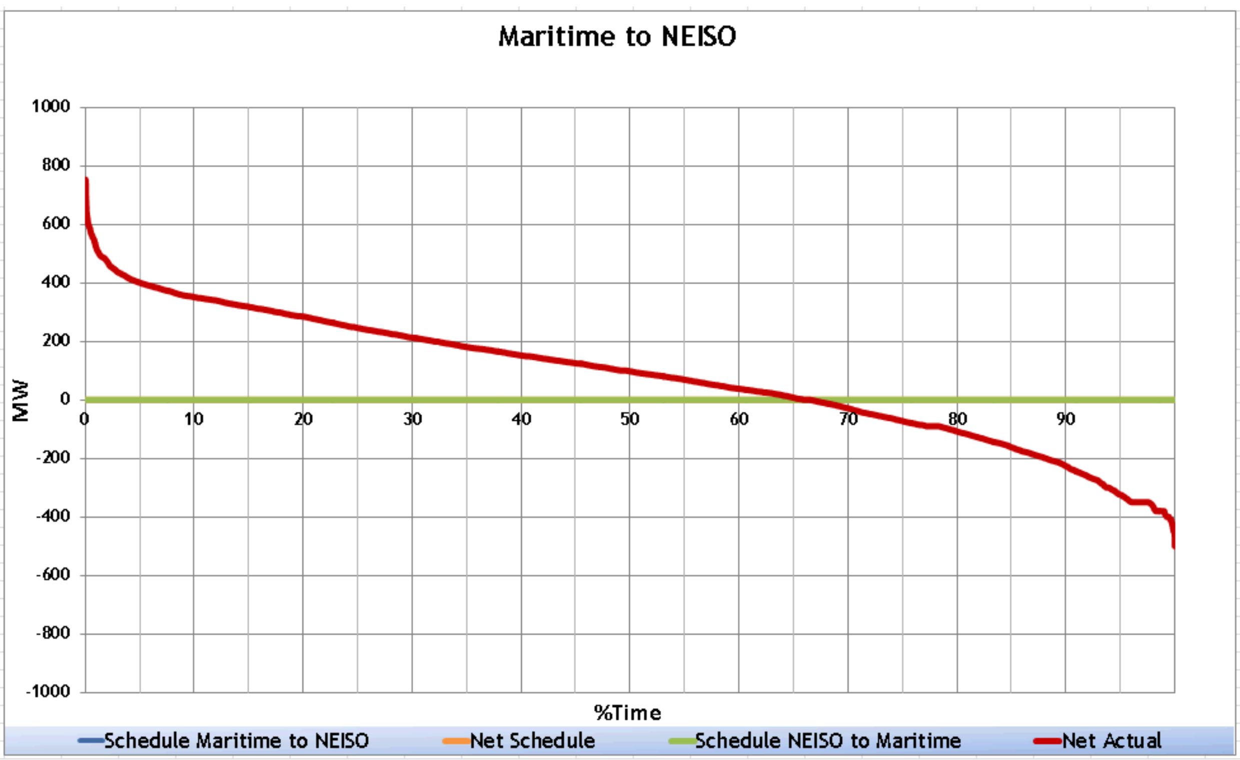

Figure 46: Load for Maritime to NEISO

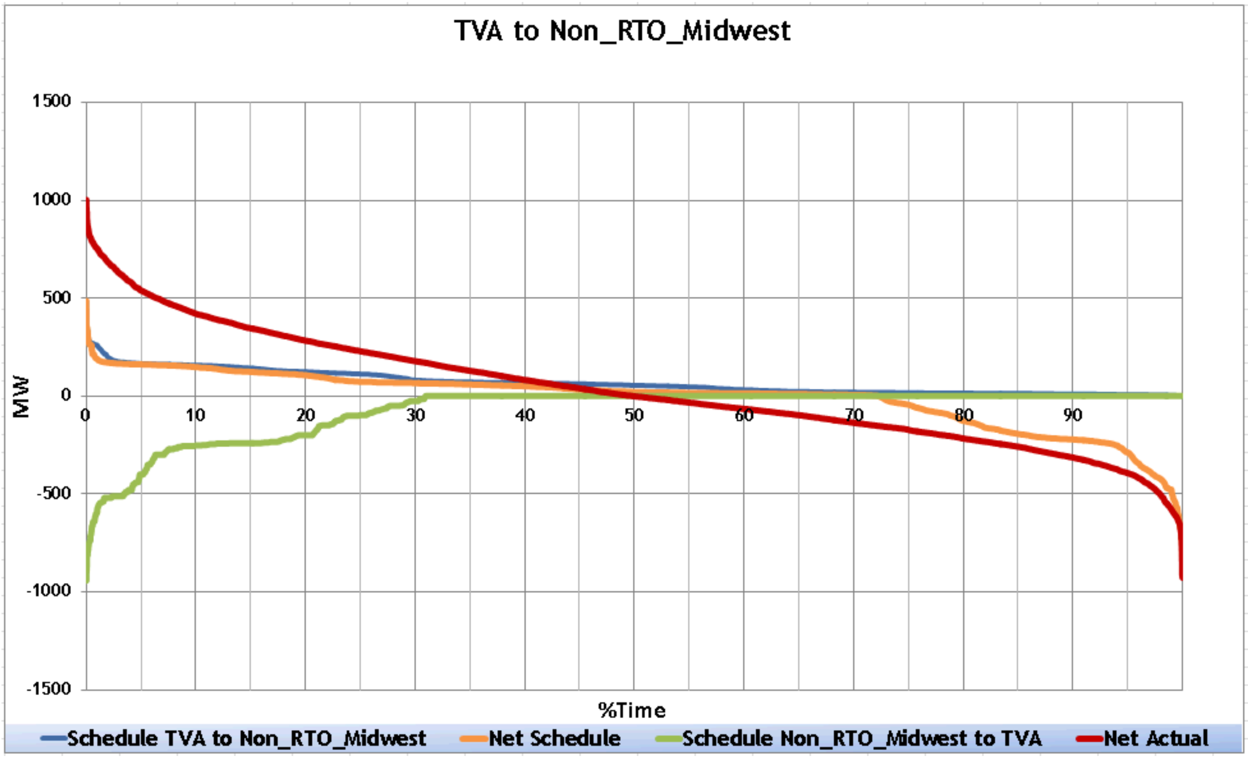

Figure 47: Load for TVA to NON RTO Midwest

Appendix A: Calculation Details

This Appendix summarizes calculations for the schedule and actual flows on the EIPC pipes, and details why some of the calculations are necessary. The calculations are described by pipe types.

RED, Type 1 Pipes - EIPC pipes between non-market and/or markets representing one EIPC sub-region

Estimated schedules are calculated by summing tags between Non-Market regions. Actual Schedules computed based on metered flows between regions. The metered data between the BAs was provided from their tie meter reads.

a. NYISO Type 1 (red) pipes

NYISO posts data for interfaces with other sub-regions; therefore, the following association between the posted data and the type 1 interfaces was used:

- SCH - HQ_CEDARS + SCH - HQ_IMPORT_EXPORT = HQ to NYISO AG
- SCH - NPX_1385 + SCH - NPX_CSC = NEISO_ NYISO JK
- SCH - OH – NY = OH_NYISO AG

where

- SCH - HQ_CEDARS = HQ-CEDARS
- SCH - NPX_CSC = NPX-CSC
- SCH - NPX_1385 = NPX-1385
- SCH - OH – NY = IMO-NYISO

GREEN, Type 2 Pipes - EIPC pipes contained within the same BA (RTO/ISO)

a. MISO Internal Type 2 pipes.

MISO identified flowgate(s) that could be surrogate for each of the Type 2 (green) pipes as flow gates on:

MISO W to MISO WUMS Path

- MWEX (West to East) Flow gate - NERC ID 6193
- North Appleton-Werner West 345 (flo) Weston 4 (East to West) NERC ID 3529

MISO WUMS to MISO MI

- This path is normally open and no good proxy exists for this path

MISO W to MISO MO IL (both of these are West to East)

- Oak Grove-Galesburg 161 (flo) Nelson-Electric Jct 345 – NERC ID 6229
- Nelson-Electric Jct 345 (flo) Cherry Valley-Silver Lake 345 (PJM)- NERC ID 3250

MISO MO IL to MISO IN (all of these are West to East)

- Bunsonville-Eugene 345 (flo) Casey-Breed 345 - NERC ID 3405
- Breed-Wheatland 345 (flo) Rockport-Jefferson 765 – NERC ID 230 PJM Flowgate
- Prairie State-W Mt Vernon 345 (flo) St. Francois-Lutesville 345 – NERC ID 3314 MISO IN to MISO MI
- Benton Harbor-Palisades 345 (flo) Cook-Palisades 345 – NERC ID 2336

The estimated schedule flows on these flowgates were computed by adding tag impact and market flow provided by each coordinating market entity. The IDC historical data system stores the tag impact for the past six months. Therefore, the tag impact factors were re-computed based on the stored IDC model and outages for each hour of 2010.

MISO provided hourly actual flows between the neighboring BAs and also the net actual (metered) flow for load balancing authorities within MISO. The following equations were used to calculate actual flow on MISO Type 2 (green) pipes.

- MISO_W – MISO_WUMS + MISO_W – MISO_IL + MISO_W_Non-MISO= MISO_W _NAI
- MISO_WUMS – MISO_W + MISO_W UMS– MISO_MI + MISO_WUMS_Non-MISO= MISO_WUMS _NAI
- MISO_MI – MISO_WUM + MISO_MI– MISO_IN+ MISO_MI _Non-MISO= MISO_MI _NAI

- MISO_IN – MISO_IL+ MISO_IN– MISO_MI + MISO_NI _Non-MISO= MISO_IN _NAI
- MISO_IL – MISO_IN+ MISO_IL– MISO_W+ MISO_IL _Non-MISO= MISO_IL _NAI

where:

- MISO_W _NAI =sum of all NAI provided by MISO for MISO_W LBAs
- MISO_WUMS _NAI = sum of all NAI provided by MISO for MISO_WUMS LBAs
- MISO_MI _NAI = sum of all NAI provided by MISO for MISO_MI LBAs
- MISO_IN _NAI = sum of all NAI provided by MISO for MISO_IN LBAs
- MISO_IL _NAI = sum of all NAI provided by MISO for MISO_IL LBAs
- MISO_W_Non-MISO = sum of the MISO to external BA hourly NAI as defined by MISO_W connection;
- MISO_WUMS_Non-MISO = sum of the MISO to external BA hourly NAI as defined by MISO_WUMS connection;
- MISO_MI_Non-MISO = sum of the MISO to external BA hourly NAI as defined by MISO_MI connection;
- MISO_IN_Non-MISO = sum of the MISO to external BA hourly NAI as defined by MISO_NI connection;
- MISO_IL_Non-MISO = sum of the MISO to external BA hourly NAI as defined by MISO_IL connection;

The above five equations with five unknowns were solved to compute the actual flow on the MISO Internal, Type 2 (green) "Pipes."

b. PJM Type 2 (green) Pipes

PJM flowgates provide the limitations/schedules from west to east. There are three flowgates that limit the schedules, and hence real-time flows, on the two Type 2 green pipes within PJM that were not developed per this analysis. However, the schedules on these three flow gates are presented as a representation of flow though PJM.

These three flowgates are the limiting flow gates for west to east flow through PJM. The limitation on these flowgates is a reactive flow limitation to avoid voltage collapse conditions. These flowgates are:

a. PJM Eastern Interface
b. PJM Central Interface
c. PJM Western Interface

c. NYISO Type 2 (green) pipes

There are two internal, Type 2 (green) EIPC pipes within NYISO. NYISO staff identified the interfaces to correspond with these pipes. This correlation was possible by assuming a change in the sub-region definition. The original EIPC region NYISO A-F was changed to NYISO AG and NYISO GHI was changed to NYISO HI for the interfaces to match better with the NYISO posted interfaces.

The following flowgates were used to represent the NYISO Type 2 (green) pipes:

- SPR/DUN-SOUTH = NYISO HI to NYISO JK
- UPNY CONED = NYISO_AG to NYISO_HI

d. SPP Type 2 (green) pipe

SPP type 2 pipes used tag data for schedules; and actual metered flows provided by SPP.

<u>BLUE, Type 3 Pipes – EIPC pipes connecting BAs containing more than one EIPC sub-region</u>

a. PJM and NYISO Type 3 (blue) pipes

Three pipes between PJM and NYISO comprise the Type 3 (blue) pipes which are represented by the following interfaces:

- SCH - PJ – NY + SCH - PJM_NEPTUNE + SCH - PJM_VFT = PJM_NYISO (total of all 3 pipes from PJM 2 regions to NYISO 3 regions)

where

- SCH - PJM_NEPTUNE = PJM-NEPTUNE
- NYPP EAST = TOTAL EAST

b. MISO Type 3 (blue) pipes

Schedules for MISO were developed using etags; and actuals were developed using metered flow between BAs.

When there are multiple pipes between two BAs, the tag data would provide the total schedules for these multiple pipes between two BAs. Whenever there was a total schedule and/or actual flow available for multiple pipes, the individual flows were calculated as a weighted average number.

Appendix B: Region/Entity/BA Association

This Appendix lists the Region/Entity/BA association used by OATI for the utilization analysis.

Region	Entity	BA/SE
AZ NM SNV	LDWP	LDWP
AZ_NM_SNV	AEPC	WALC
AZ_NM_SNV	AZPS	AZPS
AZ_NM_SNV	DEAA	DEAA
AZ_NM_SNV	DSW	WALC
AZ_NM_SNV	EPE	EPE
AZ_NM_SNV	GRIF	GRIF
AZ_NM_SNV	GRMA	GRMA
AZ_NM_SNV	HGMA	HGMA
AZ_NM_SNV	IID	IID
AZ_NM_SNV	NEVP	NEVP
AZ_NM_SNV	PNM	PNM
AZ_NM_SNV	SRP	SRP
AZ_NM_SNV	TEPC	TEPC
AZ_NM_SNV	WALC	WALC
ENTERGY	AECI	AECI
ENTERGY	CNWY	CNWY
ENTERGY	DENL	DENL
ENTERGY	EES	EES
ENTERGY	LAGN	LAGN
ERCOT	ERCO	ERCO
ERCOT	TUEG	ERCO
FRCC	FMPA	FMPA
FRCC	FMPP	FMPP
FRCC	FPC	FPC
FRCC	FPL	FPL
FRCC	GVL	GVL
FRCC	HST	HST
FRCC	JEA	JEA
FRCC	LKET	FMPA
FRCC	LWU	FMPA
FRCC	NSB	NSB

Region	Entity	BA/SE
FRCC	OUCT	FMPA
FRCC	RC	RC
FRCC	SEC	SEC
FRCC	St Cloud (City of)	FMPA
FRCC	TAL	TAL
FRCC	TEC	TEC
HQ	HQ	HQ
HQ	HQT	HQT
MAPP CA	MHEB	MHEB
MAPP CA	SPC	SPC
MAPP US	BEPC	WAUE
MAPP US	GREC	GRE
MAPP US	HCPD	WAUE
MAPP US	MP	WAUE
MAPP US	MPCN	MISO
MAPP US	MRES	MISO
MAPP US	NWPS	WAUE
MAPP US	WAUE	WAUE
Maritimes	MAR	MAR
MISO_IN	HE	MISO
MISO_IN	IMPA	MISO
MISO_IN	IPL	MISO
MISO_IN	NIPS	MISO
MISO_IN	PSI	MISO
MISO_IN	SIGE	MISO
MISO_IN	WVPA	MISO
MISO_MI	CETR	MISO
MISO_MI	DEMO	MISO
MISO_MI	MECS	MISO
MISO_MI	WPSC	MISO
MISO_MO-IL	AMIL	MISO
MISO_MO-IL	CILC	MISO
MISO_MO-IL	CWLD	MISO
MISO_MO-IL	EEI	MISO
MISO_MO-IL	IP	MISO
MISO_MO-IL	IPCA	MISO

Region	Entity	BA/SE
MISO_MO-IL	SIPC	MISO
MISO_W	ALGN	MISO
MISO_W	ALTW	MISO
MISO_W	AMES	MISO
MISO_W	AMU	MISO
MISO_W	DPC	MISO
MISO_W	GRE	MISO
MISO_W	HMMU	MISO
MISO_W	HUC	MISO
MISO_W	MDU	MISO
MISO_W	MEC	MISO
MISO_W	MMPA	MISO
MISO_W	MP	MISO
MISO_W	MPW	MISO
MISO_W	NSP	MISO
MISO_W	OTP	MISO
MISO_W	PMEU	MISO
MISO_W	RPU	MISO
MISO_W	SMP	MISO
MISO_W	WLMR	MISO
MISO_WUMS	ALTE	MISO
MISO_WUMS	MGE	MISO
MISO_WUMS	UPPC	MISO
MISO_WUMS	WEPM	MISO
MISO_WUMS	WPPI	MISO
MISO_WUMS	WPS	MISO
NE	HAST	NPPD
NE	LES	LES
NE	MEAN	NPPD
NE	NPPD	NPPD
NE	OPPD	OPPD
NEISO	ISNE	ISNE
Non - RTO Midwest	BBA	BBA
Non - RTO Midwest	BREC	MISO
Non - RTO Midwest	BUBA	BUBA
Non - RTO Midwest	DERS	DERS

Region	Entity	BA/SE
NonRTO_Midwest	EKPC	EKPC
NonRTO_Midwest	LGEE	LGEE
NonRTO_Midwest	OVEC	OVEC
NWPP	AESO	AESO
NWPP	AVA	AVA
NWPP	BCHA	BCHA
NWPP	BCTC	BCTC
NWPP	BPAT	BPAT
NWPP	CHPD	CHPD
NWPP	CISO	CISO
NWPP	DOPD	DOPD
NWPP	EWEB	
NWPP	GCPD	GCPD
NWPP	GWA	GWA
NWPP	IPCO	IPCO
NWPP	NWMT	NWMT
NWPP	PAC	
NWPP	PACE	PACE
NWPP	PACW	PACW
NWPP	PGE	PGE
NWPP	PSEI	PSEI
NWPP	SCL	SCL
NWPP	SMUD	SMUD
NWPP	SPPC	SPPC
NWPP	TIDC	TIDC
NWPP	TPWR	TPWR
NWPP	WAUW	WAUW
NYISO AG	NYIS	NYIS
NYISO HI	NYIS	NYIS
NYISO JK	NYIS	NYIS
OH	NBSO	NBSO
OH	OH	OH
OH	ONT	ONT
PJM Eastern MAAC	ACE	PJM
PJM Eastern MAAC	DEL	PJM
PJM Eastern MAAC	JCPL	PJM

Region	Entity	BA/SE
PJM Eastern MAAC	PECO	PECO
PJM Rest of MAAC	BGE	PJM
PJM Rest of MAAC	METED	PJM
PJM Rest of MAAC	PENE	PJM
PJM Rest of MAAC	PEPW	PJM
PJM Rest of MAAC	PPL	PJM
PJM Rest of MAAC	PSEG	PJM
PJM Rest of MAAC	RECO	PJM
PJM Rest of RTO	AEPM	PJM
PJM Rest of RTO	AMPO	PJM
PJM Rest of RTO	CE	PJM
PJM Rest of RTO	CED	PJM
PJM Rest of RTO	CESO	PJM
PJM Rest of RTO	CGE	PJM
PJM Rest of RTO	DLCO	PJM
PJM Rest of RTO	DPL	PJM
PJM Rest of RTO	FE	PJM
PJM Rest of RTO	ULHP	PJM
PJM Rest of RTO	VAPG	PJM
RMPA	BHPT	WACM
RMPA	CSU	WACM
RMPA	PRPM	WACM
RMPA	PSCO	PSCO
RMPA	TSPM	WACM
RMPA	WACM	WACM
RMPA	WACM	WACM
SOCO	AEC	AEC
SOCO	SMEE	SMEE
SOCO	SOCO	SOCO
SPP N	MOWR	MOWR
SPP S	KACY	KACY
SPP S	SWPP	SWPP
SPP_N	EDE	EDE
SPP_N	INDN	INDN
SPP_N	KCPL	KCPL
SPP_N	KGE	WR

Region	Entity	BA/SE
SPP_N	MPS	MPS
SPP_N	SECI	SECI
SPP_N	SPP	SPP
SPP_N	SPRM	SPRM
SPP_N	UCU	KCPL
SPP_N	WPEL	WPEC
SPP_N	WR	WR
SPP_S	AECC	SPP
SPP_S	AEPW	AEPW
SPP_S	CLEC	CLEC
SPP_S	CSWS	CSWS
SPP_S	GRDA	GRDA
SPP_S	GSEC	SPP
SPP_S	LAFA	LAFA
SPP_S	LEPA	LEPA
SPP_S	OKGE	OKGE
SPP_S	OMPA	OMPA
SPP_S	SPA	SPA
SPP_S	SPS	SPS
SPP_S	TEC	SPP
SPP_S	Tex-La Electric Coop	SPP
SPP_S	WFEC	WFEC
TVA	FPU	TVA
TVA	TVA	TVA
VACA	CPLE	CPLE
VACA	CPLW	CPLW
VACA	DUK	DUK
VACA	GTC	GTC
VACA	NHC1	NHC1
VACA	NLR	NLR
VACA	OMLP	OMLP
VACA	PLUM	PLUM
VACA	PUPP	PUPP
VACA	SC	SC
VACA	SCEG	SCEG
VACA	SEHA	SEHA

Region	Entity	BA/SE
VACA	SERU	SERU
VACA	SETH	SETH
VACA	SME	SME
VACA	WMUC	WMUC
VACA	YAD	YAD