Interchange Transactions

PJM market participants import energy from, and export energy to, external regions continuously. The transactions involved may fulfill long-term or short-term bilateral contracts or respond to price differentials. The external regions include both market and nonmarket balancing authorities.

Overview

Interchange Transaction Activity

- **Aggregate Imports and Exports in the Real-Time Energy Market.** In the first three months of 2017, PJM was a monthly net exporter of energy in the Real-Time Energy Market in all months.[1] In the first three months of 2017, the real-time net interchange of -3,715.0 GWh was lower than the net interchange of 5,689.8 GWh in the first three months of 2016.
- **Aggregate Imports and Exports in the Day-Ahead Energy Market.** In the first three months of 2017, PJM was a monthly net exporter of energy in the Day-Ahead Energy Market in all months. In the first three months of 2017, the total day-ahead net interchange of -3,622.8 GWh was lower than net interchange of 1,369.2 GWh in the first three months of 2016.
- **Aggregate Imports and Exports in the Day-Ahead and the Real-Time Energy Market.** In the first three months of 2017, gross imports in the Day-Ahead Energy Market were 152.8 percent of gross imports in the Real-Time Energy Market (108.1 percent in the first three months of 2016). In the first three months of 2017, gross exports in the Day-Ahead Energy Market were 133.9 percent of the gross exports in the Real-Time Energy Market (174.3 percent in the first three months of 2016).
- **Interface Imports and Exports in the Real-Time Energy Market.** In the first three months of 2017, there were net scheduled exports at nine of PJM's 20 interfaces in the Real-Time Energy Market.
- **Interface Pricing Point Imports and Exports in the Real-Time Energy Market.** In the first three months of 2017, there were net scheduled exports at nine of PJM's 18 interface pricing points eligible for real-time transactions in the Real-Time Energy Market.[2]
- **Interface Imports and Exports in the Day-Ahead Energy Market.** In the first three months of 2017, there were net scheduled exports at 11 of PJM's 20 interfaces in the Day-Ahead Energy Market.
- **Interface Pricing Point Imports and Exports in the Day-Ahead Energy Market.** In the first three months of 2017, there were net scheduled exports at ten of PJM's 19 interface pricing points eligible for day-ahead transactions in the Day-Ahead Energy Market.
- **Up to Congestion Interface Pricing Point Imports and Exports in the Day-Ahead Energy Market.** In the first three months of 2017, up to congestion transactions were net exports at five of PJM's 19 interface pricing points eligible for day-ahead transactions in the Day-Ahead Market.
- **Inadvertent Interchange.** In the first three months of 2017, net scheduled interchange was -3,715 GWh and net actual interchange was -3,661 GWh, a difference of 54 GWh. In the first three months of 2016, the difference was 874 GWh. This difference is inadvertent interchange.
- **Loop Flows.** In the first three months of 2017, the Wisconsin Energy Corporation (WEC) interface had the largest loop flows of any interface with -301 GWh of net scheduled interchange and 2,598 GWh of net actual interchange, a difference of 2,899 GWh. In the first three months of 2017, the SouthIMP interface pricing point had the largest loop flows of any interface pricing point with 3,736 GWh of net scheduled interchange and 7,250 GWh of net actual interchange, a difference of 3,514 GWh.

Interactions with Bordering Areas

PJM Interface Pricing with Organized Markets

- **PJM and MISO Interface Prices.** In the first three months of 2017, the direction of the hourly flow was consistent with the real-time hourly price differences between the PJM/MISO Interface and the MISO/PJM Interface in 64.3 percent of the hours.

1 Calculated values shown in Section 9, "Interchange Transactions," are based on unrounded, underlying data and may differ from calculations based on the rounded values in the tables.

2 There is one interface pricing point eligible for day-ahead transaction scheduling only (NIPSCO).

- **PJM and New York ISO Interface Prices.** In the first three months of 2017, the direction of the hourly flow was consistent with the real-time hourly price differences between the PJM/NYIS Interface and the NYISO/PJM proxy bus in 50.4 percent of the hours.
- **Neptune Underwater Transmission Line to Long Island, New York.** In the first three months of 2017, the hourly flow (PJM to NYISO) was consistent with the real-time hourly price differences between the PJM Neptune Interface and the NYISO Neptune bus in 65.6 percent of the hours.
- **Linden Variable Frequency Transformer (VFT) Facility.** In the first three months of 2017, the hourly flow (PJM to NYISO) was consistent with the real-time hourly price differences between the PJM Linden Interface and the NYISO Linden bus in 61.7 percent of the hours.
- **Hudson DC Line.** In the first three months of 2017, the hourly flow (PJM to NYISO) was consistent with the real-time hourly price differences between the PJM Hudson Interface and the NYISO Hudson bus in 0.2 percent of the hours.[3]

Interchange Transaction Issues

- **PJM Transmission Loading Relief Procedures (TLRs).** PJM issued three TLRs of level 3a or higher in the first three months of 2017, compared to eight such TLRs issued in the first three months of 2016.
- **Up to congestion.** There was an increase in up to congestion volume starting in December 2015, coincident with the expiration of the fifteen month limit on the payment of prior uplift charges.[4] The average number of up to congestion bids submitted in the Day-Ahead Energy Market increased by 47.4 percent, from 134,610 bids per day in the first three months of 2016 to 198,362 bids per day in the first three months of 2017. The average cleared volume of up to congestion bids submitted in the Day-Ahead Energy Market increased by 16.0 percent, from 879,068 MWh per day in the first three months of 2016, to 1,019,907 MWh per day in the first three months of 2017.
- **45 Minute Schedule Duration Rule.** Effective May 19, 2014, PJM removed the 45 minute scheduling duration rule in response to FERC Order No. 764.[5] [6] PJM and the MMU issued a statement indicating ongoing concern about market participants' scheduling behavior, and a commitment to address any scheduling behavior that raises operational or market manipulation concerns.[7]

Recommendations

- The MMU recommends that PJM implement rules to prevent sham scheduling. The MMU recommends that PJM apply after the fact market settlement adjustments to identified sham scheduling segments to ensure that market participants cannot benefit from sham scheduling. (Priority: High. First reported 2012. Status: Not adopted. Stakeholder process.)
- The MMU recommends that PJM implement a validation method for submitted transactions that would prohibit market participants from breaking transactions into smaller segments to defeat the interface pricing rule by concealing the true source or sink of the transaction. (Priority: Medium. First reported 2013. Status: Not adopted.)
- The MMU recommends that PJM implement a validation method for submitted transactions that would require market participants to submit transactions on paths that reflect the expected actual power flow in order to reduce unscheduled loop flows. (Priority: Medium. First reported 2013. Status: Not adopted.)
- The MMU recommends that PJM end the practice of maintaining outdated definitions of interface pricing points, eliminate the NIPSCO, Southeast and Southwest interface pricing points from the Day-Ahead and Real-Time Energy Markets and, with VACAR, assign the transactions created under the reserve sharing agreement to the SouthIMP/EXP pricing point. (Priority: Medium. First reported 2013. Status: Not adopted.)

3 The Hudson line was out of service for all hours in the first three months of 2017. In the first three months of 2017, there were five hours with less than 1 MW of unscheduled flow across the Hudson line.

4 148 FERC ¶ 61,144 (2014). *Order Instituting Section 206 Proceeding and Establishing Procedures.* 16 U.S.C. § 824e.

5 *Integration of Variable Energy Resources*, Order No. 764, 139 FERC ¶ 61,246 (2012), *order on reh'g*, Order No. 764-A, 141 FERC ¶ 61231 (2012).

6 *See* Letter Order, Docket No. ER14-381-000 (June 30, 2014).

7 *See* joint statement of PJM and the MMU re Interchange Scheduling issued July 29, 2014, which can be accessed at: <http://www.monitoringanalytics.com/reports/Market_Messages/Messages/PJM_IMM_Statement_on_Interchange_Scheduling_20140729.pdf>.

- The MMU recommends that PJM eliminate the IMO interface pricing point, and assign the transactions that originate or sink in the IESO balancing authority to the MISO interface pricing point. (Priority: Medium. First reported 2013. Status: Not adopted.)
- The MMU recommends that PJM monitor, and adjust as necessary, the weights applied to the components of the interfaces to ensure that the interface prices reflect ongoing changes in system conditions. The MMU also recommends that PJM review the mappings of external balancing authorities to individual interface pricing points to reflect changes to the impact of the external power source on PJM tie lines as a result of system topology changes. The MMU recommends that this review occur at least annually. (Priority: Low. First reported 2009. Status: Not adopted.)
- The MMU requests that, in order to permit a complete analysis of loop flow, FERC and NERC ensure that the identified data are made available to market monitors as well as other industry entities determined appropriate by FERC. (Priority: Medium. First reported 2003. Status: Not adopted.)
- The MMU recommends that PJM explore an interchange optimization solution with its neighboring balancing authorities that would remove the need for market participants to schedule physical transactions across seams. Such a solution would include an optimized, but limited, joint dispatch approach that uses supply curves and treats seams between balancing authorities as constraints, similar to other constraints within an LMP market. (Priority: Medium. First reported 2014. Status: Not adopted.)
- The MMU recommends that PJM permit unlimited spot market imports as well as unlimited nonfirm point-to-point willing to pay congestion imports and exports at all PJM interfaces in order to improve the efficiency of the market. (Priority: Medium. First reported 2012. Status: Not adopted.)
- The MMU recommends that PJM immediately provide the required 12-month notice to Duke Energy Progress (DEP) to unilaterally terminate the Joint Operating Agreement. (Priority: Low. First reported 2013. Status: Not adopted.)
- The MMU recommends that PJMSettlement Inc. immediately request a credit evaluation from all companies that engaged in up to congestion transactions between September 8, 2014, and December 31, 2015. If PJM has the authority, PJM should ensure that the potential exposure to uplift for that period be included as a contingency in the companies' calculations for credit levels and/or collateral requirements. If PJM does not have the authority to take such steps, PJM should request guidance from FERC. (Priority: High. First reported 2015. Status: Not adopted.)
- The MMU recommends that the emergency interchange cap be replaced with a market based solution. (Priority: Low. First reported 2015. Status: Not adopted.)
- The MMU recommends that the submission deadline for real-time dispatchable transactions be modified from 1800 on the day prior, to three hours prior to the requested start time, and that the minimum duration be modified from one hour to 15 minutes. These changes would give PJM a more flexible product that could be used to meet load in the most economic manner. (Priority: Medium. First reported 2014. Status: Adopted partially, 2015.)
- The MMU recommends that PJM and MISO work together to align interface pricing definitions, using the same number of external buses and selecting buses in close proximity on either side of the border with comparable bus weights. (Priority: Medium. First reported 2012. Status: Adopted partially, 2013.)

Conclusion

Transactions between PJM and multiple balancing authorities in the Eastern Interconnection are part of a single energy market. While some of these balancing authorities are termed market areas and some are termed nonmarket areas, all electricity transactions are part of a single energy market. Nonetheless, there are significant differences between market and nonmarket areas. Market areas, like PJM, include essential features such as locational marginal pricing, financial congestion offsets (FTRs and ARRs in PJM) and transparent, least cost, security constrained economic dispatch for all available generation. Nonmarket areas do not include these features. The market areas are extremely transparent and the nonmarket areas are not transparent.

The MMU's recommendations related to transactions with external balancing authorities all share the goal of improving the economic efficiency of interchange transactions. The standard of comparison is an LMP market. In an LMP market, redispatch based on LMP and competitive generator offers results in an efficient dispatch and efficient prices. The goal of designing interface transaction rules should be to match the outcomes that would exist in an LMP market.

Interchange Transaction Activity

Charges and Credits Applied to Interchange Transactions

Interchange transactions are subject to various charges and credits. These charges and credits are dependent on whether the interchange transaction is submitted in the Real-Time or Day-Ahead Energy Market, the type of transaction, the transmission service used and whether the transaction is an import, export or wheel. Table 9-1 shows the billing line items that represent the charges and credits applied to real-time and day-ahead interchange transactions.[8]

8 For an explanation and current rate for each billing line item, see "*Customer Guide to PJM Billing*," (March 1, 2017) <http://www.pjm.com/~/media/markets-ops/settlements/custgd.ashx>.

Table 9-1 Charges and Credits Applied to Interchange Transactions

	Real-Time Transactions				Day-Ahead Transactions				
Billing Item	Import (Firm or Non Firm)	Import (Spot in)	Export	Wheel	Import (Firm or Non Firm)	Import (Spot in)	Export	Wheel	Up to Congestion
Firm or Non-Firm Point-to-Point Transmission Service	X		X[1]	X[1]	X		X[1]	X[1]	
Spot Import Service		X[2]				X[2]			
Day-ahead Spot Market Energy					X	X	X		
Balancing Spot Market Energy	X	X	X						
Day-ahead Transmission Congestion					X	X	X	X	X
Balancing Transmission Congestion	X	X	X	X					X
Day-ahead Transmission Losses					X	X	X	X	X
Balancing Transmission Losses	X	X	X	X					X
PJM Scheduling, System Control and Dispatch Service - Control Area Administration	X		X	X	X		X	X	
PJM Scheduling, System Control and Dispatch Service - Market Support	X	X	X		X	X	X		X
PJM Scheduling, System Control and Dispatch Service - Advanced Second Control Center	X	X	X	X	X	X	X	X	X
PJM Scheduling, System Control and Dispatch Service - Market Support Offset	X	X	X		X	X	X		X
PJM Settlement, Inc.	X	X	X		X	X	X		X
Market Monitoring Unit (MMU) Funding	X	X	X		X	X	X		X
FERC Annual Recovery	X		X	X	X		X	X	
Organization of PJM States, Inc. (OPSI) Funding	X		X	X	X		X	X	
Synchronous Condensing			X				X		
Transmission Owner Scheduling, System Control and Dispatch Service	X		X	X	X		X	X	
Reactive Supply and Voltage Control from Generation and Other Sources Service	X		X	X	X		X	X	
Day-ahead Operating Reserve					X	X	X		
Balancing Operating Reserve	X	X	X						
Black Start Service	X		X	X	X		X	X	
Marginal Loss Surplus Allocation (for those paying for transmission service only)			X				X		

1 No charge if Point of Delivery is MISO

2 No charge for spot in transmission

Aggregate Imports and Exports

In the first three months of 2017, PJM was a monthly net exporter of energy in the Real-Time Energy Market in all months (Figure 9-1).[9] In the first three months of 2017, the total real-time net interchange of -3,715.0 GWh was lower than the net interchange of 5,689.8 GWh in the first three months of 2016. The large difference in net interchange volumes from the first three months of 2016 to the first three months of 2017 was primarily a result of the requirement for external capacity resources to be pseudo tied into PJM. Prior to June 1, 2016, these units were dynamically scheduled into PJM or were block scheduled into PJM and were part of scheduled interchange as imports. Pseudo tied units are treated as internal generation and therefore do not affect interchange volume. The reduction of the import volume based on the switch to pseudo tie status contributed to the shift from importing to exporting interchange, as the previously scheduled imports became internal generation. In the first three months of 2017, the peak month for net exporting interchange was March, -1,608.2 GWh; in the first three months of 2016 there were no months with net exports. Gross monthly export volumes in the first three months of 2017 averaged 3,623.2 GWh compared to 2,406.2 GWh in the first three months of 2016, while gross monthly imports in the first three

9 Calculated values shown in Section 9, "Interchange Transactions," are based on unrounded, underlying data and may differ from calculations based on the rounded values in the tables.

months of 2017 averaged 2,384.8 GWh compared to 4,302.8 GWh in the first three months of 2016.

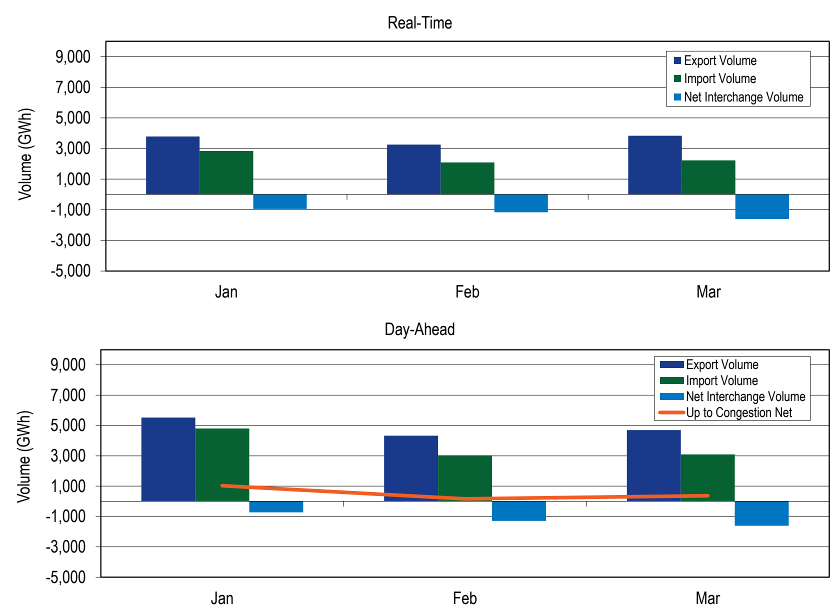
In the first three months of 2017, PJM was a monthly net exporter of energy in the Day-Ahead Energy Market in all months (Figure 9-1). In the first three months of 2017, the total day-ahead net interchange of -3,622.8 GWh was lower than the net interchange of 1,369.2 GWh in the first three months of 2016. The implementation of the pseudo-tied units on June 1, 2016, also impacted the day-ahead interchange totals. Prior to June 1, 2016, some external units were able to meet their day-ahead must offer requirements by submitting day-ahead energy schedules. When those external units became pseudo-tied units in PJM, they were required to offer into the Day-Ahead Energy Market through the Markets Gateway application. These offers replaced the day-ahead energy schedules that those units had submitted in the form of import transactions. The removal of these day-ahead transactions resulted in approximately 61.0 percent of the difference in the day-ahead net interchange totals in the first three months of 2017 compared to the first three months of 2016. In the first three months of 2017, the peak month for net exporting interchange was March, -1,606.7 GWh; in the first three months of 2016 there were no months with net exports. Gross monthly export volumes in the first three months of 2017 averaged 4,852.5 GWh compared to 4,193.4 GWh in the first three months of 2016, while gross monthly imports in the first three months of 2017 averaged 3,644.8 compared to 4,649.8 GWh in the first three months of 2016.

Figure 9-1 shows real-time and day-ahead import, export and net interchange volumes. The day-ahead totals include fixed, dispatchable and up to congestion transaction totals. The net interchange of up to congestion transactions are represented by the orange line.

In the first three months of 2017, gross imports in the Day-Ahead Energy Market were 152.8 percent of gross imports in the Real-Time Energy Market (108.1 percent in the first three months of 2016). In the first three months of 2017, gross exports in the Day-Ahead Energy Market were 133.9 percent of gross exports in the Real-Time Energy Market (174.3 percent in the first three months of 2016). In the first three months of 2017, net interchange was -3,622.8 GWh in the Day-Ahead Energy Market and -3,715.0 GWh in the Real-Time Energy Market compared to 1,369.2 GWh in the Day-Ahead Energy Market and 5,689.8 GWh in the Real-Time Energy Market in the first three months of 2016.

Transactions in the Day-Ahead Energy Market create financial obligations to deliver in the Real-Time Energy Market and to pay operating reserve charges based on differences between the transaction MW and price differences in the Day-Ahead and Real-Time Energy Markets.[10] In the first three months of 2017, the total day-ahead gross imports and exports were higher than the real-time gross imports and exports, the day-ahead imports net of up to congestion transactions were less than the real-time imports, and the day-ahead exports net of up to congestion transactions were less than real-time exports.

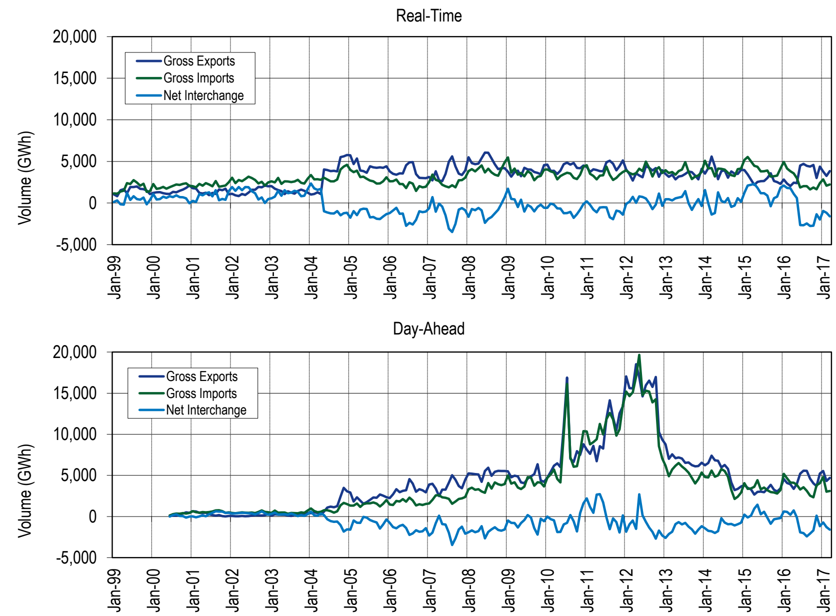
Figure 9-1 PJM real-time and day-ahead scheduled imports and exports: January 1 through March 31, 2017



10 Up to congestion transactions create financial obligations to deliver in real time, but do not pay operating reserve charges.

Figure 9-2 shows the real-time and day-ahead import and export volume for PJM from 1999 through March 31, 2017. PJM shifted from a consistent net importer of energy to relatively consistent net exporter of energy in 2004 in both the Real-Time and Day-Ahead Energy Markets, coincident with the expansion of the PJM footprint that included the integrations of Commonwealth Edison, American Electric Power and Dayton Power and Light into PJM. The net direction of power flows is generally a function of price differences net of transactions costs. Since the modification of the up to congestion product in September 2010, up to congestion transactions have played a significant role in power flows between PJM and external balancing authorities in the Day-Ahead Energy Market. On November 1, 2012, PJM eliminated the requirement that every up to congestion transaction include an interface pricing point as either the source or sink. As a result, the volume of import and export up to congestion transactions decreased, and the volume of internal up to congestion transactions increased. While the gross import and export volumes in the Day-Ahead Energy Market decreased, PJM has remained primarily a net exporter in the Day-Ahead Energy Market. The requirement for external capacity resources to be pseudo tied into PJM has affected the real-time and day-ahead import volumes. Prior to June 1, 2016, these units were dynamically scheduled into PJM or were block scheduled into PJM and were part of scheduled interchange as imports. Pseudo tied units are treated as internal generation and therefore do not affect interchange volume. The reduction of the import volume based on the switch to pseudo tie status contributed to PJM remaining a primary net exporter in the Real-Time and Day-Ahead Energy Markets.

Figure 9-2 PJM real-time and day-ahead scheduled import and export transaction volume history: January 1, 1999 through March 31, 2017



Real-Time Interface Imports and Exports

In the Real-Time Energy Market, scheduled imports and exports are defined by the scheduled path, which is the transmission path a market participant selects from the original source to the final sink. These scheduled flows are measured at each of PJM's interfaces with neighboring balancing authorities. Table 9-17 includes a list of active interfaces in the first three months of 2017. Figure 9-3 shows the approximate geographic location of the interfaces. In the first three months of 2017, PJM had 20 interfaces with neighboring balancing authorities. While the Linden (LIND) Interface, the Hudson (HUDS) Interface and the Neptune (NEPT) Interface are separate from the NYIS Interface, all four are interfaces between PJM and the NYISO. Similarly, there are ten separate interfaces that make up the MISO Interface between PJM and MISO. Table 9-2 through Table 9-4 show the Real-Time Energy Market scheduled interchange totals at the individual NYISO interfaces, as well as with the NYISO as a whole. Similarly, the scheduled interchange totals at the individual interfaces between PJM and MISO are shown, as well as with MISO as a whole. Net scheduled interchange in the Real-Time Energy Market is shown by interface for the first three months of 2017 in Table 9-2, while gross scheduled imports and exports are shown in Table 9-3 and Table 9-4.

In the Real-Time Energy Market, in the first three months of 2017, there were net scheduled exports at nine of PJM's 20 interfaces. The top three net exporting interfaces in the Real-Time Energy Market accounted for 57.3 percent of the total net scheduled exports: PJM/Neptune (NEPT) with 19.5 percent, PJM/New York Independent System Operator (NYIS) with 19.2 percent and PJM/MidAmerican Energy Company (MEC) with 18.6 percent of the net scheduled export volume. The four separate interfaces that connect PJM to the NYISO (PJM/NYIS, PJM/NEPT, PJM/HUDS and PJM/Linden (LIND)) together represented 46.3 percent of the total net PJM scheduled exports in the Real-Time Energy Market. There were net scheduled exports in the Real-Time Energy Market at five of the ten separate interfaces that connect PJM to MISO. Those five exporting interfaces represented 52.9 percent of the total net PJM scheduled exports in the Real-Time Energy Market. Eight PJM interfaces had net scheduled imports, with the top three importing interfaces accounting for 80.1 percent of the total net scheduled imports: PJM/DUK (DUK) with 35.6 percent, PJM/Ameren-Illinois (AMIL) with 25.4 percent and PJM/Tennessee Valley Authority (TVA) with 19.1 percent of the net scheduled import volume.[11] The four separate interfaces that connect PJM to the NYISO (PJM/NYIS, PJM/NEPT, PJM/HUDS and PJM/Linden (LIND)) had net scheduled exports in the Real-Time Energy Market. In the first three months of 2017, there were net imports in the Real-Time Energy Market at four of the ten separate interfaces that connect PJM to MISO. Those four interfaces represented 29.9 percent of the total net PJM scheduled imports in the Real-Time Energy Market.

Table 9-2 Real-time scheduled net interchange volume by interface (GWh): January 1 through March 31, 2017

	Jan	Feb	Mar	Total
CPLE	(15.7)	27.0	(8.6)	2.7
CPLW	0.0	0.0	0.0	0.0
DUK	453.7	315.0	373.3	1,141.9
LGEE	225.2	95.7	169.3	490.1
MISO	(522.8)	(806.3)	(1,370.5)	(2,699.6)
ALTE	(39.0)	(349.6)	(429.9)	(818.5)
ALTW	0.4	0.5	0.0	0.9
AMIL	376.2	223.5	212.9	812.6
CIN	(319.6)	(282.3)	(560.3)	(1,162.2)
CWLP	0.0	0.0	0.0	0.0
IPL	(18.4)	(35.9)	(34.8)	(89.1)
MEC	(472.9)	(402.7)	(410.5)	(1,286.1)
MECS	100.4	(20.8)	56.0	135.5
NIPS	0.0	8.6	0.0	8.6
WEC	(149.9)	52.5	(203.8)	(301.3)
NYISO	(1,336.9)	(1,045.2)	(823.5)	(3,205.6)
HUDS	0.0	0.0	0.0	0.0
LIND	(222.2)	(157.9)	(147.5)	(527.6)
NEPT	(484.9)	(419.9)	(444.6)	(1,349.4)
NYIS	(629.8)	(467.4)	(231.5)	(1,328.7)
OVEC	(20.8)	(17.5)	(18.3)	(56.7)
TVA	273.9	268.0	70.2	612.1
Total	(943.5)	(1,163.3)	(1,608.2)	(3,715.0)

11 In the Real-Time Energy Market, three PJM interfaces had a net interchange of zero (PJM/Progress Energy Carolinas-West (CPLW), PJM/City Water Light & Power (CWLP) and PJM/Hudson (HUDS)).

Table 9-3 Real-time scheduled gross import volume by interface (GWh): January 1 through March 31, 2017

	Jan	Feb	Mar	Total
CPLE	7.2	39.3	5.9	52.4
CPLW	0.0	0.0	0.0	0.0
DUK	519.8	382.9	428.6	1,331.3
LGEE	225.2	99.6	171.7	496.4
MISO	992.0	562.9	793.9	2,348.8
ALTE	267.9	0.0	25.0	292.9
ALTW	0.4	0.5	0.0	0.9
AMIL	377.8	224.6	219.5	821.8
CIN	115.5	100.8	328.5	544.8
CWLP	0.0	0.0	0.0	0.0
IPL	30.7	13.0	39.0	82.7
MEC	26.7	31.5	40.4	98.6
MECS	173.0	27.8	141.5	342.3
NIPS	0.0	8.6	0.0	8.6
WEC	0.0	156.1	0.0	156.1
NYISO	788.6	694.5	674.5	2,157.6
HUDS	0.0	0.0	0.0	0.0
LIND	0.3	1.3	6.0	7.6
NEPT	0.0	0.0	0.0	0.0
NYIS	788.4	693.2	668.4	2,150.0
OVEC	0.0	0.0	0.0	0.0
TVA	305.5	311.7	150.9	768.1
Total	2,838.3	2,090.8	2,225.4	7,154.5

Table 9-4 Real-time scheduled gross export volume by interface (GWh): January 1 through March 31, 2017

	Jan	Feb	Mar	Total
CPLE	22.9	12.2	14.5	49.6
CPLW	0.0	0.0	0.0	0.0
DUK	66.2	67.9	55.3	189.3
LGEE	0.0	3.9	2.4	6.3
MISO	1,514.8	1,369.2	2,164.4	5,048.4
ALTE	306.9	349.6	454.9	1,111.4
ALTW	0.0	0.0	0.0	0.0
AMIL	1.6	1.1	6.6	9.3
CIN	435.1	383.1	888.8	1,707.0
CWLP	0.0	0.0	0.0	0.0
IPL	49.1	48.9	73.8	171.8
MEC	499.6	434.2	450.9	1,384.7
MECS	72.6	48.6	85.5	206.8
NIPS	0.0	0.0	0.0	0.0
WEC	149.9	103.6	203.8	457.4
NYISO	2,125.5	1,739.7	1,498.0	5,363.2
HUDS	0.0	0.0	0.0	0.0
LIND	222.4	159.2	153.5	535.1
NEPT	484.9	419.9	444.6	1,349.4
NYIS	1,418.2	1,160.6	899.9	3,478.7
OVEC	20.8	17.5	18.3	56.7
TVA	31.5	43.7	80.8	156.0
Total	3,781.8	3,254.1	3,833.6	10,869.5

Real-Time Interface Pricing Point Imports and Exports

Interfaces differ from interface pricing points. An interface is a point of interconnection between PJM and a neighboring balancing authority which market participants may designate as a path on which scheduled imports or exports will flow.[12] An interface pricing point defines the price at which transactions are priced, and is based on the path of the actual, physical transfer of energy. While a market participant designates a scheduled path from a generation control area (GCA) to a load control area (LCA), this path reflects the scheduled path as defined by the transmission reservations only, and may not reflect how the energy actually flows from the GCA to LCA. For example, the import transmission path from LG&E Energy, L.L.C. (LGEE), through MISO and into PJM would show the transfer of power into PJM at the

12 There are multiple paths between any generation and load balancing authority. Market participants select the path based on transmission service availability and the transmission costs for moving energy from generation to load and interface prices.

PJM/MISO Interface based on the scheduled path of the transaction. However, the physical flow of energy does not enter the PJM footprint at the PJM/MISO Interface, but enters PJM at the southern boundary. For this reason, PJM prices an import with the GCA of LGEE at the SouthIMP interface pricing point rather than the MISO pricing point.

Interfaces differ from interface pricing points. The challenge is to create interface prices, composed of external pricing points, which accurately represent the locational price impact of flows between PJM and external sources of energy and that reflect the underlying economic fundamentals across balancing authority borders.[13]

Transactions can be scheduled to an interface based on a contract transmission path, but pricing points are developed and applied based on the estimated electrical impact of the external power source on PJM tie lines, regardless of the contract transmission path.[14] PJM establishes prices for transactions with external balancing authorities by assigning interface pricing points to individual balancing authorities based on the generation control area and load control area as specified on the NERC Tag. Dynamic interface pricing calculations use actual system conditions to determine a set of weights for each external pricing point in an interface price definition. The weights are designed so that the interface price reflects actual system conditions. However, the weights are an approximation given the complexity of the transmission network outside PJM and the dynamic nature of power flows. Table 9-18 presents the interface pricing points used in the first three months of 2017. On September 16, 2014, PJM updated the mappings of external balancing authorities to individual pricing points. The MMU recommends that PJM review these mappings, at least annually, to reflect the fact that changes to the system topology can affect the impact of external power sources on PJM.

The interface pricing method implies that the weighting factors reflect the actual system flows in a dynamic manner. In fact, the weightings are static, and are modified by PJM only occasionally.[15] The MMU recommends that PJM monitor, and adjust as necessary, the weights applied to the components of the interfaces to ensure that the interface prices reflect ongoing changes in system conditions.

The contract transmission path only reflects the path of energy into or out of PJM to one neighboring balancing authority. The NERC Tag requires the complete path to be specified from the generation control area (GCA) to the load control area (LCA), but participants do not always do so. The NERC Tag path is used by PJM to determine the interface pricing point that PJM assigns to the transaction. This approach will correctly identify the interface pricing point only if the market participant provides the complete path in the Tag. This approach will not correctly identify the interface pricing point if the market participant breaks the transaction into portions, each with a separate Tag. The breaking of transactions into portions can be a way to manipulate markets and the result of such behavior can be incorrect and noncompetitive pricing of transactions.

There are several pricing points mapped to the region south of PJM. The SouthIMP and SouthEXP pricing points serve as the default pricing point for transactions at the southern border of PJM. The CPLEEXP, CPLEIMP, DUKEXP, DUKIMP, NCMPAEXP and NCMPAIMP were also established to account for various special agreements with neighboring balancing areas, and PJM continued to use the Southwest pricing point for certain grandfathered transactions which have since expired.[16]

In the Real-Time Energy Market, in the first three months of 2017, there were net scheduled exports at nine of PJM's 18 interface pricing points eligible for real-time transactions.[17] The top three net exporting interface pricing points in the Real-Time Energy Market accounted for 88.4 percent of the total net scheduled exports: PJM/MISO with 57.0 percent, PJM/NEPTUNE with 15.8 percent and PJM/NYIS with 15.6 percent of the net scheduled export volume. The four separate interface pricing points that connect PJM to the NYISO

13 See the *2007 State of the Market Report for PJM*, Volume II, Appendix D, "Interchange Transactions," for a more complete discussion of the development of pricing points.

14 See "Interface Pricing Point Assignment Methodology," (August 28, 2014) <http://www.pjm.com/~/media/etools/exschedule/interface-pricing-point-assignment-methodology.ashx>. PJM periodically updates these definitions on its website.

15 On June 1, 2015, PJM began using a dynamic weighting factor in the calculation for the Ontario Interface Pricing Point.

16 The MMU does not believe that it is appropriate to allow the use of the Southwest pricing point for grandfathered transactions, and recommends that no further such agreements be entered into.

17 There is one interface pricing point eligible for day-ahead transaction scheduling only (NIPSCO).

(PJM/NYIS, PJM/NEPTUNE, PJM/HUDSONTP and PJM/LINDENVFT) together represented 37.6 percent of the total net PJM scheduled exports in the Real-Time Energy Market. Five PJM interface pricing points had net scheduled imports, with two importing interface pricing points accounting for 89.5 percent of the total net scheduled imports: PJM/SouthIMP with 77.4 percent and PJM/Ontario Independent Market Operator (IMO) with 12.0 percent of the net scheduled import volume.[18]

Table 9-5 Real-time scheduled net interchange volume by interface pricing point (GWh): January 1 through March 31, 2017

	Jan	Feb	Mar	Total
IMO	222.1	127.6	231.4	581.1
MISO	(1,466.3)	(1,322.5)	(2,082.4)	(4,871.2)
NORTHWEST	0.1	(0.2)	(0.1)	(0.2)
NYISO	(1,336.9)	(1,045.2)	(825.9)	(3,208.0)
HUDSONTP	0.0	0.0	0.0	0.0
LINDENVFT	(222.2)	(157.9)	(147.5)	(527.6)
NEPTUNE	(484.9)	(419.9)	(444.6)	(1,349.4)
NYIS	(629.8)	(467.4)	(233.8)	(1,331.0)
OVEC	(20.8)	(17.5)	(18.3)	(56.7)
Southern Imports	1,780.5	1,222.6	1,240.1	4,243.2
CPLEIMP	5.9	2.0	4.4	12.2
DUKIMP	11.1	6.0	35.2	52.3
NCMPAIMP	173.4	151.6	118.1	443.1
SOUTHEAST	0.0	0.0	0.0	0.0
SOUTHWEST	0.0	0.0	0.0	0.0
SOUTHIMP	1,590.2	1,063.0	1,082.4	3,735.6
Southern Exports	(122.1)	(128.0)	(153.0)	(403.2)
CPLEEXP	(14.0)	(1.9)	(9.0)	(25.0)
DUKEXP	(28.3)	(40.7)	(7.4)	(76.5)
NCMPAEXP	0.0	0.0	0.0	0.0
SOUTHEAST	0.0	0.0	0.0	0.0
SOUTHWEST	0.0	0.0	0.0	0.0
SOUTHEXP	(79.8)	(85.4)	(136.6)	(301.7)
Total	(943.5)	(1,163.3)	(1,608.2)	(3,715.0)

Table 9-6 Real-time scheduled gross import volume by interface pricing point (GWh): January 1 through March 31, 2017

	Jan	Feb	Mar	Total
IMO	222.3	127.6	231.6	581.5
MISO	46.7	46.1	81.7	174.6
NORTHWEST	0.1	0.0	0.0	0.1
NYISO	788.6	694.5	672.0	2,155.1
HUDSONTP	0.0	0.0	0.0	0.0
LINDENVFT	0.3	1.3	6.0	7.6
NEPTUNE	0.0	0.0	0.0	0.0
NYIS	788.4	693.2	666.0	2,147.6
OVEC	0.0	0.0	0.0	0.0
Southern Imports	1,780.5	1,222.6	1,240.1	4,243.2
CPLEIMP	5.9	2.0	4.4	12.2
DUKIMP	11.1	6.0	35.2	52.3
NCMPAIMP	173.4	151.6	118.1	443.1
SOUTHEAST	0.0	0.0	0.0	0.0
SOUTHWEST	0.0	0.0	0.0	0.0
SOUTHIMP	1,590.2	1,063.0	1,082.4	3,735.6
Southern Exports	0.0	0.0	0.0	0.0
CPLEEXP	0.0	0.0	0.0	0.0
DUKEXP	0.0	0.0	0.0	0.0
NCMPAEXP	0.0	0.0	0.0	0.0
SOUTHEAST	0.0	0.0	0.0	0.0
SOUTHWEST	0.0	0.0	0.0	0.0
SOUTHEXP	0.0	0.0	0.0	0.0
Total	2,838.3	2,090.8	2,225.4	7,154.5

18 In the Real-Time Energy Market, four PJM interface pricing points had a net interchange of zero (HUDSONTP, NCMPAEXP, Southeast and Southwest).

Table 9-7 Real-time scheduled gross export volume by interface pricing point (GWh): January 1 through March 31, 2017

	Jan	Feb	Mar	Total
IMO	0.3	0.1	0.1	0.4
MISO	1,513.0	1,368.6	2,164.2	5,045.8
NORTHWEST	0.0	0.2	0.1	0.3
NYISO	2,125.5	1,739.7	1,497.9	5,363.1
HUDSONTP	0.0	0.0	0.0	0.0
LINDENVFT	222.4	159.2	153.5	535.1
NEPTUNE	484.9	419.9	444.6	1,349.4
NYIS	1,418.2	1,160.6	899.8	3,478.6
OVEC	20.8	17.5	18.3	56.7
Southern Imports	0.0	0.0	0.0	0.0
CPLEIMP	0.0	0.0	0.0	0.0
DUKIMP	0.0	0.0	0.0	0.0
NCMPAIMP	0.0	0.0	0.0	0.0
SOUTHEAST	0.0	0.0	0.0	0.0
SOUTHWEST	0.0	0.0	0.0	0.0
SOUTHIMP	0.0	0.0	0.0	0.0
Southern Exports	122.1	128.0	153.0	403.2
CPLEEXP	14.0	1.9	9.0	25.0
DUKEXP	28.3	40.7	7.4	76.5
NCMPAEXP	0.0	0.0	0.0	0.0
SOUTHEAST	0.0	0.0	0.0	0.0
SOUTHWEST	0.0	0.0	0.0	0.0
SOUTHEXP	79.8	85.4	136.6	301.7
Total	3,781.8	3,254.1	3,833.6	10,869.5

Day-Ahead Interface Imports and Exports

In the Day-Ahead Energy Market, as in the Real-Time Energy Market, scheduled imports and exports are determined by the scheduled path, which is the transmission path a market participant selects from the original source to the final sink. Entering external energy transactions in the Day-Ahead Energy Market requires fewer steps than in the Real-Time Energy Market. Market participants need to acquire a valid, willing to pay congestion (WPC) OASIS reservation to prove that their day-ahead schedule could be supported in the Real-Time Energy Market.[19] Day-ahead energy market schedules need to be cleared through the day-ahead energy market process in order to become an approved schedule. The day-ahead energy market transactions are financially binding, but will not physically flow unless they are also submitted in the Real-Time Energy Market. In the Day-Ahead Energy Market, a market participant is not required to acquire a ramp reservation, a NERC Tag, or to go through a neighboring balancing authority checkout process.

There are three types of day-ahead external energy transactions: fixed; up to congestion; and dispatchable.[20]

In the Day-Ahead Energy Market, transaction sources and sinks are determined solely by market participants. In Table 9-8, Table 9-9, and Table 9-10, the scheduled interface designation is determined by the transmission reservation that was acquired and associated with the day-ahead market transaction, and does not bear any necessary relationship to the pricing point designation selected at the time the transaction is submitted to PJM in real time. For example, if market participants want to import energy from the Southwest Power Pool (SPP) to PJM, they are likely to choose a scheduled path with the fewest transmission providers along the path and therefore the lowest transmission costs for the transaction, regardless of whether the resultant path is related to the physical flow of power. The lowest cost transmission path runs from SPP, through MISO, and into PJM, requiring only three transmission reservations, two of which are available at no cost (MISO transmission would be free based on the regional through and out rates, and the PJM transmission would be free, if using spot import transmission). Any other transmission path entering PJM, where the generating control area is to the south, would require the market participant to acquire transmission through nonmarket balancing authorities, and thus incur additional transmission costs. PJM's interface pricing method recognizes that transactions sourcing in SPP and sinking in PJM will create flows across the southern border and prices those transactions at the SouthIMP interface price. As a result, a market participant who plans to submit a transaction from SPP to PJM may have a transmission reservation with a point of receipt of MISO and a point of delivery of PJM but may select SouthIMP as the import pricing point when submitting the transaction in the Day-Ahead Energy Market. In the scheduled interface tables, the import transaction would appear as scheduled through the MISO Interface, and in

19 Effective September 17, 2010, up to congestion transactions no longer required a willing to pay congestion transmission reservation.

20 See the *2010 State of the Market Report for PJM*, Volume II, Section 4, "Interchange Transactions," for details.

the scheduled interface pricing point tables, the import transaction would appear as scheduled through the SouthIMP/EXP interface pricing point, which reflects the expected power flow.

Table 9-8 through Table 9-10 show the day-ahead scheduled interchange totals at the individual interfaces. Net scheduled interchange in the Day-Ahead Energy Market is shown by interface for the first three months of 2017 in Table 9-8, while gross scheduled imports and exports are shown in Table 9-9 and Table 9-10.

In the Day-Ahead Energy Market, in the first three months of 2017, there were net scheduled exports at 11 of PJM's 20 interfaces. The top three net exporting interfaces in the Day-Ahead Energy Market accounted for 67.4 percent of the total net scheduled exports: PJM/New York Independent System Operator (NYIS) with 23.2 percent, PJM/MidAmerican Energy Company (MEC) with 22.2 percent and PJM/Neptune (NEPT) with 22.0 percent of the net scheduled export volume. The four separate interfaces that connect PJM to the NYISO (PJM/NYIS, PJM/NEPT, PJM/HUDS and PJM/Linden (LIND)) together represented 46.5 percent of the total net PJM scheduled exports in the Day-Ahead Energy Market. In the first three months of 2017, there were net exports in the Day-Ahead Energy Market at seven of the ten separate interfaces that connect PJM to MISO. Those seven interfaces represented 53.4 percent of the total net PJM exports in the Day-Ahead Energy Market. Three PJM interfaces had net scheduled imports, with the top importing interface, PJM/DUK, accounting for 99.0 percent of the net import volume. The four interfaces that connect PJM to the NYISO (PJM/NYIS, PJM/NEPT, PJM/HUDS and PJM/Linden (LIND)) together had net scheduled exports in the Day-Ahead Energy Market. In the first three months of 2017, there were net imports in the Day-Ahead Energy Market at none of the ten separate interfaces that connect PJM to MISO.[21]

Table 9-8 Day-ahead scheduled net interchange volume by interface (GWh): January 1 through March 31, 2017

	Jan	Feb	Mar	Total
CPLE	(11.2)	7.5	(3.2)	(6.9)
CPLW	0.0	0.0	0.0	0.0
DUK	330.8	281.6	312.4	924.8
LGEE	0.0	0.3	0.0	0.3
MISO	(934.0)	(867.5)	(1,469.1)	(3,270.6)
ALTE	(225.7)	(280.7)	(378.9)	(885.4)
ALTW	0.0	0.0	0.0	0.0
AMIL	0.0	0.0	(5.8)	(5.8)
CIN	(129.5)	(93.6)	(459.9)	(682.9)
CWLP	0.0	0.0	0.0	0.0
IPL	0.0	(2.3)	(13.0)	(15.3)
MEC	(496.4)	(433.1)	(428.2)	(1,357.7)
MECS	8.1	(18.7)	(66.9)	(77.4)
NIPS	0.0	0.0	0.0	0.0
WEC	(90.5)	(39.2)	(116.4)	(246.2)
NYISO	(1,181.0)	(894.0)	(768.1)	(2,843.1)
HUDS	0.0	0.0	0.0	0.0
LIND	(33.1)	(21.7)	(20.1)	(74.9)
NEPT	(489.6)	(412.1)	(445.4)	(1,347.1)
NYIS	(658.3)	(460.2)	(302.6)	(1,421.1)
OVEC	0.0	0.0	0.0	0.0
TVA	38.4	19.7	(48.6)	9.5
Total without Up To Congestion	(1,757.1)	(1,452.4)	(1,976.5)	(5,186.0)
Up To Congestion	1,032.7	160.6	369.8	1,563.1
Total	(724.4)	(1,291.8)	(1,606.7)	(3,622.8)

21 In the Day-Ahead Energy Market, six PJM interfaces had a net interchange of zero (PJM/Progress Energy Carolinas-West (CPLW), PJM/Western Alliant Energy (ALTW), PJM/City Water Light & Power (CWLP), PJM/Northern Indiana Public Service Company (NIPS), PJM/Hudson (HUDS) and PJM/Ohio Valley Electric Cooperative (OVEC)).

Table 9-9 Day-Ahead scheduled gross import volume by interface (GWh): January 1 through March 31, 2017

	Jan	Feb	Mar	Total
CPLE	5.4	17.8	5.2	28.3
CPLW	0.0	0.0	0.0	0.0
DUK	342.3	281.6	322.6	946.5
LGEE	0.0	0.3	0.0	0.3
MISO	54.3	11.3	15.2	80.8
ALTE	0.0	0.0	0.0	0.0
ALTW	0.0	0.0	0.0	0.0
AMIL	0.0	0.0	0.0	0.0
CIN	2.6	0.0	0.0	2.6
CWLP	0.0	0.0	0.0	0.0
IPL	0.0	0.0	0.0	0.0
MEC	0.0	0.0	0.0	0.0
MECS	51.6	11.3	15.2	78.1
NIPS	0.0	0.0	0.0	0.0
WEC	0.0	0.0	0.0	0.0
NYISO	645.8	571.7	496.6	1,714.2
HUDS	0.0	0.0	0.0	0.0
LIND	0.0	0.2	0.5	0.7
NEPT	0.0	0.0	0.0	0.0
NYIS	645.8	571.5	496.1	1,713.5
OVEC	0.0	0.0	0.0	0.0
TVA	41.9	43.8	0.9	86.6
Total without Up To Congestion	1,089.7	926.4	840.6	2,856.7
Up To Congestion	3,714.6	2,109.4	2,253.9	8,077.9
Total	4,804.3	3,035.8	3,094.4	10,934.5

Table 9-10 Day-Ahead scheduled gross export volume by interface (GWh): January 1 through March 31, 2017

	Jan	Feb	Mar	Total
CPLE	16.6	10.3	8.3	35.2
CPLW	0.0	0.0	0.0	0.0
DUK	11.5	0.0	10.2	21.7
LGEE	0.0	0.0	0.0	0.0
MISO	988.3	878.8	1,484.3	3,351.4
ALTE	225.7	280.7	378.9	885.4
ALTW	0.0	0.0	0.0	0.0
AMIL	0.0	0.0	5.8	5.8
CIN	132.1	93.6	459.9	685.5
CWLP	0.0	0.0	0.0	0.0
IPL	0.0	2.3	13.0	15.3
MEC	496.4	433.1	428.2	1,357.7
MECS	43.6	29.9	82.1	155.6
NIPS	0.0	0.0	0.0	0.0
WEC	90.5	39.2	116.4	246.2
NYISO	1,826.9	1,465.7	1,264.7	4,557.3
HUDS	0.0	0.0	0.0	0.0
LIND	33.1	21.9	20.6	75.6
NEPT	489.6	412.1	445.4	1,347.1
NYIS	1,304.2	1,031.7	798.7	3,134.6
OVEC	0.0	0.0	0.0	0.0
TVA	3.5	24.1	49.5	77.1
Total without Up To Congestion	2,846.8	2,378.9	2,817.0	8,042.7
Up To Congestion	2,681.9	1,948.8	1,884.1	6,514.7
Total	5,528.6	4,327.6	4,701.1	14,557.4

Day-Ahead Interface Pricing Point Imports and Exports

Table 9-11 through Table 9-16 show the day-ahead scheduled interchange totals at the interface pricing points. In the first three months of 2017, up to congestion transactions accounted for 73.9 percent of all scheduled import MW transactions and 44.8 percent of all scheduled export MW transactions in the Day-Ahead Energy Market. The day-ahead net scheduled interchange in the first three months of 2017, including up to congestion transactions, is shown by interface pricing point in Table 9-11. Scheduled up to congestion transactions by interface pricing point in the first three months of 2017 are shown in Table 9-12. Day-ahead gross scheduled imports and exports, including up to congestion transactions, are shown in Table 9-13 and Table 9-15, while gross scheduled import and export up to congestion transactions are show in Table 9-14 and Table 9-16.

There is one interface pricing point eligible for day-ahead transaction scheduling only (NIPSCO). The NIPSCO interface pricing point was created when the individual balancing authorities that integrated to form MISO still operated independently. Transactions sourcing or sinking in the NIPSCO balancing authority were eligible to receive the real-time NIPSCO interface pricing point. After the formation of the MISO RTO, all real-time transactions sourcing or sinking in NIPSCO are represented on the NERC Tag as sourcing or sinking in MISO, and thus receive the MISO interface pricing point in the Real-Time Energy Market. For this reason, it was no longer possible to receive the NIPSCO interface pricing point in the Real-Time Energy Market after the integration of NIPSCO into MISO.

After NIPSCO integrated into MISO on May 1, 2004, PJM kept the NIPSCO interface pricing point for the purpose of facilitating the long term day-ahead positions created at the NIPSCO Interface prior to the integration. However, the NIPSCO interface pricing point remains an eligible interface pricing point in the PJM Day-Ahead Energy Market today, and is available for all market participants to use as the pricing point for day-ahead imports, exports and wheels, INCs, DECs and up to congestion transactions. The NIPSCO interface pricing point continues to also be used as an eligible source or sink for new FTRs.

In the first three months of 2017, the day-ahead net scheduled interchange at the NIPSCO interface pricing point was -1,585.0 GWh (Table 9-11). Table 9-12 shows that all -1,585.0 GWh of day-ahead net scheduled interchange submitted at the NIPSCO interface pricing point were made up of up to congestion transactions. While there is no corresponding interface pricing point available for real-time transaction scheduling, a real-time LMP is still calculated. This real-time price is used for balancing the deviations between the Day-Ahead and Real-Time Energy Markets.

PJM consolidated the Southeast and Southwest interface pricing points to a single interface pricing point with separate import and export prices (SouthIMP and SouthEXP) on October 31, 2006. At that time, the real-time Southeast and Southwest interface pricing points remained only to support certain grandfathered agreements with specific generating units and to price energy under the reserve sharing agreement with VACAR. The reserve sharing agreement allows for the transfer of energy during emergencies. Interchange transactions created as part of the reserve sharing agreement are currently settled at the Southeast interface price. PJM also kept the day-ahead Southeast and Southwest interface pricing points to facilitate long-term day-ahead positions that were entered prior to the consolidation.

Maintaining outdated definitions of interface pricing points is unnecessary, inconsistent with the tariff and creates artificial opportunities for gaming by virtual transactions and FTRs. The MMU recommends that PJM end the practice of maintaining outdated definitions of interface pricing points, eliminate the NIPSCO, Southeast and Southwest interface pricing points from the Day-Ahead and Real-Time Energy Markets and, with VACAR, assign the transactions created under the reserve sharing agreement to the SouthIMP/EXP pricing point.

In the Day-Ahead Energy Market, in the first three months of 2017, there were net scheduled exports at ten of PJM's 19 interface pricing points eligible for day-ahead transactions. The top three net exporting interface pricing points in the Day-Ahead Energy Market accounted for 53.1 percent of the total net scheduled exports: PJM/NIPSCO with 20.4 percent, PJM/MISO with 16.6 percent and PJM/NEPTUNE with 16.2 percent of the net scheduled export volume. The four separate interface pricing points that connect PJM to the NYISO (PJM/NYIS, PJM/NEPTUNE, PJM/HUDSONTP and PJM/LINDENVFT) together represented 32.3 percent of the total net PJM scheduled exports in the Day-Ahead Energy Market (the PJM/HUDSONTP Interface Pricing Point had net scheduled imports). Seven PJM interface pricing points had net scheduled imports, with three importing interface pricing points accounting for 83.0 percent of the total net scheduled imports: PJM/Ohio Valley Electric Corporation (OVEC) with 31.4 percent, PJM/Southeast with 28.8 percent and

PJM/SOUTHIMP with 22.8 percent of the net import volume. The four separate interface pricing points that connect PJM to the NYISO (PJM/NYIS, PJM/NEPTUNE, PJM/HUDSONTP and PJM/LINDENVFT) together had net scheduled exports in the Day-Ahead Energy Market. However, the PJM/HUDSONTP interface pricing points had net scheduled imports that represented 3.8 percent of the total PJM net scheduled imports in the Day-Ahead Energy Market.[22]

In the Day-Ahead Energy Market, in the first three months of 2017, up to congestion transactions had net scheduled exports at five of PJM's 19 interface pricing points eligible for day-ahead transactions. The top two net exporting interface pricing points eligible for up to congestion transactions accounted for 79.0 percent of the total net up to congestion scheduled exports: PJM/NIPSCO with 56.2 percent and PJM/Southwest with 22.8 percent of the net scheduled export up to congestion volume. The four separate interface pricing points that connect PJM to the NYISO (PJM/NYIS, PJM/NEPTUNE, PJM/HUDSONTP and PJM/LINDENVFT) together had net scheduled import up to congestion transactions in the Day-Ahead Energy Market (the PJM/LINDENVFT interface pricing point had net scheduled exports representing 2.0 percent of the net export up to congestion volume). Eight PJM interface pricing points had net scheduled up to congestion imports, with the top three importing interface pricing points accounting for 73.7 percent of the total net up to congestion imports: PJM/OVEC with 29.8 percent, PJM/Southeast with 27.3 percent and PJM/MISO with 16.7 percent of the net import up to congestion volume. The four separate interface pricing points that connect PJM to the NYISO (PJM/NYIS, PJM/NEPTUNE, PJM/HUDSONTP and PJM/LINDENVFT) together represented 12.4 percent of the total net scheduled up to congestion exports in the Day-Ahead Energy Market.[23]

Table 9-11 Day-ahead scheduled net interchange volume by interface pricing point (GWh): January 1 through March 31, 2017

	Jan	Feb	Mar	Total
IMO	134.8	(25.0)	(202.5)	(92.7)
MISO	(100.3)	(259.5)	(931.6)	(1,291.4)
NIPSCO	(950.4)	(289.9)	(344.8)	(1,585.0)
NORTHWEST	(370.1)	(455.6)	(326.7)	(1,152.4)
NYISO	(838.4)	(756.8)	(759.1)	(2,354.3)
HUDSONTP	191.8	24.8	(57.5)	159.1
LINDENVFT	(58.5)	(43.6)	(28.0)	(130.1)
NEPTUNE	(482.9)	(387.4)	(386.8)	(1,257.1)
NYIS	(488.9)	(350.5)	(286.8)	(1,126.2)
OVEC	742.4	64.9	497.4	1,304.7
Southern Imports	1,418.8	988.4	996.3	3,403.5
CPLEIMP	5.4	3.2	5.2	13.7
DUKIMP	8.2	26.9	19.6	54.8
NCMPAIMP	175.1	152.1	149.9	477.1
SOUTHEAST	424.7	377.5	439.6	1,241.8
SOUTHWEST	376.6	125.7	164.6	666.9
SOUTHIMP	428.8	303.1	217.5	949.3
Southern Exports	(761.1)	(558.4)	(535.7)	(1,855.2)
CPLEEXP	(15.8)	(9.8)	(7.7)	(33.3)
DUKEXP	0.0	0.0	0.0	0.0
NCMPAEXP	0.0	0.0	0.0	0.0
SOUTHEAST	(13.3)	(21.9)	(9.7)	(45.0)
SOUTHWEST	(576.6)	(401.3)	(332.9)	(1,310.8)
SOUTHEXP	(155.4)	(125.4)	(185.4)	(466.1)
Total	(724.4)	(1,291.8)	(1,606.7)	(3,622.8)

22 In the Day-Ahead Energy Market, two PJM interface pricing points (PJM/DUKEXP and PJM/NCMPAEXP) had net interchange of zero.
23 In the Day-Ahead Energy Market, six PJM interface pricing points (PJM/CPLEIMP, PJM/DUKIMP, PJM/NCMPAIMP, PJM/CPLEEXP, PJM/DUKEXP and PJM/NCMPAEXP) had up to congestion net interchange of zero.

Table 9-12 Up to congestion scheduled net interchange volume by interface pricing point (GWh): January 1 through March 31, 2017

	Jan	Feb	Mar	Total
IMO	83.2	(36.3)	(217.7)	(170.9)
MISO	404.5	198.9	127.9	731.2
NIPSCO	(950.4)	(289.9)	(344.8)	(1,585.0)
NORTHWEST	110.7	(35.1)	98.1	173.7
NYISO	342.6	137.2	9.0	488.8
HUDSONTP	191.8	24.8	(57.5)	159.1
LINDENVFT	(25.4)	(22.0)	(7.9)	(55.3)
NEPTUNE	6.8	24.7	58.6	90.0
NYIS	169.4	109.7	15.8	294.9
OVEC	742.4	64.9	497.4	1,304.7
Southern Imports	1,029.2	645.0	667.6	2,341.8
CPLEIMP	0.0	0.0	0.0	0.0
DUKIMP	0.0	0.0	0.0	0.0
NCMPAIMP	0.0	0.0	0.0	0.0
SOUTHEAST	424.7	377.5	439.6	1,241.8
SOUTHWEST	376.6	125.7	164.6	666.9
SOUTHIMP	227.9	141.8	63.4	433.2
Southern Exports	(729.5)	(524.0)	(467.7)	(1,721.2)
CPLEEXP	0.0	0.0	0.0	0.0
DUKEXP	0.0	0.0	0.0	0.0
NCMPAEXP	0.0	0.0	0.0	0.0
SOUTHEAST	(13.3)	(21.9)	(9.7)	(45.0)
SOUTHWEST	(576.6)	(401.3)	(332.9)	(1,310.8)
SOUTHEXP	(139.5)	(100.8)	(125.0)	(365.4)
Total Interfaces	1,032.7	160.6	369.8	1,563.1
INTERNAL	28,699.9	24,147.9	24,822.8	77,670.6
Total	29,732.6	24,308.5	25,192.6	79,233.8

Table 9-13 Day-ahead scheduled gross import volume by interface pricing point (GWh): January 1 through March 31, 2017

	Jan	Feb	Mar	Total
IMO	213.7	67.9	56.5	338.0
MISO	753.3	402.1	343.1	1,498.5
NIPSCO	60.1	158.5	137.7	356.2
NORTHWEST	398.3	184.1	261.1	843.6
NYISO	1,156.1	863.3	651.2	2,670.5
HUDSONTP	231.3	106.6	12.7	350.7
LINDENVFT	17.4	13.7	21.7	52.8
NEPTUNE	36.2	39.1	64.9	140.2
NYIS	871.2	703.8	551.8	2,126.9
OVEC	804.0	371.6	648.6	1,824.1
Southern Imports	1,418.8	988.4	996.3	3,403.5
CPLEIMP	5.4	3.2	5.2	13.7
DUKIMP	8.2	26.9	19.6	54.8
NCMPAIMP	175.1	152.1	149.9	477.1
SOUTHEAST	424.7	377.5	439.6	1,241.8
SOUTHWEST	376.6	125.7	164.6	666.9
SOUTHIMP	428.8	303.1	217.5	949.3
Southern Exports	0.0	0.0	0.0	0.0
CPLEEXP	0.0	0.0	0.0	0.0
DUKEXP	0.0	0.0	0.0	0.0
NCMPAEXP	0.0	0.0	0.0	0.0
SOUTHEAST	0.0	0.0	0.0	0.0
SOUTHWEST	0.0	0.0	0.0	0.0
SOUTHEXP	0.0	0.0	0.0	0.0
Total	4,804.3	3,035.8	3,094.4	10,934.5

Table 9-14 Up to congestion scheduled gross import volume by interface pricing point (GWh): January 1 through March 31, 2017

	Jan	Feb	Mar	Total
IMO	162.1	56.6	41.2	259.9
MISO	750.7	402.1	343.1	1,495.9
NIPSCO	60.1	158.5	137.7	356.2
NORTHWEST	398.3	184.1	261.1	843.6
NYISO	510.2	291.6	154.5	956.3
HUDSONTP	231.3	106.6	12.7	350.7
LINDENVFT	17.4	13.5	21.2	52.1
NEPTUNE	36.2	39.1	64.9	140.2
NYIS	225.4	132.3	55.7	413.4
OVEC	804.0	371.6	648.6	1,824.1
Southern Imports	1,029.2	645.0	667.6	2,341.8
CPLEIMP	0.0	0.0	0.0	0.0
DUKIMP	0.0	0.0	0.0	0.0
NCMPAIMP	0.0	0.0	0.0	0.0
SOUTHEAST	424.7	377.5	439.6	1,241.8
SOUTHWEST	376.6	125.7	164.6	666.9
SOUTHIMP	227.9	141.8	63.4	433.2
Southern Exports	0.0	0.0	0.0	0.0
CPLEEXP	0.0	0.0	0.0	0.0
DUKEXP	0.0	0.0	0.0	0.0
NCMPAEXP	0.0	0.0	0.0	0.0
SOUTHEAST	0.0	0.0	0.0	0.0
SOUTHWEST	0.0	0.0	0.0	0.0
SOUTHEXP	0.0	0.0	0.0	0.0
Total Interfaces	3,714.6	2,109.4	2,253.9	8,077.9

Table 9-15 Day-ahead scheduled gross export volume by interface pricing point (GWh): January 1 through March 31, 2017

	Jan	Feb	Mar	Total
IMO	78.9	92.8	259.0	430.8
MISO	853.6	661.6	1,274.7	2,789.9
NIPSCO	1,010.4	448.4	482.5	1,941.3
NORTHWEST	768.5	639.7	587.9	1,996.0
NYISO	1,994.5	1,620.1	1,410.3	5,024.8
HUDSONTP	39.5	81.8	70.2	191.5
LINDENVFT	75.9	57.3	49.7	182.9
NEPTUNE	519.0	426.6	451.7	1,397.3
NYIS	1,360.1	1,054.4	838.6	3,253.1
OVEC	61.6	306.7	151.2	519.5
Southern Imports	0.0	0.0	0.0	0.0
CPLEIMP	0.0	0.0	0.0	0.0
DUKIMP	0.0	0.0	0.0	0.0
NCMPAIMP	0.0	0.0	0.0	0.0
SOUTHEAST	0.0	0.0	0.0	0.0
SOUTHWEST	0.0	0.0	0.0	0.0
SOUTHIMP	0.0	0.0	0.0	0.0
Southern Exports	761.1	558.4	535.7	1,855.2
CPLEEXP	15.8	9.8	7.7	33.3
DUKEXP	0.0	0.0	0.0	0.0
NCMPAEXP	0.0	0.0	0.0	0.0
SOUTHEAST	13.3	21.9	9.7	45.0
SOUTHWEST	576.6	401.3	332.9	1,310.8
SOUTHEXP	155.4	125.4	185.4	466.1
Total	5,528.6	4,327.6	4,701.1	14,557.4

Table 9-16 Up to congestion scheduled gross export volume by interface pricing point (GWh): January 1 through March 31, 2017

	Jan	Feb	Mar	Total
IMO	78.9	92.8	259.0	430.8
MISO	346.2	203.3	215.2	764.6
NIPSCO	1,010.4	448.4	482.5	1,941.3
NORTHWEST	287.6	219.2	163.1	669.9
NYISO	167.6	154.4	145.5	467.5
HUDSONTP	39.5	81.8	70.2	191.5
LINDENVFT	42.8	35.5	29.1	107.3
NEPTUNE	29.4	14.5	6.4	50.2
NYIS	56.0	22.6	39.9	118.5
OVEC	61.6	306.7	151.2	519.5
Southern Imports	0.0	0.0	0.0	0.0
CPLEIMP	0.0	0.0	0.0	0.0
DUKIMP	0.0	0.0	0.0	0.0
NCMPAIMP	0.0	0.0	0.0	0.0
SOUTHEAST	0.0	0.0	0.0	0.0
SOUTHWEST	0.0	0.0	0.0	0.0
SOUTHIMP	0.0	0.0	0.0	0.0
Southern Exports	729.5	524.0	467.7	1,721.2
CPLEEXP	0.0	0.0	0.0	0.0
DUKEXP	0.0	0.0	0.0	0.0
NCMPAEXP	0.0	0.0	0.0	0.0
SOUTHEAST	13.3	21.9	9.7	45.0
SOUTHWEST	576.6	401.3	332.9	1,310.8
SOUTHEXP	139.5	100.8	125.0	365.4
Total Interfaces	2,681.9	1,948.8	1,884.1	6,514.7

Table 9-17 Active real-time and day-ahead scheduling interfaces: January 1 through March 31, 2017[24]

	Jan	Feb	Mar
ALTE	Active	Active	Active
ALTW	Active	Active	Active
AMIL	Active	Active	Active
CIN	Active	Active	Active
CPLE	Active	Active	Active
CPLW	Active	Active	Active
CWLP	Active	Active	Active
DUK	Active	Active	Active
HUDS	Active	Active	Active
IPL	Active	Active	Active
LGEE	Active	Active	Active
LIND	Active	Active	Active
MEC	Active	Active	Active
MECS	Active	Active	Active
NEPT	Active	Active	Active
NIPS	Active	Active	Active
NYIS	Active	Active	Active
OVEC	Active	Active	Active
TVA	Active	Active	Active
WEC	Active	Active	Active

24 On July 2, 2012, Duke Energy Corp. (DUK) completed a merger with Progress Energy Inc. (CPLE and CPLW). As of March 31, 2017, DUK, CPLE and CPLW continued to operate as separate balancing authorities, and are still defined as distinct interfaces in the PJM energy market.

Figure 9-3 PJM's footprint and its external day-ahead and real-time scheduling interfaces

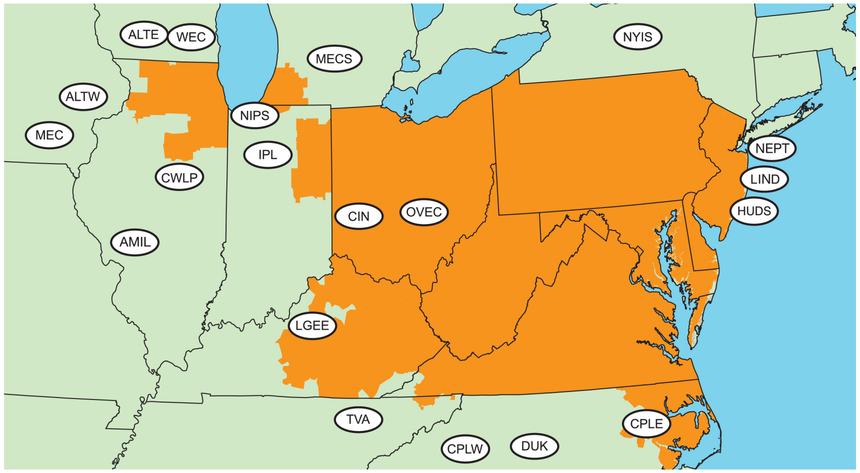


Table 9-18 Active day-ahead and real-time scheduled interface pricing points: January 1 through March 31, 2017[25]

	Jan	Feb	Mar
CPLEEXP	Active	Active	Active
CPLEIMP	Active	Active	Active
DUKEXP	Active	Active	Active
DUKIMP	Active	Active	Active
HUDSONTP	Active	Active	Active
LINDENVFT	Active	Active	Active
MISO	Active	Active	Active
NCMPAEXP	Active	Active	Active
NCMPAIMP	Active	Active	Active
NEPTUNE	Active	Active	Active
NIPSCO	Active	Active	Active
Northwest	Active	Active	Active
NYIS	Active	Active	Active
Ontario IESO	Active	Active	Active
OVEC	Active	Active	Active
Southeast	Active	Active	Active
SOUTHEXP	Active	Active	Active
SOUTHIMP	Active	Active	Active
Southwest	Active	Active	Active

25 The NIPSCO interface pricing point is valid only in the Day-Ahead Energy Market.

Loop Flows

Actual energy flows are the real-time metered power flows at an interface for a defined period. The comparable scheduled flows are the real-time power flows scheduled at an interface for a defined period. Inadvertent interchange is the difference between the total actual flows for the PJM system (net actual interchange) and the total scheduled flows for the PJM system (net scheduled interchange) for a defined period. Loop flows are the difference between actual and scheduled power flows at a specific interface. Loop flows can exist at the same time that inadvertent interchange is zero. For example, actual imports could exceed scheduled imports at one interface and actual exports could exceed scheduled exports at another interface by the same amount. The result is loop flow, despite the fact that system actual and scheduled power flow net to a zero difference.[26]

Loop flow results, in part, from a mismatch between incentives to use a particular scheduled transmission path and the market based price differentials at interface pricing points that result from the actual physical flows on the transmission system.

PJM's approach to interface pricing attempts to match prices with physical power flows and their impacts on the transmission system. For example, if market participants want to import energy from the Southwest Power Pool (SPP) to PJM, they are likely to choose a scheduled path with the fewest transmission providers along the path and therefore the lowest transmission costs for the transaction, regardless of whether the resultant path is related to the physical flow of power. The lowest cost transmission path runs from SPP, through MISO, and into PJM, requiring only three transmission reservations, two of which are available at no cost (MISO transmission would be free based on the regional through and out rates, and the PJM transmission would be free, if using spot import transmission). Any other transmission path entering PJM, where the generating control area is to the south, would require the market participant to acquire transmission through nonmarket balancing authorities, and thus incur additional transmission costs. PJM's interface pricing method recognizes that transactions sourcing in SPP and sinking in

26 See the *2012 State of the Market Report for PJM*, Volume II, Section 8, "Interchange Transactions," for a more detailed discussion.

PJM will create flows across the southern border and prices those transactions at the SouthIMP interface price. As a result, the transaction is priced appropriately, but a difference between scheduled and actual flows is created at PJM's borders. For example, if a 100 MW transaction were submitted, there would be 100 MW of scheduled flow at the PJM/MISO interface border, but there would be no actual flows on the interface. Correspondingly, there would be no scheduled flows at the PJM/Southern interface border, but there would be 100 MW of actual flows on the interface. In the first three months of 2017, there were net scheduled flows of 1,593 GWh through MISO that received an interface pricing point associated with the southern interface but there were no net scheduled flows across the southern interface that received the MISO interface pricing point.

In the first three months of 2017, net scheduled interchange was -3,715 GWh and net actual interchange was -3,661 GWh, a difference of 54 GWh. In the first three months of 2016, net scheduled interchange was 5,690 GWh and net actual interchange was 6,564 GWh, a difference of 874 GWh. This difference is inadvertent interchange. PJM attempts to minimize the amount of accumulated inadvertent interchange by continually monitoring and correcting for inadvertent interchange. PJM can reduce the accumulation of inadvertent interchange using unilateral or bilateral paybacks.[27]

Table 9-19 shows that in the first three months of 2017, the Wisconsin Energy Corporation (WEC) interface had the largest loop flows of any interface with -301 GWh of net scheduled interchange and 2,598 GWh of net actual interchange, a difference of 2,899 GWh.

27 See PJM. "Manual 12: Balancing Operations," Revision 36 (February 1, 2017).

Table 9-19 Net scheduled and actual PJM flows by interface (GWh): January 1 through March 31, 2017

	Actual	Net Scheduled	Difference (GWh)
CPLE	1,677	3	1,674
CPLW	(296)	0	(296)
DUK	334	1,142	(808)
LGEE	989	490	498
MISO	(5,761)	(2,700)	(3,061)
ALTE	(1,522)	(818)	(703)
ALTW	(472)	1	(473)
AMIL	372	813	(441)
CIN	(2,738)	(1,162)	(1,576)
CWLP	(42)	0	(42)
IPL	(204)	(89)	(115)
MEC	(716)	(1,286)	570
MECS	(1,458)	136	(1,593)
NIPS	(1,580)	9	(1,589)
WEC	2,598	(301)	2,899
NYISO	(3,260)	(3,206)	(54)
HUDS	0	0	0
LIND	(528)	(528)	0
NEPT	(1,349)	(1,349)	0
NYIS	(1,383)	(1,329)	(54)
OVEC	543	(57)	600
TVA	2,113	612	1,501
Total	(3,661)	(3,715)	54

Every external balancing authority is mapped to an import and export interface pricing point. The mapping is designed to reflect the physical flow of energy between PJM and each balancing authority. The net scheduled values for interface pricing points are defined as the MWh of scheduled transactions that will receive the interface pricing point based on the external balancing authority mapping.[28] For example, the MWh for a transaction whose transmission path is SPP through MISO and into PJM would be reflected in the SouthIMP interface pricing point net schedule totals because SPP is mapped to the SouthIMP interface pricing point. The actual flow on an

28 The terms balancing authority and control area are used interchangeably in this section. The NERC Tag applications maintained the terminology of generation control area (GCA) and load control area (LCA) after the implementation of the NERC functional model. The NERC functional model classifies the balancing authority as a reliability service function, with, among other things, the responsibility for balancing generation, demand and interchange balance. See "Reliability Functional Model," <http://www.nerc.com/files/Functional_Model_V4_CLEAN_2008Dec01.pdf>. (August 2008)

interface pricing point is defined as the metered flow across the transmission lines that are included in the interface pricing point.

The differences between the scheduled MWh mapped to a specific interface pricing point and actual power flows at the interface pricing points provide a better measure of loop flows than differences at the interfaces. The scheduled transactions are mapped to interface pricing points based on the expected flow from the generation balancing authority and load balancing authority, whereas scheduled transactions are assigned to interfaces based solely on the OASIS path that the market participants reflect the transmission path into or out of PJM to one neighboring balancing authority. Power flows at the interface pricing points provide a more accurate reflection of where scheduled power flows actually enter or leave the PJM footprint based on the complete transaction path.

Table 9-20 shows the net scheduled and actual PJM flows by interface pricing point. The CPLEEXP, CPLEIMP, DUKEXP, DUKIMP, NCMPAEXP, and NCMPAIMP interface pricing points were created as part of operating agreements with external balancing authorities, and reflect the same physical ties as the SouthIMP and SouthEXP interface pricing points.

Because the SouthIMP and SouthEXP interface pricing points are the same physical point, if there are net actual exports from the PJM footprint to the southern region, by definition, there cannot be net actual imports into the PJM footprint from the southern region and therefore there will not be actual flows at the SouthIMP interface pricing point. In the case of PJM's southern border, loop flows can be analyzed by comparing the net scheduled and net actual flows as a sum of the pricing points, rather than the individual pricing points. To accurately calculate the loop flows from the southern region, the net actual flows from the southern region are compared to the net scheduled flows from the southern region. The net actual flows from the southern region are determined by summing the total southern import actual flows (7,250 GWh) and the total southern export actual flows (-2,433 GWh) for 4,817 GWh of net imports. The net scheduled flows from the southern region are determined by summing the total southern import scheduled flows (4,243 GWh) and the total southern export scheduled flows (-403 GWh) for 3,840 GWh of net imports. In the first three months of 2017, the loop flows at the southern region were the difference between the southern region net scheduled flows (3,840 GW) and the southern region net actual flows (4,817 GWh) for a total of 977 GWh of loop flows.

The IMO interface pricing point with the Ontario IESO was created to reflect the fact that transactions that originate or sink in the Ontario Independent Electricity System Operator (IMO) balancing authority create physical flows that are split between the MISO and NYISO interface pricing points depending on transmission system conditions, so a mapping to a single interface pricing point does not reflect the actual flows. PJM created the IMO interface pricing point to reflect the actual power flows across both the MISO/PJM and NYISO/PJM interfaces. The IMO does not have physical ties with PJM because it is not contiguous. Table 9-20 shows actual flows associated with the IMO interface pricing point as zero because there is no PJM/IMO Interface. The actual flows between IMO and PJM are included in the actual flows at the MISO and NYISO interface pricing points.

Table 9-20 Net scheduled and actual PJM flows by interface pricing point (GWh): January 1 through March 31, 2017

	Actual	Net Scheduled	Difference (GWh)
IMO	0	581	(581)
MISO	(5,761)	(4,871)	(890)
NORTHWEST	0	(0)	0
NYISO	(3,260)	(3,208)	(52)
HUDSONTP	0	0	0
LINDENVFT	(528)	(528)	(0)
NEPTUNE	(1,349)	(1,349)	0
NYIS	(1,383)	(1,331)	(52)
OVEC	543	(57)	600
Southern Imports	7,250	4,243	3,006
CPLEIMP	0	12	(12)
DUKIMP	0	52	(52)
NCMPAIMP	0	443	(443)
SOUTHEAST	0	0	0
SOUTHWEST	0	0	0
SOUTHIMP	7,250	3,736	3,514
Southern Exports	(2,433)	(403)	(2,030)
CPLEEXP	0	(25)	25
DUKEXP	0	(76)	76
NCMPAEXP	0	0	0
SOUTHEAST	0	0	0
SOUTHWEST	0	0	0
SOUTHEXP	(2,433)	(302)	(2,131)
Total	(3,661)	(3,715)	54

Table 9-21 shows the net scheduled and actual PJM flows by interface pricing point, with adjustments made to the MISO and NYISO scheduled interface pricing points based on the quantities of scheduled interchange where transactions from the IMO entered the PJM energy market. For example, Table 9-23 shows that 579 of the 581 GWh (99.7 percent) of gross scheduled transactions that were mapped to the IMO interface pricing point were scheduled as imports through MISO, and 2 of the 581 GWh (0.3 percent) were scheduled as imports through the NYISO.

Table 9-21 shows that in the first three months of 2017, the SouthIMP interface pricing point had the largest loop flows of any interface pricing point with 3,736 GWh of net scheduled interchange and 7,250 GWh of net actual interchange, a difference of 3,514 GWh.

Table 9-21 Net scheduled and actual PJM flows by interface pricing point (GWh) (Adjusted for IMO Scheduled Interfaces): January 1 through March 31, 2017

	Actual	Net Scheduled	Difference (GWh)
MISO	(5,761)	(4,292)	(1,468)
NORTHWEST	0	(0)	0
NYISO	(3,260)	(3,206)	(54)
HUDSONTP	0	0	0
LINDENVFT	(528)	(528)	(0)
NEPTUNE	(1,349)	(1,349)	0
NYIS	(1,383)	(1,329)	(54)
OVEC	543	(57)	600
Southern Imports	7,250	4,243	3,006
CPLEIMP	0	12	(12)
DUKIMP	0	52	(52)
NCMPAIMP	0	443	(443)
SOUTHEAST	0	0	0
SOUTHWEST	0	0	0
SOUTHIMP	7,250	3,736	3,514
Southern Exports	(2,433)	(403)	(2,030)
CPLEEXP	0	(25)	25
DUKEXP	0	(76)	76
NCMPAEXP	0	0	0
SOUTHEAST	0	0	0
SOUTHWEST	0	0	0
SOUTHEXP	(2,433)	(302)	(2,131)
Total	(3,661)	(3,715)	54

PJM attempts to ensure that external energy transactions are priced appropriately through the assignment of interface prices based on the expected actual flow from the generation balancing authority (source) and load balancing authority (sink) as specified on the NERC Tag. Assigning prices in this manner is a reasonable approach to ensuring that transactions receive or pay the PJM market value of the transaction based on expected flows, but this method does not address loop flow issues.

Loop flows remain a significant concern for the efficiency of the PJM market. Loop flows can have negative impacts on the efficiency of markets with explicit locational pricing, including impacts on locational prices, on FTR revenue adequacy and on system operations, and can be evidence of attempts to game the markets.

The MMU recommends that PJM implement a validation method for submitted transactions that would prohibit market participants from breaking transactions into smaller segments to defeat the interface pricing rule and receive higher prices (for imports) or lower prices (for exports) from PJM resulting from the inability to identify the true source or sink of the transaction. If all of the Northeast ISOs and RTOs implemented validation to prohibit the breaking of transactions into smaller segments, the level of Lake Erie loop flow would be reduced.

The MMU also recommends that PJM implement a validation method for submitted transactions that would require market participants to submit transactions on paths that reflect the expected actual power flow in order to reduce unscheduled loop flows.

Table 9-22 shows the net scheduled and actual PJM flows by interface and interface pricing point. This table shows the interface pricing points that were assigned to energy transactions that had paths at each of PJM's interfaces. For example, Table 9-22 shows that in the first three months of 2017, the majority of imports to the PJM energy market for which a market participant specified Cinergy as the interface with PJM based on the scheduled transmission path, had a generation control area mapped to the IMO Interface, and thus actual flows were assigned the IMO interface pricing point (271 GWh). The majority of exports from the PJM energy market for which a market participant specified Cinergy as the interface with PJM based on the scheduled transmission path had a load control area for which the actual flows would leave the PJM energy market at the MISO Interface, and were assigned the MISO interface pricing point (-1,655 GWh).

Table 9-22 Net scheduled and actual PJM flows by interface and interface pricing point (GWh): January 1 through March 31, 2017

Interface	Interface Pricing Point	Actual	Net Scheduled	Difference (GWh)	Interface	Interface Pricing Point	Actual	Net Scheduled	Difference (GWh)
ALTE		(1,522)	(818)	(703)	HUDS		0	0	0
	IMO	0	25	(25)		HUDSONTP	0	0	0
	MISO	(1,522)	(1,111)	(410)	IPL		(204)	(89)	(115)
	SOUTHIMP	0	268	(268)		IMO	0	67	(67)
ALTW		(472)	1	(473)		MISO	(204)	(162)	(42)
	IMO	0	1	(1)		SOUTHIMP	0	7	(7)
	MISO	(472)	0	(472)	LGEE		989	490	498
AMIL		372	813	(441)		SOUTHEXP	(1,547)	(6)	(1,541)
	MISO	372	(1)	373		SOUTHIMP	2,536	496	2,039
	SOUTHIMP	0	813	(813)	LIND		(528)	(528)	0
CIN		(2,738)	(1,162)	(1,576)		LINDENVFT	(528)	(528)	0
	IMO	0	271	(271)	MEC		(716)	(1,286)	570
	MISO	(2,738)	(1,655)	(1,083)		MISO	(716)	(1,288)	572
	NORTHWEST	0	(0)	0		SOUTHIMP	0	2	(2)
	SOUTHEXP	0	(1)	1	MECS		(1,458)	136	(1,593)
	SOUTHIMP	0	223	(223)		IMO	0	216	(216)
CPLE		1,677	3	1,674		MISO	(1,458)	(205)	(1,253)
	CPLEEXP	0	(25)	25		SOUTHEXP	0	(1)	1
	CPLEIMP	0	12	(12)		SOUTHIMP	0	126	(126)
	NCMPAIMP	0	29	(29)	NEPT		(1,349)	(1,349)	0
	SOUTHEXP	(291)	(25)	(267)		NEPTUNE	(1,349)	(1,349)	0
	SOUTHIMP	1,968	11	1,957	NIPS		(1,580)	9	(1,589)
CPLW		(296)	0	(296)		MISO	(1,580)	9	(1,589)
	SOUTHEXP	(309)	0	(309)		SOUTHIMP	0	0	(0)
	SOUTHIMP	13	0	13	NYIS		(1,383)	(1,329)	(54)
CWLP		(42)	0	(42)		IMO	0	2	(2)
	MISO	(42)	0	(42)		NYIS	(1,383)	(1,331)	(52)
DUK		334	1,142	(808)	OVEC		543	(57)	600
	DUKEXP	0	(76)	76		OVEC	543	(57)	600
	DUKIMP	0	52	(52)	TVA		2,113	612	1,501
	NCMPAIMP	0	414	(414)		SOUTHEXP	(122)	(156)	34
	SOUTHEXP	(163)	(113)	(50)		SOUTHIMP	2,235	768	1,467
	SOUTHIMP	498	865	(367)	WEC		2,598	(301)	2,899
						MISO	2,598	(457)	3,056
						SOUTHIMP	0	156	(156)
					Grand Total		(3,661)	(3,715)	54

Table 9-23 shows the net scheduled and actual PJM flows by interface pricing point and interface. The grouping is reversed from Table 9-22. Table 9-23 shows the interfaces where transactions were scheduled which received the individual interface pricing points. For example, Table 9-23 shows that in the first three months of 2017, the majority of imports to the PJM energy market for which a market participant specified a generation control area for which it was assigned the MISO interface pricing point, had a path that entered the PJM energy market at the NIPS Interface (9 GWh). The majority of exports from the PJM energy market for which a market participant specified a load control area for which it was assigned the MISO interface pricing point, had a path that exited the PJM energy market at the CIN Interface (-1,655 GWh).

Table 9-23 Net scheduled and actual PJM flows by interface pricing point and interface (GWh): January 1 through March 31, 2017

Interface Pricing Point	Interface	Actual	Net Scheduled	Difference (GWh)	Interface Pricing Point	Interface	Actual	Net Scheduled	Difference (GWh)
CPLEEXP		0	(25)	25	NEPTUNE		(1,349)	(1,349)	0
	CPLE	0	(25)	25		NEPT	(1,349)	(1,349)	0
CPLEIMP		0	12	(12)	NORTHWEST		0	(0)	0
	CPLE	0	12	(12)		CIN	0	(0)	0
DUKEXP		0	(76)	76	NYIS		(1,383)	(1,331)	(52)
	DUK	0	(76)	76		NYIS	(1,383)	(1,331)	(52)
DUKIMP		0	52	(52)	OVEC		543	(57)	600
	DUK	0	52	(52)		OVEC	543	(57)	600
HUDSONTP		0	0	0	SOUTHEXP		(2,433)	(302)	(2,131)
	HUDS	0	0	0		CIN	0	(1)	1
IMO		0	581	(581)		CPLE	(291)	(25)	(267)
	ALTE	0	25	(25)		CPLW	(309)	0	(309)
	ALTW	0	1	(1)		DUK	(163)	(113)	(50)
	CIN	0	271	(271)		LGEE	(1,547)	(6)	(1,541)
	IPL	0	67	(67)		MECS	0	(1)	1
	MECS	0	216	(216)		TVA	(122)	(156)	34
	NYIS	0	2	(2)	SOUTHIMP		7,250	3,736	3,514
LINDENVFT		(528)	(528)	0		ALTE	0	268	(268)
	LIND	(528)	(528)	0		AMIL	0	813	(813)
MISO		(5,761)	(4,871)	(890)		CIN	0	223	(223)
	ALTE	(1,522)	(1,111)	(410)		CPLE	1,968	11	1,957
	ALTW	(472)	0	(472)		CPLW	13	0	13
	AMIL	372	(1)	373		DUK	498	865	(367)
	CIN	(2,738)	(1,655)	(1,083)		IPL	0	7	(7)
	CWLP	(42)	0	(42)		LGEE	2,536	496	2,039
	IPL	(204)	(162)	(42)		MEC	0	2	(2)
	MEC	(716)	(1,288)	572		MECS	0	126	(126)
	MECS	(1,458)	(205)	(1,253)		NIPS	0	0	(0)
	NIPS	(1,580)	9	(1,589)		TVA	2,235	768	1,467
	WEC	2,598	(457)	3,056		WEC	0	156	(156)
NCMPAIMP		0	443	(443)	Grand Total		(3,661)	(3,715)	54
	CPLE	0	29	(29)					
	DUK	0	414	(414)					

Data Required for Full Loop Flow Analysis

Loop flows are defined as the difference between actual and scheduled power flows at one or more specific interfaces. The differences between actual and scheduled power flows can be the result of a number of underlying causes. To adequately investigate the causes of loop flows, complete data are required.

Loop flows exist because electricity flows on the path of least resistance regardless of the path specified by contractual agreement or regulatory prescription. Loop flows can arise from transactions scheduled into, out of or around a balancing authority on contract paths that do not correspond to the actual physical paths on which energy flows. Outside of LMP-based energy markets, energy is scheduled and paid for based on contract path, without regard to the path of the actual energy flows. Loop flows can also result from actions within balancing authorities.

Loop flows are a significant concern. Loop flows can have negative impacts on the efficiency of markets with explicit locational pricing, including impacts on locational prices, on FTR revenue adequacy and on system operations, and can be evidence of attempts to game such markets. Loop flows also have poorly understood impacts on nonmarket areas. In general, the detailed sources of the identified differences between scheduled and actual flows remain unclear as a result of incomplete or inadequate access to the required data.

A complete analysis of loop flow could provide additional insight that could lead to enhanced overall market efficiency and clarify the interactions among market and nonmarket areas. A complete analysis of loop flow would improve the overall transparency of electricity transactions. There are areas with transparent markets, and there are areas with less transparent markets (nonmarket areas), but these areas together comprise a market, and overall market efficiency would benefit from the increased transparency that would derive from a better understanding of loop flows.

For a complete loop flow analysis, several types of data are required from all balancing authorities in the Eastern Interconnection. The Commission recently required access to NERC Tag data. In addition to the Tag data, actual tie line data, dynamic schedule and pseudo-tie data are required in order to analyze the differences between actual and scheduled transactions. ACE data, market flow impact data and generation and load data are required in order to understand the sources, within each balancing authority, of loop flows that do not result from differences between actual and scheduled transactions.[29]

NERC Tag Data

An analysis of loop flow requires knowledge of the scheduled path of energy transactions. NERC Tag data includes the scheduled path and energy profile of the transactions, including the Generation Control Area (GCA), the intermediate Control Areas, the Load Control Area (LCA) and the energy profile of all transactions. Additionally, complete tag data include the identity of the specific market participants. FERC Order No. 771 required access to NERC Tag data for the Commission, regional transmission organizations, independent system operators and market monitoring units.[30]

Actual Tie Line Flow Data

An analysis of loop flow requires knowledge of the actual path of energy transactions. Currently, a very limited set of tie line data is made available via the NERC IDC and the Central Repository for Curtailments (CRC) website. Additionally, the available tie line data, and the data within the IDC, are presented as information on a screen, which does not permit analysis of the underlying data.

Dynamic Schedule and Pseudo-Tie Data

Dynamic schedule and pseudo ties represent another type of interchange transaction between balancing authorities. While dynamic schedules are required to be tagged, the tagged profile is only an estimate of what energy is expected to flow. Dynamic schedules are implemented within each balancing authority's Energy Management System (EMS), with the current values shared over Inter-Control Center Protocol (ICCP) links. By definition, the dynamic schedule scheduled and actual values will always be identical from a balancing authority standpoint, and the tagged profile should be removed

29 It is requested that all data be made available in downloadable format in order to make analysis possible. A data viewing tool alone is not adequate.
30 141 FERC ¶ 61,235 (2012). *Availability of E-Tag Information to Commission Staff.*

from the calculation of loop flows to eliminate double counting of the energy profile. Dynamic schedule data from all balancing authorities are required in order to account for all scheduled and actual flows.

Pseudo-ties are similar to dynamic schedules in that they represent a transaction between balancing authorities and are handled within the EMS systems and data are shared over the ICCP. Pseudo-ties only differ from dynamic schedules in how the generating resource is modeled within the balancing authorities' ACE equations. Dynamic schedules are modeled as resources located in one area serving load in another, while pseudo-ties are modeled as resources in one area moved to another area. Unlike dynamic schedules, pseudo-tie transactions are not required to be tagged. Pseudo-tie data from all balancing authorities are required in order to account for all scheduled and actual flows.

Area Control Error (ACE) Data

Area Control Error (ACE) data provides information about how well each balancing authority is matching their generation with their load. This information, combined with the scheduled and actual interchange values will show whether an individual balancing authority is pushing on or leaning on the interconnection, contributing to loop flows.

NERC makes real-time ACE graphs available on their Reliability Coordinator Information System (RCIS) website. This information is presented only in graphical form, and the underlying data is not available for analysis.

Market Flow Impact Data

In addition to interchange transactions, internal dispatch can also affect flows on balancing authorities' tie lines. The impact of internal dispatch on tie lines is called market flow. Market flow data are imported in the IDC, but there is only limited historical data, as only market flow data related to TLR levels 3 or higher are required to be made available via a Congestion Management Report (CMR). The remaining data are deleted.

There is currently a project in development through the NERC Operating Reliability Subcommittee (ORS) called the Market Flow Impact Tool. The purpose of this tool is to make visible the impacts of dispatch on loop flows. The MMU supports the development of this tool, and requests that FERC and NERC ensure that the underlying data are provided to market monitors and other approved entities.

Generation and Load Data

Generation data (both real-time scheduled generation and actual output) and load data would permit analysis of the extent to which balancing authorities are meeting their commitments to serve load. If a balancing authority is not meeting its load commitment with adequate generation, the result is unscheduled flows across the interconnections to establish power balance.

Market areas are transparent in providing real-time load while nonmarket areas are not. For example, PJM posts real-time load via its eDATA application. Most nonmarket balancing authorities provide only the expected peak load on their individual web sites. Data on generation are not made publicly available, as this is considered market sensitive information.

The MMU requests, that in order to permit a complete analysis of loop flow, FERC and NERC ensure that the identified data are made available to market monitors as well as other industry entities determined appropriate by FERC.

PJM and MISO Interface Prices

If interface prices were defined in a comparable manner by PJM and MISO, and if time lags were not built into the rules governing interchange transactions, then prices at the interfaces would be expected to be very close and the level of transactions would be expected to be related to any price differentials. The fact that these conditions do not exist is important in explaining the observed relationship between interface prices and inter-RTO power flows, and those price differentials.

Both the PJM/MISO and MISO/PJM interface pricing points represent the value of power at the relevant border, as determined in each market. In both cases, the interface price is the price at which transactions are settled. For example, a transaction into PJM from MISO would receive the PJM/MISO interface price upon entering PJM, while a transaction into MISO from PJM would receive the MISO/PJM interface price. PJM and MISO use network models to determine these prices and to attempt to ensure that the prices are consistent with the underlying electrical flows.

Under the PJM/MISO Joint Operating Agreement, the two RTOs mutually determine a set of transmission facilities on which both RTOs have an impact, and therefore jointly operate to those constraints. These jointly controlled facilities are M2M (Market to Market) flowgates. When a M2M constraint binds, PJM's LMP calculations at the buses that make up PJM's MISO interface pricing point, as well as for all buses in the PJM model, are based on the PJM model's distribution factors of the selected buses to the binding M2M constraint and PJM's shadow price of the binding M2M constraint. MISO's LMP calculations at the buses that make up MISO's PJM interface pricing point are based on the MISO model's distribution factors of the selected buses to the binding M2M constraint and MISO's shadow price of the binding M2M constraint.

Prior to June 1, 2014, the PJM interface definition for MISO consisted of nine buses located near the middle of the MISO system and not at the border between the RTOs. The MISO interface definition for PJM currently consists of all PJM generator buses which are spread across the entire PJM system. The interface definitions led to questions about the level of congestion included in interchange pricing.[31] [32]

PJM modified the definition of the PJM/MISO interface price effective June 1, 2014. PJM's new MISO interface pricing point includes 10 equally weighted buses that are close to the PJM/MISO border. The 10 buses were selected based on PJM's analysis that showed that over 80 percent of the hourly tie line flows between PJM and MISO occurred on ten ties composed of MISO and PJM monitored facilities. MISO is currently planning to modify their MISO/PJM interface definition to match PJM's PJM/MISO interface definition, effective June 1, 2017.

31 See "LMP Aggregate Definitions," (March 9, 2017) <http://www.pjm.com/~/media/markets-ops/energy/lmp-model-info/lmp-aggregate-definitions.ashx>. PJM periodically updates these definitions on its web site. See <http://www.pjm.com>.
32 Based on information obtained from MISO's extranet <http://extranet.midwestiso.org> (Accessed April 11, 2017).

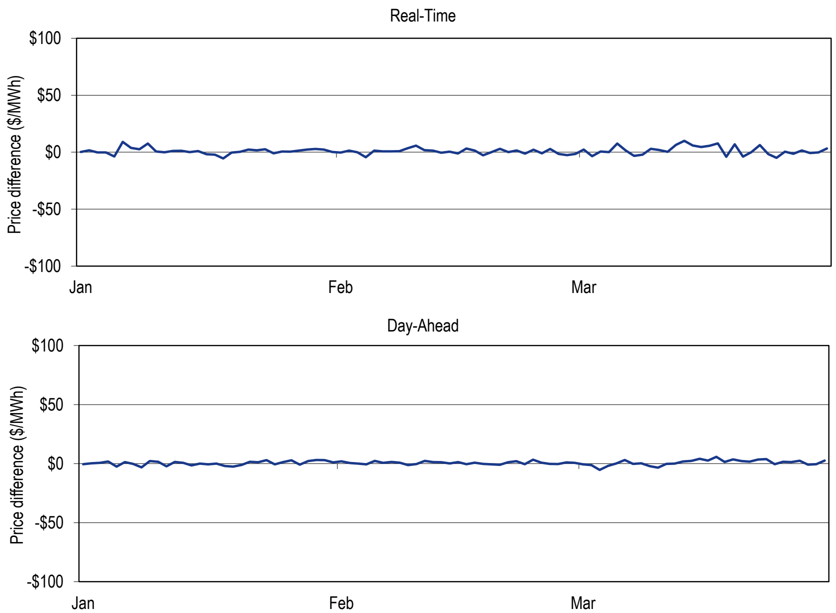
Real-Time and Day-Ahead PJM/MISO Interface Prices

In the first three months of 2017, the direction of flow was consistent with price differentials in 64.3 percent of the hours. Table 9-24 shows the number of hours and average hourly price differences between the PJM/MISO Interface and the MISO/PJM Interface based on LMP differences and flow direction. Figure 9-4 shows the underlying hourly variability in prices. There are a number of relevant measures of variability, including the number of times the price differential fluctuates between positive and negative, the standard deviation of individual prices and of price differences and the absolute value of the price differences (Table 9-28).

Table 9-24 PJM and MISO flow based hours and average hourly price differences: January 1 through March 31, 2017

LMP Difference	Flow Direction	Number of Hours	Average Hourly Price Difference
MISO/PJM LMP > PJM/MISO LMP	Total Hours	1,390	$4.44
	Consistent Flow (PJM to MISO)	1,386	$4.43
	Inconsistent Flow (MISO to PJM)	4	$9.76
	No Flow	0	$0.00
PJM/MISO LMP > MISO/PJM LMP	Total Hours	769	$5.15
	Consistent Flow (MISO to PJM)	2	$0.65
	Inconsistent Flow (PJM to MISO)	767	$5.16
	No Flow	0	$0.00

Figure 9-4 Real-time and day-ahead daily hourly average price difference (MISO/PJM Interface minus PJM/MISO Interface): January 1 through March 31, 2017



Distribution and Prices of Hourly Flows at the PJM/MISO Interface

In the first three months of 2017, the direction of hourly energy flows was consistent with PJM and MISO interface price differentials in 1,388 hours (64.3 percent of all hours), and was inconsistent with price differentials in 771 hours (35.7 percent of all hours). Table 9-25 shows the distribution of hourly energy flows between PJM and MISO based on the price differences between the PJM/MISO and MISO/PJM prices. Of the 771 hours where flows were in a direction inconsistent with price differences, 537 of those hours (69.6 percent) had a price difference greater than or equal to $1.00 and 204 of those hours (26.5 percent) had a price difference greater than or equal to $5.00. The largest price difference with such flows was $66.65. Of the 1,388 hours where flows were consistent with price differences, 1,044 of those hours (75.2 percent) had a price difference greater than or equal to $1.00 and 284 of all such hours (20.5 percent) had a price difference greater than or equal to $5.00. The largest price difference with such flows was $171.04.

Table 9-25 Distribution of hourly flows that are consistent and inconsistent with price differences between PJM and MISO: January 1 through March 31, 2017

Price Difference Range (Greater Than or Equal To)	Inconsistent Hours	Percent of Inconsistent Hours	Consistent Hours	Percent of Consistent Hours
$0.00	771	100.0%	1,388	100.0%
$1.00	537	69.6%	1,044	75.2%
$5.00	204	26.5%	284	20.5%
$10.00	107	13.9%	136	9.8%
$15.00	73	9.5%	80	5.8%
$20.00	51	6.6%	53	3.8%
$25.00	36	4.7%	35	2.5%
$50.00	6	0.8%	9	0.6%
$75.00	0	0.0%	3	0.2%
$100.00	0	0.0%	1	0.1%
$200.00	0	0.0%	0	0.0%
$300.00	0	0.0%	0	0.0%
$400.00	0	0.0%	0	0.0%
$500.00	0	0.0%	0	0.0%

PJM and NYISO Interface Prices

If interface prices were defined in a comparable manner by PJM and the NYISO, if identical rules governed external transactions in PJM and the NYISO, if time lags were not built into the rules governing such transactions and if no risks were associated with such transactions, then prices at the interfaces would be expected to be very close and the level of transactions would be expected to be related to any price differentials. The fact that none of these conditions exists is important in explaining the observed relationship between interface prices and inter-RTO/ISO power flows, and those price differentials.[33]

PJM and NYISO each calculate an interface LMP using network models including distribution factor impacts. PJM currently uses two buses within

33 See the *2012 State of the Market Report for PJM*, Volume II, Section 8, "Interchange Transactions," for a more detailed discussion.

NYISO to calculate the PJM/NYIS interface pricing point LMP while NYISO calculates the PJM interface price (represented by the Keystone proxy bus) based on the assumption that 40 percent of the scheduled energy will flow across the PJM/NYISO border on the Branchburg to Ramapo PAR controlled tie, and the remaining 60 percent will enter the NYISO on their free flowing A/C tie lines.

The existing definition interface definition was created to reflect the impact of the ConEd wheeling arrangement. On April 28, 2016, Con Edison announced its intent to terminate the wheeling agreement effective May 1, 2017. The end of the wheeling agreement means that the expected actual power flows will change and therefore the definition of the interface price needs to change. Effective May 1, 2017, PJM will replace the old PJM/NYIS interface price definition. The new PJM/NYIS interface price will be based on four buses within NYISO. These buses were chosen based on the assumption that, in the absence of the wheeling arrangement, 68 percent of the scheduled energy will flow across the PJM/NYISO border on the Branchburg to Ramapo PAR controlled tie, and the remaining 32 percent will enter the NYISO on free flowing A/C tie lines.

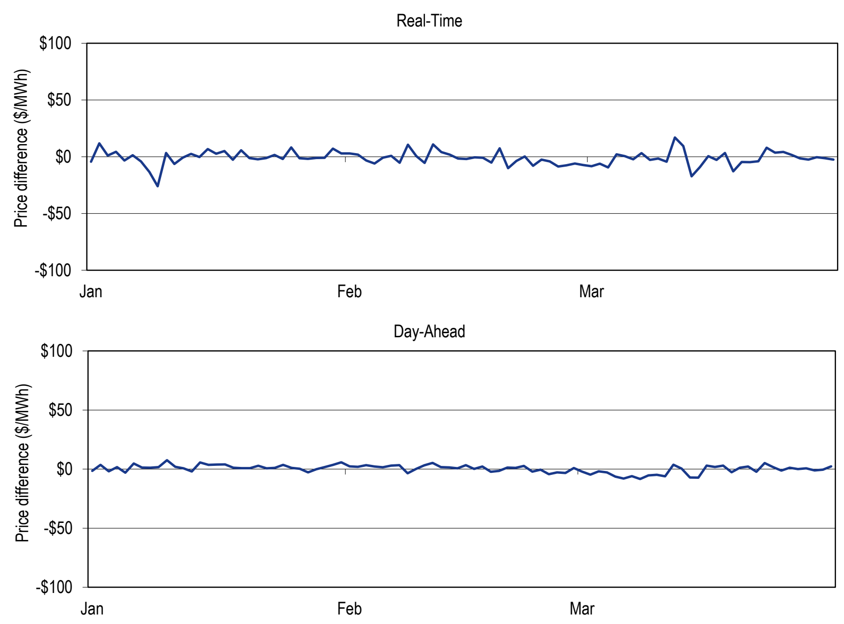
Real-Time and Day-Ahead PJM/NYISO Interface Prices

In the first three months of 2017, the relationship between prices at the PJM/NYIS Interface and at the NYISO/PJM proxy bus and the relationship between interface price differentials and power flows continued to be affected by differences in institutional and operating practices between PJM and the NYISO. The direction of flow was consistent with price differentials in 50.4 percent of the hours in 2016. Table 9-26 shows the number of hours and average hourly price differences between the PJM/NYIS Interface and the NYIS/PJM proxy bus based on LMP differences and flow direction. Figure 9-5 shows the underlying hourly variability in prices. There are a number of relevant measures of variability, including the number of times the price differential fluctuates between positive and negative, the standard deviation of individual prices and of price differences and the absolute value of the price differences (Table 9-28).

Table 9-26 PJM and NYISO flow based hours and average hourly price differences: January 1 through March 31, 2017[34]

LMP Difference	Flow Direction	Number of Hours	Average Hourly Price Difference
NYIS/PJM proxy bus LBMP > PJM/NYIS LMP	Total Hours	860	$9.80
	Consistent Flow (PJM to NYIS)	795	$9.13
	Inconsistent Flow (NYIS to PJM)	65	$17.97
	No Flow	0	$0.00
PJM/NYIS LMP > NYIS/PJM proxy bus LBMP	Total Hours	1,299	$8.33
	Consistent Flow (NYIS to PJM)	294	$8.41
	Inconsistent Flow (PJM to NYIS)	1,005	$8.31
	No Flow	0	$0.00

Figure 9-5 Real-time and day-ahead daily hourly average price difference (NY/PJM proxy - PJM/NYIS Interface): January 1 through March 31, 2017



34 The NYISO Locational Based Marginal Price (LBMP) is the equivalent term to PJM's Locational Marginal Price (LMP).

Distribution and Prices of Hourly Flows at the PJM/NYISO Interface

In the first three months of 2017, the direction of hourly energy flows was consistent with PJM/NYISO and NYISO/PJM price differences in 1,089 hours (50.4 percent of all hours), and was inconsistent with price differences in 1,070 hours (49.6 percent of all hours). Table 9-27 shows the distribution of hourly energy flows between PJM and NYISO based on the price differences between the PJM/NYISO and NYISO/PJM prices. Of the 1,070 hours where flows where flows were in a direction inconsistent with price differences, 945 of those hours (88.3 percent) had a price difference greater than or equal to $1.00 and 537 of all those hours (50.2 percent) had a price difference greater than or equal to $5.00. The largest price difference with such flows was $152.30. Of the 1,089 hours where flows were consistent with price differences, 931 of those hours (85.5 percent) had a price difference greater than or equal to $1.00 and 451 of all such hours (41.4 percent) had a price difference greater than or equal to $5.00. The largest price difference with such flows was $271.25.

Table 9-27 Distribution of hourly flows that are consistent and inconsistent with price differences between PJM and NYISO: January 1 through March 31, 2017

Price Difference Range (Greater Than or Equal To)	Inconsistent Hours	Percent of Inconsistent Hours	Consistent Hours	Percent of Consistent Hours
$0.00	1,070	100.0%	1,089	100.0%
$1.00	945	88.3%	931	85.5%
$5.00	537	50.2%	451	41.4%
$10.00	261	24.4%	230	21.1%
$15.00	158	14.8%	130	11.9%
$20.00	104	9.7%	97	8.9%
$25.00	80	7.5%	79	7.3%
$50.00	18	1.7%	33	3.0%
$75.00	6	0.6%	14	1.3%
$100.00	3	0.3%	11	1.0%
$200.00	0	0.0%	2	0.2%
$300.00	0	0.0%	0	0.0%
$400.00	0	0.0%	0	0.0%
$500.00	0	0.0%	0	0.0%

Summary of Interface Prices between PJM and Organized Markets

Some measures of the real-time and day-ahead PJM interface pricing with MISO and with the NYISO are summarized and compared in Table 9-28, including average prices and measures of variability.

Table 9-28 PJM, NYISO and MISO real-time and day-ahead border price averages: January 1 through March 31, 2017

		Real-Time		Day-Ahead	
	Description	NYISO	MISO	NYISO	MISO
Average Hourly Price	PJM Price at ISO Border	$29.36	$26.01	$29.70	$26.51
	ISO Price at PJM Border	$28.85	$27.04	$29.94	$27.11
	Difference at Border (PJM-ISO)	$0.51	($1.03)	($0.24)	($0.60)
	Average Absolute Value of Hourly Difference at Border	$8.92	$4.69	$3.36	$2.17
	Sign Changes per Day	5.9	6.6	2.9	4.2
Standard Deviation	PJM Price at ISO Border	$13.81	$9.19	$9.58	$6.12
	ISO Price at PJM Border	$20.44	$9.67	$10.04	$5.67
	Difference at Border (PJM-ISO)	$18.16	$9.92	$4.40	$2.89

Neptune Underwater Transmission Line to Long Island, New York

The Neptune Line is a 65 mile direct current (DC) merchant 230 kV transmission line, with a capacity of 660 MW, providing a direct connection between PJM (Sayreville, New Jersey), and NYISO (Nassau County on Long Island). Schedule 14 of the PJM Open Access Transmission Tariff provides that power flows will only be from PJM to New York. The flows were consistent with price differentials in 65.6 percent of the hours in the first three months of 2017. Table 9-29 shows the number of hours and average hourly price differences between the PJM/NEPT Interface and the NYIS/Neptune bus based on LMP differences and flow direction.

Table 9-29 PJM and NYISO flow based hours and average hourly price differences (Neptune): January 1 through March 31, 2017

LMP Difference	Flow Direction	Number of Hours	Average Hourly Price Difference
NYIS/Neptune Bus LBMP > PJM/NEPT LMP	Total Hours	1,417	$12.29
	Consistent Flow (PJM to NYIS)	1,417	$12.29
	Inconsistent Flow (NYIS to PJM)	0	$0.00
	No Flow	0	$0.00
PJM/NEPT LMP > NYIS/Neptune Bus LBMP	Total Hours	742	$8.52
	Consistent Flow (NYIS to PJM)	0	$0.00
	Inconsistent Flow (PJM to NYIS)	742	$8.52
	No Flow	0	$0.00

To move power from PJM to NYISO using the Neptune Line, two PJM transmission service reservations are required. A transmission service reservation is required from the PJM Transmission System to the Neptune HVDC Line ("Out Service") and another transmission service reservation is required on the Neptune HVDC line ("Neptune Service").[35] The PJM Out Service is covered by normal PJM OASIS business operations.[36] The Neptune Service falls under the provisions for controllable merchant facilities, Schedule 14 of the PJM Tariff. The Neptune Service is also acquired on the PJM OASIS.

Table 9-30 Percent of scheduled interchange across the Neptune line by primary rights holder: July 1, 2007 through March 31, 2017

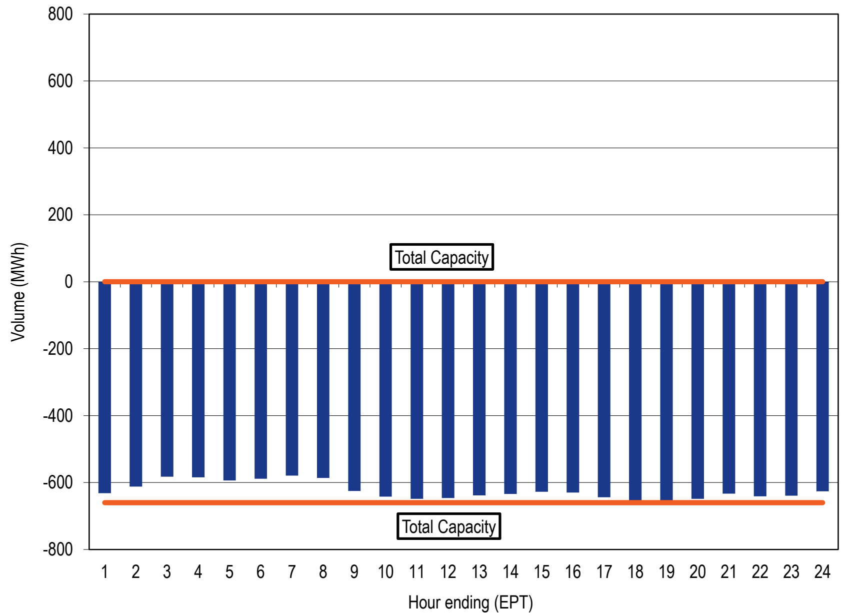
	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
January	NA	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
February	NA	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
March	NA	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
April	NA	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	99.99%	100.00%	
May	NA	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	
June	NA	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	
July	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	
August	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	
September	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	
October	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	
November	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	
December	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	

Neptune Service is owned by a primary rights holder, and any nonfirm service that is not used (as defined by a schedule on a NERC Tag) may be released either voluntarily by the primary rights holder or by default by PJM. The primary rights holder may elect to voluntarily release monthly, weekly, daily or hourly firm or nonfirm service. Voluntarily releasing the service allows for the primary rights holder to specify a rate to be charged for the released service. If the primary rights holder does not elect to voluntarily release nonfirm service, and does not use the service, the available transmission will be released by default at 12:00, one business day before the start of service. On March 31, 2017, the rate for the nonfirm service released by default was $10 per MWh. The primary rights holder remains obligated to pay for the released service unless a second transmission customer acquires the released service.

Table 9-30 shows the percent of scheduled interchange across the Neptune Line by the primary rights holder since commercial operations began in July, 2007. Table 9-30 shows that in the first three months of 2017, the primary rights holder was responsible for 100 percent of the scheduled interchange across the Neptune Line in all months. Figure 9-6 shows the hourly average flow across the Neptune Line for the first three months of 2017.

35 See OASIS "PJM Business Practices for Neptune Transmission Service," <http://www.pjm.com/~/media/etools/oasis/merch-trans-facilities/neptune-oasis-Business-practices-doc-clean.ashx>.
36 See OASIS "Regional Transmission and Energy Scheduling Practices," (March 31, 2016) <http://www.pjm.com/~/media/etools/oasis/regional-practices-clean-pdf.ashx>.

Figure 9-6 Neptune hourly average flow: January 1 through March 31, 2017



Linden Variable Frequency Transformer (VFT) facility

The Linden VFT facility is a controllable AC merchant transmission facility, with a capacity of 300 MW, providing a direct connection between PJM (Linden, New Jersey) and NYISO (Staten Island, New York). The flows were consistent with price differentials in 61.7 percent of the hours in the first three months of 2017. Table 9-31 shows the number of hours and average hourly price differences between the PJM/LIND Interface and the NYIS/Linden bus based on LMP differences and flow direction.

Table 9-31 PJM and NYISO flow based hours and average hourly price differences (Linden): January 1 through March 31, 2017

LMP Difference	Flow Direction	Number of Hours	Average Hourly Price Difference
NYIS/Linden Bus LBMP > PJM/LIND LMP	Total Hours	1,332	$10.84
	Consistent Flow (PJM to NYIS)	1,332	$10.84
	Inconsistent Flow (NYIS to PJM)	0	$0.00
	No Flow	0	$0.00
PJM/LIND LMP > NYIS/Linden Bus LBMP	Total Hours	827	$8.33
	Consistent Flow (NYIS to PJM)	0	$0.00
	Inconsistent Flow (PJM to NYIS)	827	$8.33
	No Flow	0	$0.00

To move power from PJM to NYISO on the Linden VFT Line, two PJM transmission service reservations are required. A transmission service reservation is required from the PJM Transmission System to the Linden VFT ("Out Service") and another transmission service reservation is required on the Linden VFT ("Linden VFT Service").[37] The PJM Out Service is covered by normal PJM OASIS business operations.[38] The Linden VFT Service falls under the provisions for controllable merchant facilities, Schedule 16 and Schedule 16-A of the PJM Tariff. The Linden VFT Service is also acquired on the PJM OASIS.

Linden VFT Service is owned by a primary rights holder, and any nonfirm service that is not used (as defined by a schedule on a NERC Tag) may be released either voluntarily by the primary rights holder or by default by PJM. The primary rights holder may elect to voluntarily release monthly, weekly, daily or hourly firm or nonfirm service. Voluntarily releasing the service allows for the primary rights holder to specify a rate to be charged for the released service. If the primary rights holder elects to not voluntarily release nonfirm service, and does not use the service, the available transmission will be released by default at 12:00, one business day before the start of service. On March 31, 2017, the rate for the nonfirm service released by default was $6.00 per MWh. The primary rights holder remains obligated to pay for the

37 See OASIS "PJM Business Practices for Linden VFT Transmission Service," <http://www.pjm.com/~/media/etools/oasis/merch-trans-facilities/linden-vft-oasis-Business-practices-doc-clean.ashx>.

38 See OASIS "Regional Transmission and Energy Scheduling Practices," (March 31, 2016) <http://www.pjm.com/~/media/etools/oasis/regional-practices-clean-doc.ashx>.

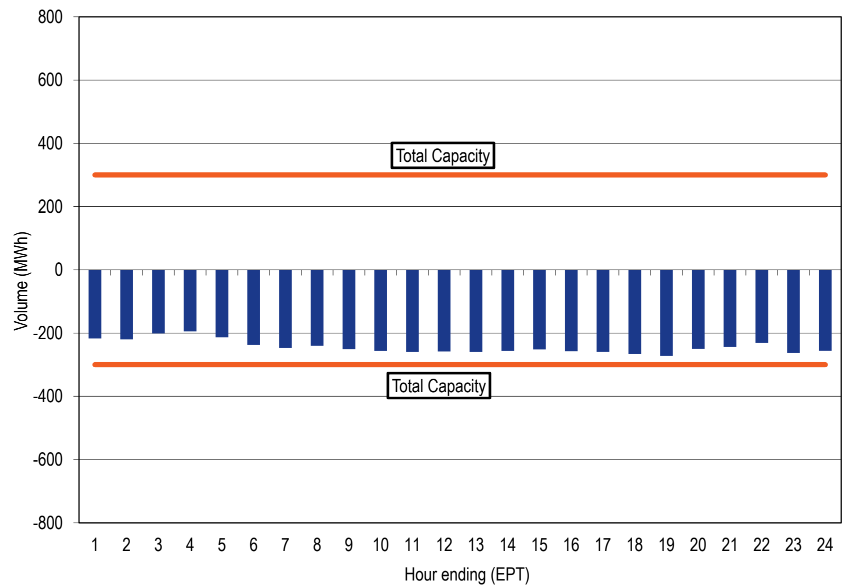
released service unless a second transmission customer acquires the released service.

Table 9-32 shows the percent of scheduled interchange across the Linden VFT Line by the primary rights holder since commercial operations began in November, 2009. Table 9-32 shows that in the first three months of 2017, the primary rights holder was responsible for 100 percent of the scheduled interchange across the Linden VFT Line. Figure 9-7 shows the hourly average flow across the Linden VFT Line for the first three months of 2017.

Table 9-32 Percent of scheduled interchange across the Linden VFT Line by primary rights holder: November 1, 2009 through March 31, 2017

	2009	2010	2011	2012	2013	2014	2015	2016	2017
January	NA	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	70.53%	100.00%
February	NA	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	94.95%	100.00%
March	NA	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	96.46%	100.00%
April	NA	99.97%	100.00%	100.00%	100.00%	99.98%	100.00%	49.32%	
May	NA	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	
June	NA	100.00%	100.00%	100.00%	100.00%	27.27%	100.00%	100.00%	
July	NA	100.00%	100.00%	100.00%	100.00%	29.56%	100.00%	100.00%	
August	NA	100.00%	100.00%	100.00%	100.00%	82.46%	100.00%	100.00%	
September	NA	100.00%	100.00%	100.00%	100.00%	81.68%	100.00%	100.00%	
October	NA	100.00%	100.00%	100.00%	100.00%	100.00%	35.05%	100.00%	
November	100.00%	100.00%	100.00%	100.00%	99.86%	100.00%	61.45%	100.00%	
December	100.00%	100.00%	100.00%	98.22%	100.00%	100.00%	84.57%	100.00%	

Figure 9-7 Linden hourly average flow: January 1 through March 31, 2017[39]



Hudson Direct Current (DC) Merchant Transmission Line

The Hudson direct current (DC) Line is a bidirectional merchant 230 kV transmission line, with a capacity of 673 MW, providing a direct connection between PJM (Public Service Electric and Gas Company's (PSE&G) Bergen 230 kV Switching Station located in Ridgefield, New Jersey) and NYISO (Consolidated Edison's (ConEd) W. 49th Street 345 kV Substation in New York City). The connection is a submarine cable system. While the Hudson DC Line is a bidirectional line, power flows are only from PJM to New York because the Hudson Transmission Partners, LLC have only requested withdrawal rights (320 MW of firm withdrawal rights, and 353 MW of nonfirm withdrawal rights). The flows were consistent with price differentials in 0.2 percent of the hours in the first three months of 2017. Table 9-33 shows the number of hours

39 The Linden VFT Line is a bidirectional facility. The "Total Capacity" lines represent the maximum amount of interchange possible in either direction. These lines were included to maintain a consistent scale, for comparison purposes, with the Neptune DC Tie Line.

and average hourly price differences between the PJM/HUDS Interface and the NYIS/Hudson bus based on LMP differences and flow direction.

Table 9-33 PJM and NYISO flow based hours and average hourly price differences (Hudson): January 1 through March 31, 2017[40]

LMP Difference	Flow Direction	Number of Hours	Average Hourly Price Difference
NYIS/Hudson Bus LBMP > PJM/HUDS LMP	Total Hours	1,316	$10.86
	Consistent Flow (PJM to NYIS)	5	$18.55
	Inconsistent Flow (NYIS to PJM)	0	$0.00
	No Flow	1,311	$10.83
PJM/HUDS LMP > NYIS/Hudson Bus LBMP	Total Hours	843	$8.29
	Consistent Flow (NYIS to PJM)	0	$0.00
	Inconsistent Flow (PJM to NYIS)	0	$0.00
	No Flow	841	$8.29

To move power from PJM to NYISO on the Hudson Line, two PJM transmission service reservations are required. A transmission service reservation is required from the PJM Transmission System to the Hudson Line ("Out Service") and another transmission service reservation is required on the Hudson Line ("Hudson Service").[41] The PJM Out Service is covered by normal PJM OASIS business operations.[42] The Hudson Service falls under the provisions for controllable merchant facilities, Schedule 17 of the PJM Tariff. The Hudson Service is also acquired on the PJM OASIS.

Hudson Service is owned by a primary rights holder, and any nonfirm service that is not used (as defined by scheduled on a NERC Tag) may be released either voluntarily by the primary rights holder or by default by PJM. The primary rights holder may elect to voluntarily release monthly, weekly, daily or hourly firm or nonfirm service. Voluntarily releasing the service allows for the primary rights holder to specify a rate to be charged for the released service. If the primary rights holder elects to not voluntarily release nonfirm service, and does not use the service, the available transmission will be released by default at 12:00, one business day before the start of service. On March 31, 2017, the rate for the nonfirm service released by default was $10 per MWh. The primary rights holder remains obligated to pay for the released service unless a second transmission customer acquires the released service.

Table 9-34 shows the percent of scheduled interchange across the Hudson Line by the primary rights holder since commercial operations began in May, 2013. Table 9-34 shows that in the first three months of 2017, there was no scheduled interchange across the Hudson Line. Figure 9-8 shows the hourly average flow across the Hudson Line for the first three months of 2017.

Table 9-34 Percent of scheduled interchange across the Hudson Line by primary rights holder: May 1, 2013 through March 31, 2017

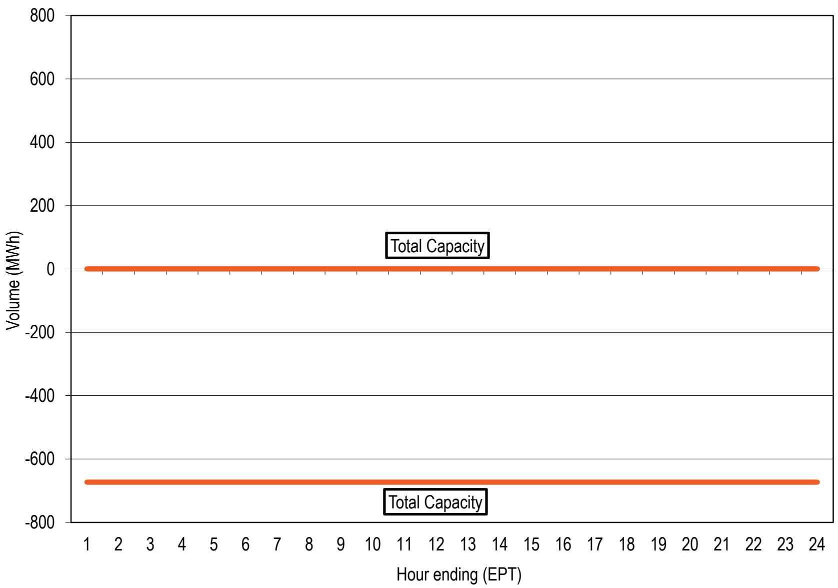
	2013	2014	2015	2016	2017
January	NA	51.22%	16.27%	100.00%	NA
February	NA	49.00%	14.67%	NA	NA
March	NA	40.40%	71.88%	NA	NA
April	NA	100.00%	100.00%	NA	
May	100.00%	26.87%	100.00%	100.00%	
June	100.00%	5.89%	59.72%	100.00%	
July	100.00%	18.51%	84.34%	NA	
August	100.00%	75.17%	65.48%	NA	
September	100.00%	75.31%	78.73%	NA	
October	100.00%	99.71%	18.65%	100.00%	
November	85.57%	99.60%	24.67%	100.00%	
December	28.32%	1.68%	100.00%	NA	

40 The Hudson line was out of service for all hours in the first three months of 2017. In the first three months of 2017, there were five hours with less than 1 MW of unscheduled flow across the Hudson line.

41 See OASIS "PJM Business Practices for Hudson Transmission Service,"<http://www.pjm.com/~/media/etools/oasis/merch-trans-facilities/htp-Business-practices.ashx>.

42 See OASIS "Regional Transmission and Energy Scheduling Practices," (March 31, 2016) <http://www.pjm.com/~/media/etools/oasis/regional-practices-clean-doc.ashx>.

Figure 9-8 Hudson hourly average flow: January 1 through March 31, 2017



Interchange Activity During High Load Hours

The PJM metered system peak load during the first three months of 2017 was 124,210 MW in the HE 0800 on January 9, 2017. PJM did not declare any emergency alerts, warnings or actions in that hour. PJM did not make any emergency energy purchases or sales in that hour. During the month of January 2017, PJM was a net scheduled exporter of energy in 618 of the 744 hours (83.1 percent of all hours). During those 618 hours, the average hourly scheduled exports were 1,645 MW (representing 1.8 percent of the average hourly load of 91,579 MW in January 2017). With the exception of HE 2400, PJM was a net importer of energy in all hours on January 9, 2017, with average hourly scheduled imports of 685 MW.

Operating Agreements with Bordering Areas

To improve reliability and reduce potential seams issues, PJM and its neighbors have developed operating agreements. These agreements include operating agreements with MISO and the NYISO, a reliability agreement with TVA, an operating agreement with Duke Energy Progress, Inc., a reliability coordination agreement with VACAR South, a balancing authority operations agreement with the Wisconsin Electric Power Company (WEC) and a Northeastern planning coordination protocol with NYISO and ISO New England.

Table 9-35 shows a summary of the elements included in each of the operating agreements PJM has with its bordering areas.

Table 9-35 Summary of elements included in operating agreements with bordering areas

Agreement:	PJM-MISO	PJM-NYISO	PJM-TVA	PJM-DEP	PJM-VACAR	PJM-WEP	Northeastern Protocol
Data Exhange							
Real-Time Data	YES	YES	YES	YES	YES	YES	NO
Projected Data	YES	YES	YES	YES	NO	NO	NO
SCADA Data	YES	YES	YES	YES	NO	NO	NO
EMS Models	YES	YES	YES	YES	NO	NO	YES
Operations Planning Data	YES	YES	YES	YES	NO	NO	YES
Available Flowgate Capability Data	YES	YES	YES	YES	NO	NO	YES
Near-Term System Coordination							
Operating Limit Violation Assistance	YES	YES	YES	YES	YES	NO	NO
Over/Under Voltage Assistance	YES	YES	YES	YES	YES	NO	NO
Emergency Energy Assistance	YES	YES	NO	YES	YES	NO	NO
Outage Coordination	YES	YES	YES	YES	YES	NO	NO
Long-Term System Coordination	YES	YES	YES	YES	NO	NO	YES
Congestion Management Process							
ATC Coordination	YES	YES	YES	YES	NO	NO	NO
Market Flow Calculations	YES	YES	YES	NO	NO	NO	NO
Firm Flow Entitlements	YES	YES	YES	NO	NO	NO	NO
Market to Market Redispatch	YES - Redispatch	YES - Redispatch	NO	YES - Dynamic Schedule	NO	NO	NO
Joint Checkout Procedures	YES	YES	YES	YES	NO	YES	NO

PJM-MISO = MISO/PJM Joint Operating Agreement
PJM-NYISO = New York ISO/PJM Joint Operating Agreement
PJM-TVA = Joint Reliablity Coordination Agreement Between PJM - Tennessee Valley Authority (TVA)
PJM-DEP = Duke Energy Progress (DEP) - PJM Joint Operating Agreement
PJM-VACAR = PJM-VACAR South Reliability Coordination Agreement
PJM-WEP = Balancing Authority Operations Coordination Agreement Between Wisconsin Electric Power Company and PJM Interconnection, LLC
Northeastern Protocol = Northeastern ISO-Regional Transmission Organization Planning Coordination Protocol

PJM and MISO Joint Operating Agreement[43]

The Joint Operating Agreement between MISO and PJM Interconnection, L.L.C. was executed on December 31, 2003. The PJM/MISO JOA includes provisions for market based congestion management that, for designated flowgates within MISO and PJM, allow for redispatch of units within the PJM and MISO regions to jointly manage congestion on these flowgates and to assign the costs of congestion management appropriately. In 2012, MISO and PJM initiated a joint stakeholder process to address issues associated with the operation of the markets at the seam.[44]

Under the market to market rules, the organizations coordinate pricing at their borders. PJM and MISO each calculate an interface LMP using network models including distribution factor impacts. PJM uses 10 buses along the PJM/MISO border to calculate the PJM/MISO interface pricing point LMP while MISO uses all

43 See "Joint Operating Agreement Between the Midwest Independent Transmission System Operator, Inc. and PJM Interconnection, L.L.C.," (December 11, 2008) <http://www.pjm.com/media/documents/merged-tariffs/miso-joa.pdf>.
44 See "PJM/MISO Joint and Common Market Initiative," <http://www.pjm.com/committees-and-groups/stakeholder-meetings/pjm-miso-joint-common.aspx>.

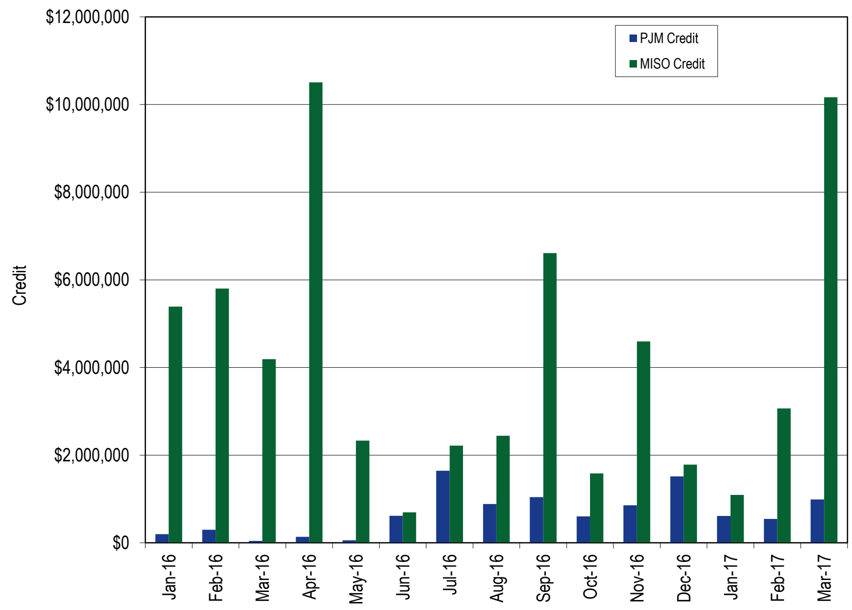
of the PJM generator buses in its model of the PJM system in its calculation of the MISO/PJM interface pricing point.[45] MISO is currently planning to modify their MISO/PJM interface definition to match PJM's PJM/MISO interface definition on June 1, 2017.[46]

Coordinated flowgates (CF) are flowgates that are monitored and/or controlled by PJM or MISO, on which only one has a significant impact (defined as a greater than five percent impact based on transmission distribution factors and/or generation to load distribution factors). A reciprocal coordinated flowgate (RCF) is a CF that is monitored and controlled by PJM or MISO, on which both have significant impacts. Only RCFs are subject to the market to market congestion management process.

As of January 1, 2017, PJM had 150 flowgates eligible for M2M (Market to Market) coordination. In the first three months of 2017, PJM added 13 flowgates and deleted 12 flowgates, leaving 151 flowgates eligible for M2M coordination as of March 31, 2017. As of January 1, 2017, MISO had 261 flowgates eligible for M2M coordination. In the first three months of 2017, MISO added 35 flowgates and deleted 26 flowgates, leaving 270 flowgates eligible for M2M coordination as of March 31, 2017.

The firm flow entitlement (FFE) represents the amount of historic 2004 flow that each RTO had created on each RCF used in the market to market settlement process. The FFE establishes the amount of market flow that each RTO is permitted to create on the RCF before incurring redispatch costs during the market to market process. If the nonmonitoring RTO's real-time market flow is greater than their FFE plus the approved MW adjustment from day-ahead coordination, then the non-monitoring RTO will pay the monitoring RTO based on the difference between their market flow and their FFE. If the non-monitoring RTO's real-time market flow is less than their FFE plus the approved MW adjustment from day-ahead coordination, then the monitoring RTO will pay the nonmonitoring RTO for congestion relief provided by the non-monitoring RTO based on the difference between the nonmonitoring RTO's market flow and their FFE. In the first three months of 2017, market to market operations resulted in MISO and PJM redispatching units to control congestion on M2M flowgates and in the exchange of payments for this redispatch. Figure 9-9 shows credits for coordinated congestion management between PJM and MISO.

Figure 9-9 Credits for coordinated congestion management: January 1, 2016 through March 31, 2017[47]



45 See the *2012 State of the Market Report for PJM*, Volume II, Section 8, "Interchange Transactions," for a more detailed discussion.

46 See "Joint and Common Market: MISO-PJM Interface Pricing Update," (November 15, 2016) <http://www.pjm.com/~/media/committees-groups/stakeholder-meetings/pjm-miso-joint-common/20161115/20161115-item-03a-interface-pricing-post-implementation.ashx>.

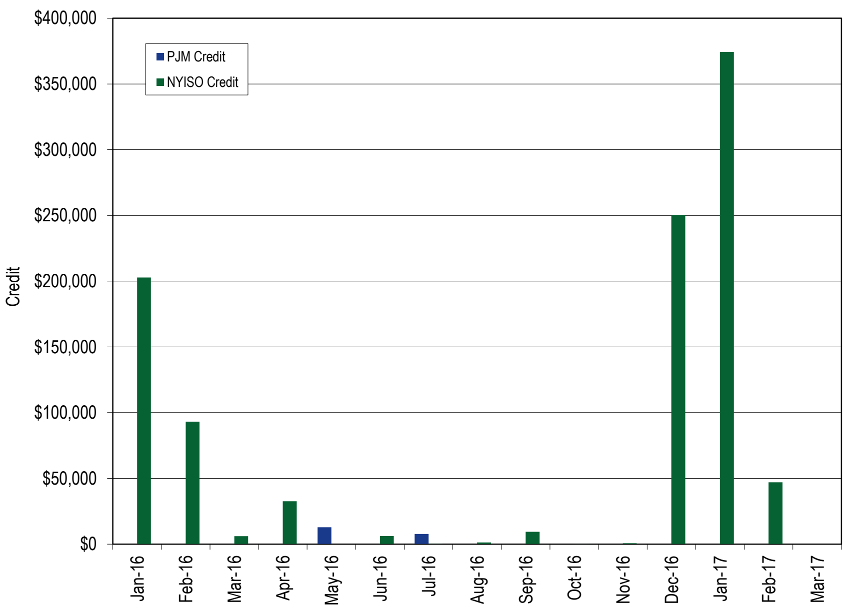
47 The totals represented in this figure represent the settlements as of the time of this report and may not include adjustments or resettlements.

PJM and New York Independent System Operator Joint Operating Agreement (JOA)[48]

The Joint Operating Agreement between NYISO and PJM Interconnection, L.L.C. became effective on January 15, 2013. Under the market to market rules, the organizations coordinate pricing at their borders.

In the first three months of 2017, market to market operations resulted in NYISO and PJM redispatching units to control congestion on M2M flowgates and in the exchange of payments for this redispatch. Figure 9-10 shows credits for coordinated congestion management between PJM and NYISO.

Figure 9-10 Credits for coordinated congestion management (flowgates): January 1, 2016 through March 31, 2017[49]



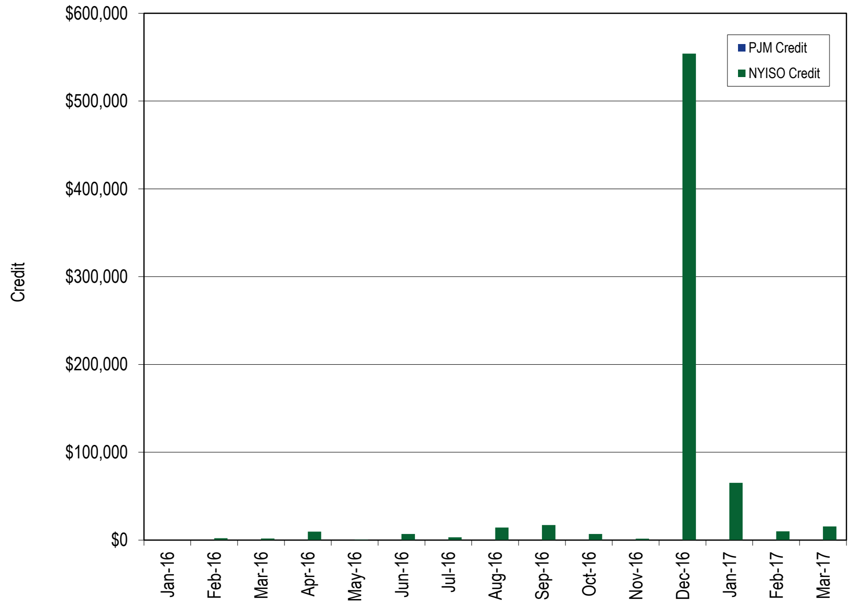
The M2M coordination process focuses on real-time market coordination to manage transmission limitations that occur on M2M flowgates in a cost effective manner. Coordination between NYISO and PJM includes not only joint redispatch, but also incorporates coordinated operation of the Ramapo PARs that are located at the PJM/NYIS border. This real-time coordination results in an efficient economic dispatch solution across both markets to manage the real-time transmission constraints that impact both markets, focusing on the actual flows in real time to manage constraints.[50] For each M2M flowgate, a Ramapo PAR settlement will occur for each interval during coordinated operations. The Ramapo PAR settlements are determined based on whether the measured real-time flow on each of the Ramapo PARs is greater than or less than the calculated target value. If the actual flow is greater than the target flow, NYISO will make a payment to PJM. This payment is calculated as the product of the M2M flowgate shadow price, the PAR shift factor and the difference between the actual and target PAR flow. If the actual flow is less than the target flow, PJM will make a payment to NYISO. This payment is calculated as the product of the M2M flowgate shadow price, the PAR shift factor and the difference between the target and actual PAR flow. In the first three months of 2017, PAR settlements resulted in monthly payments from PJM to NYISO. Figure 9-11 shows the Ramapo PAR credits for coordinated congestion management between PJM and NYISO.

48 See "New York Independent System Operator, Inc., Joint Operating Agreement with PJM Interconnection, L.L.C.," (May 26, 2016) <http://www.pjm.com/~/media/documents/agreements/nyiso-joa.ashx>.

49 The totals represented in this figure represent the settlements as of the time of this report and may not include adjustments or resettlements.

50 See "New York Independent System Operator, Inc., Joint Operating Agreement with PJM Interconnection, L.L.C.," (May 26, 2016) <http://www.pjm.com/~/media/documents/agreements/nyiso-joa.ashx>.

Figure 9-11 Credits for coordinated congestion management (Ramapo PARs): January 1, 2016 through March 31, 2017[51]



PJM and TVA Joint Reliability Coordination Agreement (JRCA)[52]

The joint reliability coordination agreement (JRCA) executed on April 22, 2005, provides for the exchange of information and the implementation of reliability and efficiency protocols between TVA and PJM. The agreement also provides for the management of congestion and arrangements for both near-term and long-term system coordination. Under the JRCA, PJM and TVA honor constraints on the other's flowgates in their Available Transmission Capability (ATC) calculations. Additionally, market flows are calculated on reciprocal flowgates. When a constraint occurs on a reciprocal flowgate within TVA, PJM has the option to redispatch generation to reduce market flow, and therefore alleviate the constraint. Unlike the M2M procedure between MISO and PJM, this redispatch does not result in M2M payments. However, electing to redispatch generation within PJM can avoid potential market disruption by curtailing transactions under the Transmission Line Loading Relief (TLR) procedure to achieve the same relief. The agreement remained in effect in the first three months of 2017.

PJM and Duke Energy Progress, Inc. Joint Operating Agreement[53]

On September 9, 2005, the FERC approved a JOA between PJM and Progress Energy Carolinas, Inc. (PEC), with an effective date of July 30, 2005. As part of this agreement, both parties agreed to develop a formal congestion management protocol (CMP). On February 2, 2010, PJM and PEC filed a revision to the JOA to include a CMP.[54] On January 20, 2011, the Commission conditionally accepted the compliance filing. On July 2, 2012, Duke Energy and Progress Energy Inc. completed a merger. At that time, Progress Energy Carolinas Inc., now a subsidiary of Duke, changed its name to Duke Energy Progress (DEP).

The PJM/DEP JOA states that the Marginal Cost Proxy Method (MCPM) will be used in the determination of the CPLEIMP and CPLEEXP interface price. Section 2.6A (2) of the PJM Tariff describes the process of calculating the interface price under the MCPM. Under the MCPM, PJM compares the individual bus LMP (as calculated by PJM) for each DEP generator in the PJM model with a telemetered output greater than zero MW to the marginal cost for that generator.

For the CPLEIMP price (imports to PJM), PJM uses the lowest LMP of any generator bus in the DEP balancing authority area, with an output greater than zero MW that has an LMP less than its marginal cost for each five minute interval. If no generator with an output greater than zero MW has an LMP less than its marginal cost, then the import price is the average of the bus LMPs for the set of generators in the DEP area with an output greater than

51 The totals represented in this figure represent the settlements as of the time of this report and may not include adjustments or resettlements.

52 See "Joint Reliability Coordination Agreement Among and Between PJM Interconnection, L.L.C., and Tennessee Valley Authority," (October 15, 2014) <http://www.pjm.com/~/media/documents/agreements/joint-reliability-coordination-agreement-miso-pjm-tva.ashx>.

53 See "Amended and Restated Joint Operating Agreement Among and Between PJM Interconnection, L.L.C., and Duke Energy Progress Inc.," (December 3, 2014) <http://www.pjm.com/media/documents/merged-tariffs/progress-joa.pdf>.

54 See *PJM Interconnection, L.L.C and Progress Energy Carolinas, Inc.* Docket No. ER10-713-000 (February 2, 2010).

zero MW that PJM determines to be the marginal units in the DEP area for that five minute interval. PJM determines the marginal units in the DEP area by summing the output of the units serving load in the DEP area in ascending order by the units' marginal costs until the sum equals the real time load in the DEP area. Units in the DEP area with marginal costs at or above that of the last unit included in the sum are the marginal units for the DEP area for that interval.

PJM calculates the CPLEEXP price for exports from PJM to DEP as the highest LMP of any generator bus in the DEP area with an output greater than zero MW (excluding nuclear and hydro units) that has an LMP greater than its marginal cost in the 5 minute interval.[55] If no generator with an output greater than zero MW has an LMP greater than its marginal cost, then the export price will be the average of the bus LMPs for the set of generators with an output greater than zero MW that PJM determines to the be marginal units in the same manner as described for the CPLEIMP interface price. The hourly integrated import and export prices are the average of all of the 5 minute intervals in each hour.

The MCPM calculation is based on the DEP units modeled in the PJM market that have an output greater than zero, and only uses the units whose output exceeds the reported DEP real-time load. When new units are added to the DEP footprint, and existing units in the DEP footprint retire, PJM does not have complete data to calculate the interface price. These new units can impact the interface price in several ways. By not having the additional units modeled, these units cannot be considered to be marginal units, and therefore cannot set price. For the import price, if the PJM calculated LMP of one of the new units were to be lower than any currently modeled unit, then PJM's CPLEIMP pricing point would be lower, and PJM would pay less for imports. If the PJM calculated LMP of one of the new units were to be higher than any currently modeled unit, then PJM's CPLEEXP pricing point would be higher, and PJM would receive more for exports.

55 The MMU has objected to the omission of nuclear and hydro units from the calculation. This omission is not included in the definition of the MCPM interface pricing method in the PJM Tariff, but is included as a special condition in the PJM/DEP JOA. The MMU does not believe it is appropriate to exclude these units from the calculation as these units could be considered marginal and impact the prices.

Not maintaining a current set of units in the DEP footprint in PJM's network model limits PJM's ability to recognize which units are marginal and it is often not possible to calculate the CPLEIMP and CPLEEXP interface prices using the MCPM. By not maintaining a complete set of units in the DEP footprint, the reported output of the modeled units are often insufficient to cover the reported real time load, and therefore no units are considered marginal. When this occurs, the MMU believes that the CPLEIMP and CPLEEXP pricing points should revert to the SOUTHIMP and SOUTHEXP interface prices, but this has not happened. When this occurs, PJM uses the high-low interface pricing method as described in Section 2.6A (1) of the PJM Tariff. The MMU does not believe that this is appropriate, and does not see the basis for this approach in either the PJM Tariff or the PJM/DEP JOA.

On July 2, 2012, Duke Energy and Progress Energy Inc. completed a merger. While the individual companies planned to operate separately for a period of time, they have a joint dispatch agreement, and a joint open access transmission tariff.[56] On October 3, 2014, Duke Energy Progress (DEP) and PJM submitted revisions to the JOA to include a new Appendix B, update references to DEP's current legal name, and incorporate other revisions.[57] The MMU submitted a protest to this filing noting that the existing JOA depends on the specific characteristics of PEC as a standalone company, and the assumptions reflected in the current JOA no longer apply under the DEP joint dispatch agreement.[58] As noted in the 2010 filing, "the terms and conditions of the bilateral agreement among PEC and PJM are grounded in an appreciation of their systems as they exist at the time of the effective date of the JOA, but they fully expect that evolving circumstances, protocols and requirements will require that they negotiate, in good faith, a response to such changes."[59] The joint dispatch agreement changed the unique operational relationship that existed when the congestion management protocol was established. However, the merged company has not engaged in discussions with PJM as to whether the congestion management protocol that was "tailored to their [PJM and PEC] unique operational relationship" is still appropriate, or whether the

56 See "Duke Energy Carolinas, LLC, Carolina Power & Light tariff filing," Docket No. ER12-1338-000 (July 12, 2012) and "Duke Energy Carolinas, LLC, Carolina Power & Light Joint Dispatch Agreement filing," Docket No. ER12-1343-000 (July 11, 2012).
57 See *Duke Energy Progress, Inc. and PJM Interconnection, L.L.C.*, Docket No. ER15-29-000 (October 3, 2014).
58 See Protest and Motion for Rehearing of the Independent Market Monitor for PJM in Docket No. ER15-29-000 (October 24, 2014).
59 Joint Motion for Leave to Answer and Answer of PJM Interconnection, L.C.C. and Progress Energy Carolinas, Inc., Docket No. ER10-713-000 (March 10, 2010) at 2. Section 3.3 of the PJM-Progress JOA.

congestion management protocol needs to be revised. The existing JOA does not apply to the merged company and should be terminated.

Article 14 of the JOA provides details of the PJM/DEP congestion management agreement (CMA). The purpose of the CMA is to allow "DEP to quickly respond to the LMP values sent by PJM to DEP. This quick response will help manage the congestion on the PJM transmission system by maintaining flows within established limits and stabilizing PJM LMP values, and will help reduce the need to use the TLR process to relieve the congestion by maintaining power flows within established reliability limits." Congestion is managed by using a dynamic schedule between CPLE and PJM. DEP responds to the dynamic pricing signal sent by PJM by increasing generation, which creates energy flow in the direction from CPLE to PJM or by decreasing generation, which creates energy flow in the direction from PJM to CPLE. The dynamic schedule calls for more DEP generation when the DEP marginal cost of online generation is less than the CPLE LMP, and it calls for less DEP generation when the DEP marginal cost exceeds the CPLE LMP. The economic energy flow on the dynamic schedule reduces congestion.

The amount of congestion relief is limited by the amount of energy that can flow on the dynamic schedule. Several factors determine this limit, including: the physical limitations of DEP's units; ATC limits on the transmission path between CPLE and PJM; the actual confirmed transmission acquired in advance by DEP. Section 14.4.1 of the JOA states that:

> The transmission service used on the DEP transmission system to support the process described in this Article will be a non-firm point to point reservation from DEP to PJM made by DEP. The Dynamic Schedule will be limited to the point to point reservation. The transmission service used on the PJM transmission system will be network secondary service.

In the first three months of 2017, DEP acquired the required transmission service in only 139 of the 2,159 hours (6.4 percent of all hours), with an average capacity of approximately 129 MW. At most, DEP could have increased their generation to help manage constraints via a sale of power to PJM 6.4 percent of the time in the first three months of 2017, and the maximum redispatch would have been only 129 MW, on average.

A CMA that can only be used in 6.4 percent of all hours is not an effective approach to congestion management. The MMU recommends that PJM immediately provide the required 12-month notice to DEP to unilaterally terminate the Joint Operating Agreement.

PJM and VACAR South Reliability Coordination Agreement[60]

On May 23, 2007, PJM and VACAR South (comprised of Duke Energy Carolinas, LLC (DUK), PEC, South Carolina Public Service Authority (SCPSA), Southeast Power Administration (SEPA), South Carolina Energy and Gas Company (SCE&G) and Yadkin Inc. (a part of Alcoa)) entered into a reliability coordination agreement which provides for system and outage coordination, emergency procedures and the exchange of data. The parties meet on a yearly basis. The agreement remained in effect in the first three months of 2017.

Balancing Authority Operations Coordination Agreement between Wisconsin Electric Power Company (WEC) and PJM Interconnection, LLC[61]

The Balancing Authority Operations Coordination Agreement executed on July 20, 2013, provides for the exchange of information between WEC and PJM. The purpose of the data exchange is to allow for the coordination of balancing authority actions to ensure the reliable operation of the systems. The agreement remained in effect in the first three months of 2017.

60 See "PJM-VACAR South RC Agreement," (November 7, 2014) <http://www.pjm.com/~/media/documents/agreements/executed-pjm-vacar-rc-agreement.ashx>.
61 See "Balancing Authority Operations Coordination Agreement between Wisconsin Electric Power Company and PJM Interconnection, LLC," (July 20, 2013) <http://www.pjm.com/~/media/documents/agreements/balancing-authority-operations-coordination-agreement.ashx>.

Northeastern ISO-Regional Transmission Organization Planning Coordination Protocol[62]

The Northeastern ISO-RTO Planning Coordination Protocol executed on December 8, 2004, provides for the exchange of information among PJM, NYISO and ISO New England. The purpose of the data exchange is to allow for the long-term planning coordination among and between the ISOs and RTOs in the Northeast. The agreement remained in effect in the first three months of 2017.

Interface Pricing Agreements with Individual Balancing Authorities

PJM consolidated the Southeast and Southwest interface pricing points to a single interface with separate import and export prices (SouthIMP and SouthEXP) on October 31, 2006.

The PJM/DEP JOA allows for the PECIMP and PECEXP interface pricing points to be calculated using the Marginal Cost Proxy Pricing method.[63] The DUKIMP, DUKEXP, NCMPAIMP and NCMPAEXP interface pricing points are calculated based on the high-low pricing method as defined in Section 2.6A (1) of the PJM Tariff.

Table 9-36 shows the real-time LMP calculated per the PJM/PEC JOA and the high/low pricing method used by Duke and NCMPA for the first three months of 2017. The values shown in Table 9-36 are the average LMP over only the hours in the first three months of 2017, where interchange transactions settled at those pricing points. The difference between the LMP under these agreements and PJM's SouthIMP LMP ranged from -$0.73 with Duke to -$0.14 with NCMPA.[64] This means that under the specific interface pricing agreements, Duke would receive, on average, $0.27 less for importing energy into PJM than if they were to receive the SouthIMP pricing point. In the first three months of 2017, market participants received $106,941 less for importing energy using these pricing points than they would have if they were to have received the SouthIMP pricing point. The difference between the LMP under these agreements and PJM's SouthEXP LMP ranged from $0.59 with DUKE to $3.18 with PEC. This means that under the specific interface pricing agreements, PEC would pay, on average, $3.18 more for exporting energy from PJM than they would have if they were to pay the SouthEXP pricing point. In the first three months of 2017, market participants paid $155,641 more for exporting energy using these pricing points than they would have if they were to have paid the SouthEXP pricing point.

62 See "Northeastern ISO/RTO Planning Coordination Protocol," (December 8, 2004) <http://www.pjm.com/~/media/documents/agreements/northeastern-iso-rto-planning-coordination-protocol.ashx>.
63 See *PJM Interconnection, L.L.C.*, Docket No. ER10-2710-000 (September 17, 2010).
64 The Progress Energy Carolinas (PEC) LMP is defined as the Carolina Power and Light (East) (CPLE) pricing point.

Table 9-36 Real-time average hourly LMP comparison for Duke, PEC and NCMPA: January 1 through March 31, 2017

	Import LMP	Export LMP	SOUTHIMP	SOUTHEXP	Difference IMP LMP - SOUTHIMP	Difference EXP LMP - SOUTHEXP
Duke	$34.54	$26.20	$35.27	$25.61	($0.73)	$0.59
PEC	$25.84	$38.48	$25.99	$35.30	($0.15)	$3.18
NCMPA	$27.50	NA	$27.63	NA	($0.14)	NA

Table 9-37 shows the day-ahead LMP calculated per the PJM/PEC JOA and the high/low pricing method used by Duke and NCMPA for the first three months of 2017. The values shown in Table 9-37 are the average LMP over only the hours in the first three months of 2017, where interchange transactions settled at those pricing points. The difference between the LMP under these agreements and PJM's SouthIMP LMP ranged from $0.09 with Duke to $0.62 with PEC. This means that under the specific interface pricing agreements, PEC would receive, on average, $0.62 more for importing energy into PJM than if they were to receive the SouthIMP pricing point. In the first three months of 2017, market participants received $71,624 more for importing energy using these pricing points than they would have if they were to have received the SouthIMP pricing point. The difference between the LMP under these agreements and PJM's SouthEXP LMP was $2.86 at the PEC interface (in the first three months of 2017, neither Duke nor NCMPA had day ahead transactions settle at their respective export pricing points). This means that under the specific interface pricing agreements, PEC would pay, on average, $2.86 more for exporting energy from PJM than if they were to pay the SouthEXP pricing point. In the first three months of 2017, market participants paid $95,715 more for exporting energy using these pricing points than they would have if they were to have paid the SouthEXP pricing point.

Table 9-37 Day-ahead average hourly LMP comparison for Duke, PEC and NCMPA: January 1 through March 31, 2017

	Import LMP	Export LMP	SOUTHIMP	SOUTHEXP	Difference IMP LMP - SOUTHIMP	Difference EXP LMP - SOUTHEXP
Duke	$31.37	NA	$31.28	NA	$0.09	NA
PEC	$28.65	$36.32	$28.03	$33.46	$0.62	$2.86
NCMPA	$28.87	NA	$28.74	NA	$0.13	NA

It is not clear that agreements between PJM and neighboring external entities, in which those entities receive some of the benefits of the PJM LMP market without either integrating into an LMP market or applying LMP internally, are in the best interest of PJM's market participants. In the case of the DEP JOA for example, the merger between Progress and Duke has resulted in a single, combined entity where one part of that entity (Duke Energy Progress) is engaged in congestion management with PJM while the other part of the entity (Duke) is not.

Other Agreements with Bordering Areas

Consolidated Edison Company of New York, Inc. (Con Edison) Wheeling Contracts

To help meet the demand for power in New York City, Con Edison uses electricity generated in upstate New York and wheeled through New Jersey on lines controlled by PJM.[65] This wheeled power creates loop flow across the PJM system. The Con Edison contracts governing the New Jersey path evolved during the 1970s and were the subject of a Con Edison complaint to the FERC in 2001.[66]

After years of litigation concerning whether or on what terms Con Edison's protocol would be renewed, PJM filed a settlement on February 23, 2009, on behalf of the parties to resolve remaining issues with these contracts and their proposed rollover of the agreements under the PJM OATT.[67] By order issued September 16, 2010, the Commission approved this settlement, which extends Con Edison's special protocol indefinitely.[68] The Commission approved transmission service agreements that provide for Con Edison to take firm point-to-point service going forward under the PJM OATT. The Commission rejected objections raised first by NRG and FERC trial staff, and later by the MMU, that this arrangement is discriminatory and inconsistent with the Commission's open access transmission policy.[69] The settlement defined Con Edison's cost responsibility for upgrades included in the PJM Regional Transmission Expansion Plan. Con Edison is responsible for required transmission enhancements, and must pay the associated charges during the term of its service, and any subsequent roll over of the service.[70] Con Edison's rolled over service became effective on May 1, 2012. At that time, Con Edison became responsible for the entire 1,000 MW of transmission service and all associated charges and credits.

The Con Edison protocol models a fixed MW level flowing from NYISO to PJM over the JK (Ramapo - Waldwick) interface, and from PJM to NYISO over the ABC (Hudson - Farragut and Linden - Goethals) interface (See Figure 9-12).

On April 28, 2016, Con Edison announced its intent to terminate its 1,000 MW long-term firm point-to-point transmission service, effective May 1, 2017. Upon termination of the transmission reservation, the Con Edison protocol would also be terminated. On October 4, 2016, the NYISO and PJM issued a draft white paper to begin discussions for developing alternative designs for using the ABC and JK interfaces upon expiration of the Con Edison protocol effective May, 1, 2017.[71] The draft white paper proposal includes modifications to the existing PJM-NY AC Proxy Bus definition to include the JK and ABC lines and the inclusion of the JK and ABC lines in the market-to-market PAR coordination process. The proposal also includes provisions for determining

65 See the *2017 Quarterly State of the Market Report for PJM: January through March*, Section 4 – "Energy Market Uplift" for the operating reserve credits paid to maintain the power flow established in the Con Edison wheeling contracts.

66 See the *2012 State of the Market Report for PJM*, Volume II, Section 8, "Interchange Transactions," for a more detailed discussion.

67 See FERC Docket Nos. ER08-858-000, et al. The settling parties are the New York Independent System Operator, Inc. (NYISO), Con Ed, PSE&G, PSE&G Energy Resources & Trading LLC and the New Jersey Board of Public Utilities.

68 132 FERC ¶ 61,221 (2010).

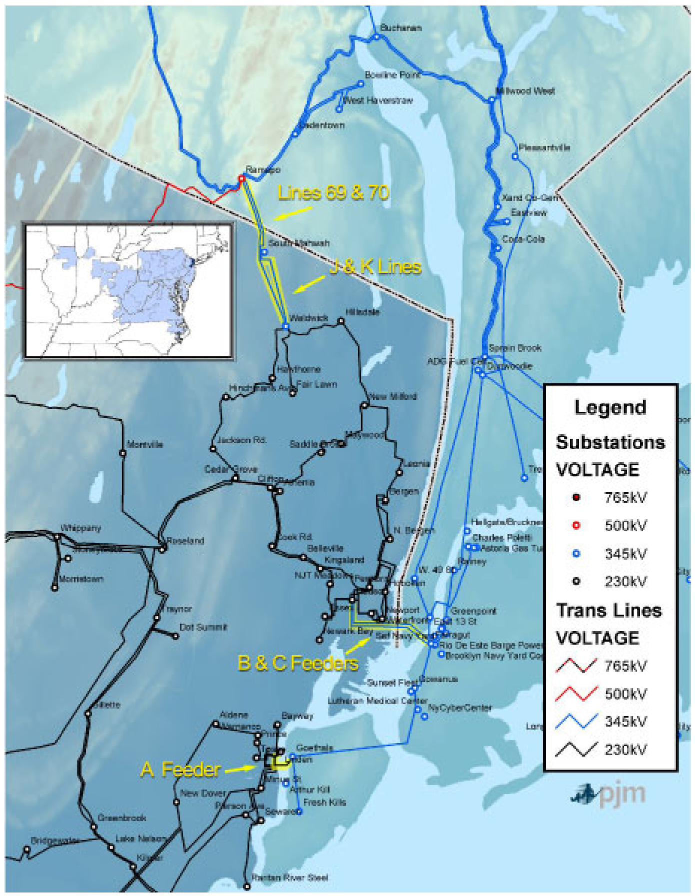
69 *See, e.g.*, Motion to Intervene Out-of-Time and Comments of the Independent Market Monitor for PJM in Docket No. ER08-858-000, et al. (May 11, 2010).

70 The terms of the settlement state that Con Edison shall have no liability for transmission enhancement charges prior to the commencement of, or after the termination of, the term of the rolled over service.

71 See "*Con Ed/PSEG Wheel Replacement Proposal*," (December 19, 2016) which can be accessed at: <http://www.pjm.com/~/media/library/reports-notices/special-reports/20161004-coned-pseg-wheel-replacement-proposal.ashx>.

the target flows over the JK and ABC interfaces. The proposed target flows will be based on a static interchange percentage and will continue to include a percentage of the Rockland Electric Company (RECO) load. Additionally, the PJM and NYISO proposal also includes an operational base flow (OBF) of 400 MW from NYISO to PJM over the JK Interface and 400 MW from PJM to NYISO over the ABC Interface.

Figure 9-12 Con Edison Protocol



Interchange Transaction Issues

PJM Transmission Loading Relief Procedures (TLRs)

TLRs are called to control flows on electrical facilities when economic redispatch cannot solve overloads on those facilities. TLRs are called to control flows related to external balancing authorities, as redispatch within an LMP market can generally resolve overloads on internal transmission facilities.

The number of PJM issued TLRs of level 3a or higher decreased from eight in the first three months of 2016 to three in the first three months of 2017.[72] The number of different flowgates for which PJM declared a TLR 3a or higher was one in the first three months of 2016 and one in the first three months of 2017. The total MWh of transactions curtailed decreased by 94.3 percent from 106,848 MWh in the first three months of 2016 to 6,140 MWh in the first three months of 2017.

The number of MISO issued TLRs of level 3a or higher increased from five in the first three months of 2016 to 18 in the first three months of 2017. The number of different flowgates for which MISO declared a TLR 3a or higher increased from three in the first three months of 2016 to six in the first three months of 2017. The total MWh of transaction curtailments increased by 186.4 percent from 6,556 MWh in the first three months of 2016 to 18,775 MWh in the first three months of 2017.

The number of NYISO issued TLRs of level 3a or higher was zero in the first three months of 2016 and zero in the first three months of 2017. The number of different flowgates for which NYISO declared a TLR 3a or higher was zero in the first three months of 2016 and zero in the first three months of 2017. The total MWh of transaction curtailments was 0 MWh in the first three months of 2016 and 0 MWh in the first three months of 2017.

72 TLR Level 3a is the first level of TLR that results in the curtailment of transactions. See the *2015 State of the Market Report for PJM*, Volume II, Appendix E, "Interchange Transactions," for a more complete discussion of TLR levels.

Table 9-38 PJM MISO, and NYISO TLR procedures: January 1, 2014 through March 31, 2017

	Number of TLRs Level 3 and Higher			Number of Unique Flowgates That Experienced TLRs			Curtailment Volume (MWh)		
Month	PJM	MISO	NYISO	PJM	MISO	NYISO	PJM	MISO	NYISO
Jan-14	3	19	0	3	10	0	1,852	11,683	0
Feb-14	0	29	1	0	10	1	0	33,189	991
Mar-14	0	11	0	0	7	0	0	14,842	0
Apr-14	0	6	0	0	3	0	0	1,233	0
May-14	0	9	0	0	4	0	0	53,153	0
Jun-14	0	19	0	0	7	0	0	24,614	0
Jul-14	1	13	1	1	6	1	317	26,616	0
Aug-14	0	7	0	0	3	0	0	6,319	0
Sep-14	1	11	0	1	4	0	935	87,296	0
Oct-14	1	5	0	1	5	0	1,386	20,581	0
Nov-14	0	10	0	0	6	0	0	23,736	0
Dec-14	2	2	0	2	2	0	1,792	1,264	0
Jan-15	2	8	1	1	4	1	7,293	626	2,261
Feb-15	6	11	2	2	6	1	37,222	9,173	331
Mar-15	8	0	1	3	0	1	14,704	0	435
Apr-15	2	6	0	2	3	0	1,033	23,518	0
May-15	1	8	0	1	2	0	961	12,048	0
Jun-15	1	20	0	1	4	0	205	42,063	0
Jul-15	2	10	0	2	4	0	1,360	9,796	0
Aug-15	0	9	0	0	3	0	0	7,041	0
Sep-15	0	6	0	0	4	0	0	5,789	0
Oct-15	0	4	0	0	4	0	0	4,212	0
Nov-15	0	2	0	0	2	0	0	1,797	0
Dec-15	0	4	0	0	1	0	0	875	0
Jan-16	6	0	0	1	0	0	83,752	0	0
Feb-16	2	0	0	1	0	0	23,096	0	0
Mar-16	0	5	0	0	3	0	0	6,556	0
Apr-16	0	6	0	0	2	0	0	2,034	0
May-16	0	6	0	0	4	0	0	5,360	0
Jun-16	0	5	1	0	2	1	0	18,121	217
Jul-16	0	18	0	0	8	0	0	38,815	0
Aug-16	0	16	0	0	3	0	0	30,181	0
Sep-16	0	8	0	0	4	0	0	19,394	0
Oct-16	0	3	0	0	2	0	0	1,702	0
Nov-16	0	9	0	0	3	0	0	5,622	0
Dec-16	1	1	0	1	1	0	443	0	0
Jan-17	3	1	0	1	1	0	6,140	255	0
Feb-17	0	8	0	0	2	0	0	10,566	0
Mar-17	0	9	0	0	4	0	0	7,954	0

Table 9-39 Number of TLRs by TLR level by reliability coordinator: January 1 through March 31, 2017[73]

Year	Reliability Coordinator	3a	3b	4	5a	5b	6	Total
2017	MISO	11	4	0	3	2	0	20
	NYIS	0	0	0	0	0	0	0
	ONT	0	0	0	0	0	0	0
	PJM	2	1	0	0	0	0	3
	SOCO	0	2	0	0	0	0	2
	SWPP	12	1	0	16	5	0	34
	TVA	3	4	0	1	0	0	8
	VACS	0	1	0	0	0	0	1
Total		28	13	0	20	7	0	68

Up to Congestion

The original purpose of up to congestion transactions (UTC) was to allow market participants to submit a maximum congestion charge, up to $25 per MWh, they were willing to pay on an import, export or wheel through transaction in the Day-Ahead Energy Market. This product was offered as a tool for market participants to limit their congestion exposure on scheduled transactions in the Real-Time Energy Market.[74]

Following the elimination of the requirement to procure and pay for transmission for up to congestion transactions effective September 17, 2010, the volume of transactions increased dramatically.

Up to congestion transactions impact the day-ahead dispatch and unit commitment. Despite that, up to congestion transactions do not pay operating reserves charges. Up to congestion transactions also negatively affect FTR funding.[75]

73 Southern Company Services, Inc. (SOCO) is the reliability coordinator covering a portion of Mississippi, Alabama, Florida and Georgia. Southwest Power Pool (SWPP) is the reliability coordinator for SPP. VACAR-South (VACS) is the reliability coordinator covering a portion of North Carolina and South Carolina.

74 See the *2012 State of the Market Report for PJM*, Volume II, Section 8, "Interchange Transactions," for a more detailed discussion.

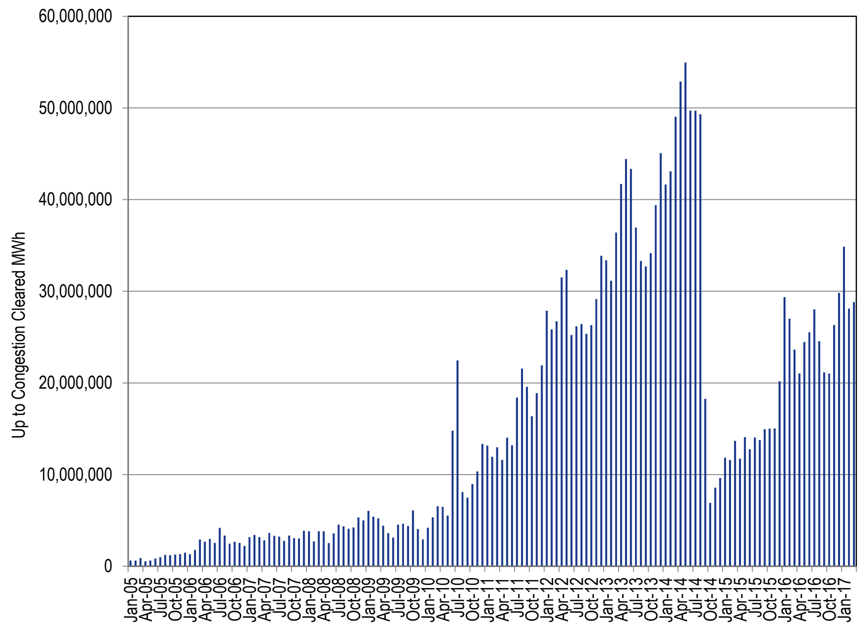
75 See the *2017 Quarterly State of the Market Report for PJM: January through March*, Section 13: FTRs and ARRs, "FTR Forfeitures" for more information on up to congestion transaction impacts on FTRs.

On August 29, 2014, FERC issued an Order which created an obligation for UTCs to pay any uplift determined to be appropriate in the Commission review, effective September 8, 2014.[76]

As a result of the requirement to pay uplift charges and the uncertainty about the level of the required uplift charges, market participants reduced up to congestion trading effective September 8, 2014. There was an increase in up to congestion volume starting in December 2015, coincident with the expiration of the fifteen month limit on the payment of prior uplift charges (Figure 9-13). Section 206(b) of the Federal Power Act states that "…the Commission may order refunds of any amounts paid, for the period subsequent to the refund effective date through a date fifteen months after such refund effective date…"[77]

The average number of up to congestion bids submitted in the Day-Ahead Energy Market increased by 47.7 percent, from 134,610 bids per day in the first three months of 2016 to 198,362 bids per day in the first three months of 2017. The average cleared volume of up to congestion bids submitted in the Day-Ahead Energy Market increased by 16.0 percent, from 879,068 MWh per day in the first three months of 2016, to 1,019,907 MWh per day in the first three months of 2017.

Figure 9-13 Monthly up to congestion cleared bids in MWh: January 1, 2005 through March 31, 2017



76 148 FERC ¶ 61,144 (2014) *Order Instituting Section 206 Proceeding and Establishing Procedures.*
77 16 U.S.C. § 824e.

Table 9-40 Monthly volume of cleared and submitted up to congestion bids: January 1, 2016 through March 31, 2017[78]

	Bid MW					Bid Volume				
Month	Import	Export	Wheel	Internal	Total	Import	Export	Wheel	Internal	Total
Jan-16	11,319,511	7,453,438	1,014,763	80,909,489	100,697,200	477,343	219,598	39,513	3,737,937	4,474,391
Feb-16	12,155,175	7,740,113	1,363,163	85,132,591	106,391,042	422,382	228,823	42,609	3,306,154	3,999,968
Mar-16	11,714,639	7,934,801	1,415,976	88,260,658	109,326,075	382,177	225,473	36,332	3,131,152	3,775,134
Apr-16	9,823,079	6,559,076	1,305,759	74,723,429	92,411,342	397,591	189,981	29,138	3,760,097	4,376,807
May-16	9,513,613	6,823,576	1,095,593	71,945,618	89,378,399	404,406	207,483	32,187	3,824,204	4,468,280
Jun-16	10,535,566	7,229,295	934,909	90,318,486	109,018,256	393,040	205,237	34,318	3,980,024	4,612,619
Jul-16	11,954,606	10,034,200	1,573,690	111,637,376	135,199,873	432,142	273,349	36,430	4,583,276	5,325,197
Aug-16	11,435,407	7,826,884	1,203,704	89,117,338	109,583,333	396,134	258,077	33,330	4,352,104	5,039,645
Sep-16	8,865,500	7,188,474	793,894	76,390,509	93,238,378	286,637	236,555	29,616	3,813,679	4,366,487
Oct-16	7,621,317	6,486,553	725,041	75,471,554	90,304,464	292,479	268,611	35,720	4,237,454	4,834,264
Nov-16	9,347,175	7,739,170	1,092,482	83,836,320	102,015,146	361,868	273,254	32,322	4,613,501	5,280,945
Dec-16	9,648,240	7,976,967	856,973	91,141,019	109,623,199	446,573	295,302	29,569	5,778,358	6,549,802
Jan-17	12,071,248	10,779,934	1,022,748	122,301,537	146,175,467	503,193	359,899	34,470	6,725,774	7,623,336
Feb-17	11,420,648	8,942,116	608,065	118,800,901	139,771,730	394,062	268,571	27,086	4,894,155	5,583,874
Mar-17	9,158,336	9,968,026	595,492	102,176,604	121,898,458	284,402	289,574	24,835	4,046,536	4,645,347
TOTAL	1,375,677,548	1,295,966,571	87,491,578	4,449,029,780	7,208,165,476	36,161,249	30,218,015	2,341,487	173,529,731	242,250,482

	Cleared MW					Cleared Volume				
Month	Import	Export	Wheel	Internal	Total	Import	Export	Wheel	Internal	Total
Jan-16	2,944,505	2,026,327	274,430	24,103,637	29,348,899	170,082	69,173	10,390	1,577,269	1,826,914
Feb-16	2,719,184	2,001,418	244,646	22,049,244	27,014,492	126,889	67,289	9,850	1,251,383	1,455,411
Mar-16	2,370,270	2,001,360	198,400	19,061,805	23,631,834	105,098	65,977	8,070	1,085,479	1,264,624
Apr-16	2,348,160	1,264,954	204,465	17,214,976	21,032,555	140,346	48,085	7,067	1,740,662	1,936,160
May-16	2,209,309	1,882,586	235,696	20,137,089	24,464,680	156,256	64,333	6,665	1,987,586	2,214,840
Jun-16	2,178,050	1,871,788	153,654	21,334,532	25,538,023	128,728	62,438	6,906	1,621,997	1,820,069
Jul-16	2,335,606	2,109,811	237,917	23,341,287	28,024,621	120,775	79,269	7,902	1,587,513	1,795,459
Aug-16	1,914,794	2,139,929	183,616	20,303,066	24,541,404	91,351	85,598	7,902	1,522,203	1,707,054
Sep-16	1,706,788	1,572,221	150,834	17,714,998	21,144,842	76,662	74,123	8,808	1,502,828	1,662,421
Oct-16	1,387,294	1,065,855	133,639	18,431,481	21,018,269	84,852	78,316	10,892	1,768,967	1,943,027
Nov-16	2,772,101	1,323,987	292,429	21,932,490	26,321,007	142,207	69,987	8,539	1,889,760	2,110,493
Dec-16	2,904,123	1,857,750	182,373	24,882,966	29,827,212	163,420	96,565	6,814	2,375,795	2,642,594
Jan-17	3,478,967	2,446,235	235,641	28,699,881	34,860,725	153,756	106,883	6,710	2,387,196	2,654,545
Feb-17	2,020,772	1,860,138	88,621	24,147,889	28,117,419	91,586	76,129	5,506	1,648,658	1,821,879
Mar-17	2,106,568	1,736,786	147,294	24,822,836	28,813,485	87,599	86,494	5,157	1,509,134	1,688,384
TOTAL	455,646,130	431,550,243	28,455,700	1,230,778,005	2,146,430,078	13,654,476	11,419,446	792,352	63,797,543	89,663,817

78 See the *2016 State of the Market Report for PJM*, Volume II, Appendix E, "Interchange Transactions," for the monthly volume of cleared and submitted up to congestion bids: 2009 through 2016.

In the first three months of 2017, the cleared MW volume of up to congestion transactions was comprised of 8.3 percent imports, 6.6 percent exports, 0.5 percent wheeling transactions and 84.6 percent internal transactions. Less than 0.1 percent of the up to congestion transactions had matching real-time energy market transactions.

Up to Congestion Credit Risk

On August 29, 2014, FERC issued an order which created an obligation for up to congestion transactions (UTCs) to pay any uplift determined to be appropriate after Commission review, effective from September 8, 2014.[79] As of March 1, 2017, the Commission has not ruled on whether up to congestion transactions will be charged for uplift accrued during this time. On January 19, 2017, a notice of proposed rulemaking was issued to address UTC uplift for all RTOs/ISOs.[80] The outcome of the investigation in PJM will be held in abeyance pending the outcome of the NOPR proceeding.[81]

During the 15 month refund period of September 8, 2014, through December 7, 2015, 185,303,891 MWh of up to congestion transactions cleared the Day-Ahead Market and are subject to potential uplift charges for that period. Based on the volume of cleared up to congestion transactions and the potential uplift obligation on a per MWh basis, the obligation to pay is estimated to be between $18.5 million and $370.6 million. As potential obligations, this exposure creates a credit risk for those UTC traders who engaged in UTC transactions during this period. Table 9-41 shows the levels of credit risk associated with the cleared up to congestion transactions, depending on the uplift charge that may be imposed on these transactions.

79 148 FERC ¶ 61,144 (2014) *Order Instituting Section 206 Proceeding and Establishing Procedures.*
80 *Uplift Cost Allocation and Transparency in Markets Operated by Regional Transmission Organizations and Independent System Operators*, 158 FERC ¶ 61,047.
81 158 FERC ¶ 61,038 at P 3 (January 19, 2017).

Table 9-41 Credit risk associated with varying levels of potential uplift: September 8, 2014 through December 7, 2015

Uplift ($/MWh)	Credit risk if uplift is applied to both sides of UTC
$0.05	$18,530,389
$0.10	$37,060,778
$0.15	$55,591,167
$0.20	$74,121,556
$0.25	$92,651,945
$0.30	$111,182,334
$0.35	$129,712,724
$0.40	$148,243,113
$0.45	$166,773,502
$0.50	$185,303,891
$0.55	$203,834,280
$0.60	$222,364,669
$0.65	$240,895,058
$0.70	$259,425,447
$0.75	$277,955,836
$0.80	$296,486,225
$0.85	$315,016,614
$0.90	$333,547,003
$0.95	$352,077,393
$1.00	$370,607,782

PJM market participants that cleared UTCs during the specified refund period of September 8, 2014 through December 7, 2015, would be responsible to pay uplift based on their cleared up to congestion volume and the uplift charge if FERC orders that UTCs pay such uplift charges. Analysis of the cleared up to congestion transactions during the refund period of September 8, 2014, through December 7, 2015, showed that the top 10 market participants would be responsible for 53.7 percent of the uplift.

The credit risk exposure to companies that traded UTCs during this period is substantial, including the possible bankruptcy of one or more companies if FERC orders that UTCs pay such uplift charges. The actual risk depends in significant part on how the companies have managed their potential exposure as they continued to trade UTCs with knowledge of the risks. These companies do not appear to have informed PJM of how or if they have managed this exposure.

The total uplift amount has already been paid by other PJM members. Thus, the risk to other PJM members has been realized. The risk that UTC traders will not be able to cover their credit exposure otherwise related to their trading activity is addressed by existing PJM credit policies. If a UTC trader went into bankruptcy as a result of the uplift risk, the exposure to other PJM members is that they will not be repaid the level of uplift that should have been paid by UTC transactions.

Absent further Commission action, the increase in UTC uplift payment risk appears to have ended as a result of the expiration of the fifteen month limit on the payment of prior uplift charges.[82]

Attachment Q: PJM Credit Policy of the PJM Open Access Transmission Tariff provides that:

> Each Participant is also required to provide with its application information as to any known Material litigation, commitments or contingencies as well as any prior bankruptcy declarations or Material defalcations by the Participant or its predecessors, subsidiaries or Affiliates, if any. These disclosures shall be made upon application, upon initiation or change, and at least annually thereafter, or as requested by PJMSettlement.[83]

The MMU recommends that PJMSettlement Inc. immediately request a credit evaluation from all companies that engaged in up to congestion transactions during the refund period of September 8, 2014, through December 7, 2015. To the full extent of its authority, PJM should ensure that the potential exposure to uplift for that period be included as a contingency in the companies' calculations for credit levels and/or collateral requirements. PJM should also calculate the UTC uplift charge contingency in a manner appropriate for the evaluation of any contingency. By definition, assessing a contingency requires a reasonable exercise of discretion. PJM should develop a reasonable assessment of the risk associated with the UTC uplift allocation and the appropriate approach to managing this risk. Zero risk is not within a reasonable range. The MMU recognizes that the exact amount of the exposure is not known. If PJM does not have the authority to take such steps, PJM should request guidance from FERC.

82 16 U.S.C. § 824e.
83 See OATT Attachment Q § I.A.4.

Sham Scheduling

Sham scheduling refers to a scheduling method under which a market participant breaks a single transaction, from generation balancing authority (source) to load balancing authority (sink), into multiple segments. Sham scheduling can also be achieved by submitting a transaction that is in the opposite direction of a portion of a larger transaction schedule. Sham scheduling hides the actual source of generation from the load balancing authority. When unable to identify the source of the energy, the load balancing authority cannot see how the power will flow to the load, which can create loop flows and result in inaccurate pricing for transactions.

For example, if the generation balancing authority (source) is NYISO, and the load balancing authority (sink) is PJM, the transaction would be priced, in the PJM energy market, at the PJM/NYIS Interface regardless of the submitted path. However, if a market participant were to break the transaction into multiple segments, one on the NYIS-ONT path, and a second segment on the ONT-MISO-PJM path, the market participant would conceal the true source (NYISO) from PJM, and PJM would price the transaction as if its source were Ontario (the ONT interface price).

For example, market participants can submit one transaction with multiple segments among balancing authorities and another transaction which offsets all or part of a segment of the first transaction. If a market participant submits two separate transactions, one on the ONT-MISO-PJM path, and a second on the PJM-MISO path, the result of these transactions would be a net scheduled transaction from ONT to MISO, as the MISO-PJM segment of the first transaction is offset by the PJM-MISO transaction. In this example, PJM is not required to raise or lower generation as a result of these transactions, as they would for an import or an export, and there are no associated power flows across PJM. Nonetheless, the market participant is paid the price difference between the PJM/ONT interface pricing point and the PJM/MISO Interface pricing point. The market participant would be paid the PJM/ONT interface pricing point for the first transaction (ONT to PJM import) and the market participant would pay the PJM/MISO interface pricing point for the second transaction (PJM to MISO export). If the PJM/ONT interface price were higher than the PJM/MISO interface price, the market participant would be paid a net profit from the PJM market even though there was no impact on PJM operations.

The MMU recommends that PJM implement rules to prevent sham scheduling. The MMU recommends that PJM apply after the fact market settlement adjustments to identified sham scheduling segments to ensure that market participants cannot benefit from sham scheduling.

Elimination of Ontario Interface Pricing Point

The PJM/IMO interface pricing point (Ontario) was created to reflect the fact that transactions that originate or sink in the IESO balancing authority create actual energy flows that are split between the MISO and NYISO interface pricing points. PJM created the PJM/IMO interface pricing point to reflect the actual power flows across both the MISO/PJM and NYISO/PJM interfaces. The IMO does not have physical ties with PJM because it is not contiguous.

Prior to June 1, 2015, the PJM/IMO interface pricing point was defined as the LMP at the IESO Bruce bus. The LMP at the Bruce bus includes a congestion and loss component across the MISO and NYISO balancing authorities.

The noncontiguous nature of the PJM/IMO interface pricing point creates opportunities for market participants to engage in sham scheduling activities. For example, a market participant can use two separate transactions to create a flow from Ontario to MISO. In this example, the market participant uses the PJM energy market as a temporary generation and load point by first submitting a wheeling transaction from Ontario, through MISO and into PJM, then by submitting a second transaction from PJM to MISO. These two transactions, combined, create an actual flow along the Ontario/MISO Interface. Through sham scheduling, the market participant receives settlements from PJM when no changes in generation occur. This activity is similar to that observed when PJM had a Southwest and Southeast interface pricing point. During that time, market participants would use the PJM spot market as a temporary load and generation point to wheel transactions through the PJM energy market. This was done to take advantage of the price differences between the interfaces without providing the market benefits of congestion relief.

A new PJM/IMO interface price method was implemented on June 1, 2015. The new method uses a dynamic weighting of the PJM/MISO interface price and the PJM/NYIS interface price, based on the performance of the Michigan-Ontario PARs. When the absolute value of the actual flows on the PARs are greater than or equal to the absolute value of the scheduled flows on the PARs, and the scheduled and actual flows are in the same direction, the PJM/IMO interface price will be equal to the PJM/MISO interface price (i.e. 100 percent weighting on the PJM/MISO interface). When actual flows on the PARs are in the opposite direction of the scheduled flows on the PARs, the PJM/IMO interface price will be equal to the PJM/NYIS interface price (i.e. 100 percent weighting on the PJM/NYIS interface). When the absolute value of the actual flows on the PARs are less than or equal to the absolute value of the scheduled flows on the PARs, and the scheduled and actual flows are in the same direction, the PJM/IMO interface price will be a combination to the PJM/MISO interface price and the PJM/NYIS interface price. In this case the weightings of the PJM/MISO and PJM/NYIS interface prices are determined based on the scheduled and actual flows. For example, in a given interval, the scheduled flow on the Michigan-Ontario PARs is 1,000 MW, and the actual flow is 800 MW. If in that same interval, the PJM/MISO interface price is $45.00 and the PJM/NYIS interface price $30.00, the PJM/IMO interface price would be calculated with a weighting of 80 percent of the PJM/MISO interface price ($45.00 * 0.8, or $36.00) and 20 percent of the PJM/NYIS interface price ($30.00 * 0.2, or $6.00), for a PJM/IMO interface price of $42.00.[84]

The MMU believes that the new PJM/IMO interface price method is a step in the right direction towards pricing energy that sources or sinks in Ontario based on the path of the actual, physical transfer of energy. The MMU remains concerned about the assumption of PAR operations, and will continue to evaluate the impact of PARs on the scheduled and actual flows and the

84 See "IMO Interface Definition Methodology Report," presented to the MIC (February 11, 2015) <http://www.pjm.com/~/media/committees-groups/committees/mic/20150211/20150211-item-08b-imo-interface-definition-methodology-report.ashx>.

impacts on the PJM/IMO interface price. The MMU remains concerned about the potential for market participants to continue to engage in sham scheduling activities after the new method is implemented.

The MMU recommends that if the PJM/IMO interface price remains and with PJM's new method in place, that PJM implement additional business rules to remove the incentive to engage in sham scheduling activities using the PJM/IMO interface price. Such rules would prohibit the same market participant from scheduling an export transaction from PJM to any balancing authority while at the same time an import transaction is scheduled to PJM that receives the PJM/IMO interface price. PJM should also prohibit the same market participant from scheduling an import transaction to PJM from any balancing authority while at the same time an export transaction is scheduled from PJM that receives the PJM/IMO interface price.

In the first three months of 2017, of the 581 GWh of the gross scheduled transactions between PJM and IESO, 579 GWh (99.7 percent) wheeled through MISO (see Table 9-23). The MMU recommends that PJM eliminate the PJM/IMO interface pricing point, and assign the transactions that originate or sink in the IESO balancing authority to the PJM/MISO interface pricing point.[85]

PJM and NYISO Coordinated Interchange Transactions

Coordinated transaction scheduling (CTS) provides the option for market participants to submit intra-hour transactions between the NYISO and PJM that include an interface spread bid on which transactions are evaluated.[86] The evaluation is based on the forward-looking prices as determined by PJM's intermediate term security constrained economic dispatch tool (ITSCED) and the NYISO's real-time commitment (RTC) tool. PJM shares its PJM/NYISO interface price ITSCED results with the NYISO. The NYISO compares the PJM/NYISO interface price with its RTC calculated NYISO/PJM interface price. If the PJM and NYISO interface price spread is greater than the market participant's CTS bid, the transaction is approved. If the PJM and NYISO interface price spread is less than the CTS bid, the transaction is denied.

85 On October 1, 2013, a sub-group of PJM's Market Implementation Committee started stakeholder discussions to address this inconsistency in market pricing.

86 PJM and the NYISO implemented CTS on November 4, 2014. 146 FERC ¶ 61,096 (2014).

The ITSCED application runs approximately every five minutes and each run produces forecast LMPs for the intervals approximately 30 minutes, 45 minutes, 90 minutes and 135 minutes ahead. Therefore, for each 15 minute interval, the various ITSCED solutions will produce 12 forecasted PJM/NYIS interface prices. To evaluate the accuracy of ITSCED forecasts, the forecasted PJM/NYIS interface price for each 15 minute interval from ITSCED was compared to the actual real-time interface LMP for the first three months of 2017. Table 9-42 shows that over all 12 forecast ranges, ITSCED predicted the real-time PJM/NYIS interface LMP within the range of $0.00 to $5.00 in 40.6 percent of the intervals. In those intervals, the average price difference between the ITSCED forecasted LMP and the actual real-time LMP was $1.39 per MWh. In 4.9 percent of all intervals, the absolute value of the average price difference between the ITSCED forecasted LMP and the actual real-time interface LMP was greater than $20.00. The average price differences were $56.19 when the price difference was greater than $20.00, and $58.35 when the price difference was greater than -$20.00.

Table 9-42 Differences between forecast and actual PJM/NYIS interface prices: January 1 through March 31, 2017

Range of Price Differences	Percent of All Intervals	Average Price Difference
> $20	1.7%	$56.19
$10 to $20	2.6%	$13.67
$5 to $10	5.2%	$7.04
$0 to $5	40.6%	$1.39
$0 to -$5	39.4%	$1.39
-$5 to -$10	4.7%	$7.03
-$10 to -$20	2.6%	$14.02
< -$20	3.2%	$58.35

Table 9-43 shows how the accuracy of the ITSCED forecasted LMPs changes as the cases approach real-time. In the final ITSCED results prior to real time, in 76.4 percent of all intervals, the average price difference between the ITSCED forecasted LMP and the actual real-time interface LMP fell within +/- $5.00 of the actual PJM/NYIS interface real-time LMP, compared to 78.5 percent in the 135 minute ahead ITSCED results.

Table 9-43 Differences between forecast and actual PJM/NYIS interface prices: January 1 through March 31, 2017

	~ 135 Minutes Prior to Real-Time		~ 90 Minutes Prior to Real-Time		~ 45 Minutes Prior to Real-Time		~ 30 Minutes Prior to Real-Time	
Range of Price Differences	Percent of Intervals	Average Price Difference	Percent of Intervals	Average Price Difference	Percent of Intervals	Average Price Difference	Percent of Intervals	Average Price Difference
> $20	1.3%	$64.47	0.7%	$87.36	0.9%	$89.57	3.6%	$63.52
$10 to $20	2.4%	$13.64	2.0%	$13.21	2.2%	$13.66	3.5%	$13.81
$5 to $10	5.1%	$7.19	4.7%	$6.92	5.0%	$7.01	6.1%	$7.00
$0 to $5	35.4%	$1.51	40.3%	$1.41	45.0%	$1.30	46.4%	$1.33
$0 to -$5	43.1%	$1.57	40.7%	$1.42	37.1%	$1.26	33.0%	$1.22
-$5 to -$10	6.0%	$7.09	5.4%	$6.99	4.4%	$6.96	2.9%	$6.93
-$10 to -$20	3.1%	$13.88	2.8%	$13.99	2.2%	$13.91	1.9%	$14.21
< -$20	3.5%	$57.23	3.4%	$58.71	3.3%	$58.05	2.6%	$56.19

In 6.2 percent of the intervals in the thirty-minute ahead forecast, the absolute value of the average price difference between the ITSCED forecasted LMP and the actual real-time interface LMP was greater than $20.00, the average price difference was $63.52 when the price difference was greater than $20.00, and $56.19 when the price difference was greater than -$20.00.

Table 9-44 and Table 9-45 show the monthly differences between forecasted and actual PJM/NYIS interface prices. Analysis of the data on a monthly basis shows that there is a decline in the accuracy of the ITSCED forecast ability during periods of cold and hot weather.

Table 9-44 Monthly Differences between forecast and actual PJM/NYIS interface prices (percent of intervals): January 1 through March 31, 2017

Interval	Range of Price Differences	Jan	Feb	Mar	YTD Avg
~ 30 Minutes Prior to Real-Time	> $20	4.8%	1.3%	4.6%	3.6%
	$10 to $20	3.6%	1.2%	5.4%	3.5%
	$5 to $10	5.5%	4.1%	8.6%	6.1%
	$0 to $5	47.8%	50.6%	41.1%	46.4%
	$0 to -$5	31.0%	37.2%	31.2%	33.0%
	-$5 to -$10	3.1%	2.9%	2.7%	2.9%
	-$10 to -$20	1.3%	1.5%	2.8%	1.9%
	< -$20	3.1%	1.2%	3.5%	2.6%
Interval	Range of Price Differences	Jan	Feb	Mar	YTD Avg
~ 45 Minutes Prior to Real-Time	> $20	1.4%	0.1%	1.1%	0.9%
	$10 to $20	2.9%	0.7%	2.8%	2.2%
	$5 to $10	4.6%	2.7%	7.5%	5.0%
	$0 to $5	44.7%	48.3%	42.3%	45.0%
	$0 to -$5	36.8%	41.4%	33.4%	37.1%
	-$5 to -$10	4.3%	3.5%	5.3%	4.4%
	-$10 to -$20	1.6%	1.7%	3.2%	2.2%
	< -$20	3.7%	1.6%	4.5%	3.3%
Interval	Range of Price Differences	Jan	Feb	Mar	YTD Avg
~ 90 Minutes Prior to Real-Time	> $20	1.1%	0.0%	0.8%	0.7%
	$10 to $20	2.2%	0.8%	3.0%	2.0%
	$5 to $10	3.2%	3.1%	7.7%	4.7%
	$0 to $5	37.8%	43.7%	39.7%	40.3%
	$0 to -$5	44.1%	43.8%	34.5%	40.7%
	-$5 to -$10	4.9%	4.8%	6.4%	5.4%
	-$10 to -$20	2.8%	2.2%	3.3%	2.8%
	< -$20	3.9%	1.6%	4.7%	3.4%
Interval	Range of Price Differences	Jan	Feb	Mar	YTD Avg
~ 135 Minutes Prior to Real-Time	> $20	1.5%	0.2%	2.0%	1.3%
	$10 to $20	1.6%	1.3%	4.2%	2.4%
	$5 to $10	4.4%	3.9%	6.9%	5.1%
	$0 to $5	33.3%	40.6%	32.8%	35.4%
	$0 to -$5	46.9%	45.3%	37.4%	43.1%
	-$5 to -$10	5.2%	4.6%	8.1%	6.0%
	-$10 to -$20	3.2%	2.3%	3.8%	3.1%
	< -$20	3.9%	1.7%	4.7%	3.5%

The NYISO uses PJM's ITSCED forecasted LMPs to compare against the NYISO Real-Time Commitment (RTC) results in its evaluation of CTS transactions. The NYISO approves CTS (spread bid) transactions when the offered spread is less than or equal to the spread between the ITSCED forecast PJM/NYIS interface LMP and the NYISO RTC forecast NYIS/PJM interface LMP. The large differences between forecast and actual LMPs in the intervals closest to real-time could cause CTS transactions to be approved that would contribute to transactions being scheduled counter to real-time economic signals, and contribute to inefficient scheduling across the PJM/NYIS border.

CTS transactions are evaluated based on the spread bid, which limits the amount of price convergence that can occur. As long as balancing operating reserve charges are applied and CTS transactions are optional, the CTS proposal represents a small incremental step toward better interface pricing. The 75 minute time lag associated with scheduling energy transactions in the NYISO should be shortened. Reducing this time lag could significantly improve pricing efficiency at the PJM/NYISO border for non-CTS transactions and for CTS transactions.

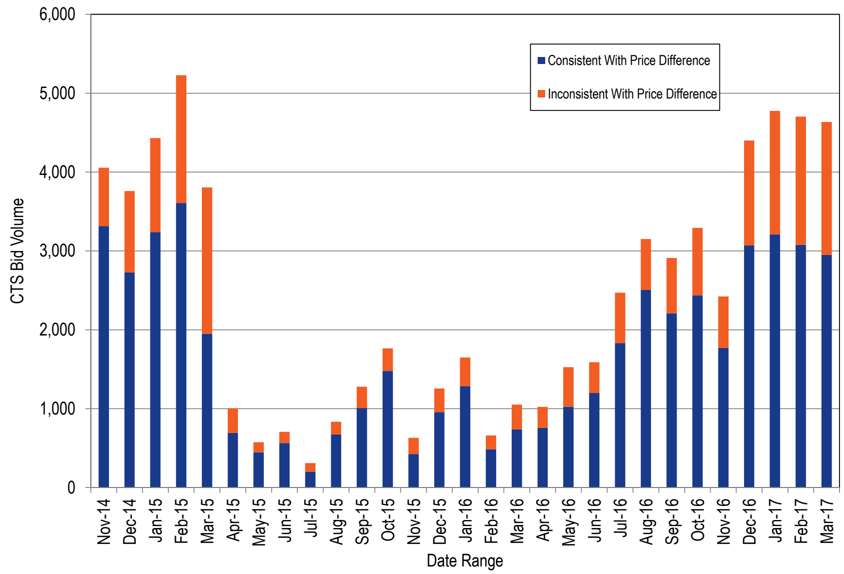
CTS transactions were evaluated for each 15 minute interval. From November 4, 2014, through March 31, 2017, 69,896 15 minute CTS schedules were approved through the CTS process based on the forecast LMPs. When the forecast LMPs for the approved intervals were compared to the hourly integrated real-time LMPs, the direction of the flow in 20,078 (28.7 percent) of the intervals was inconsistent with the differences in real-time PJM/NYISO and NYISO/PJM prices. For example, if a market participant submits a CTS transaction from NYISO to PJM with a spread bid of $5.00, and NYISO's forecasted PJM interface price was at least $5.00 lower than PJM's forecasted NYISO interface price, the transaction would be approved. For 28.7 percent of the approved transactions, the actual, real-time price differentials were in the opposite direction of the forecast differential. The actual, real-time price differentials meant that the transactions would have been economic in the opposite direction. For 71.3 percent of the intervals, the forecast price differentials were consistent with real-time PJM/NYISO and NYISO/PJM price differences. Figure 9-14 shows the monthly volume of cleared PJM/NYIS CTS

Table 9-45 Monthly differences between forecast and actual PJM/NYIS interface prices (average price difference): January 1 through March 31, 2017

Interval	Range of Price Differences	Jan	Feb	Mar	YTD Avg
~ 30 Minutes Prior to Real-Time	> $20	$63.36	$38.03	$70.05	$63.52
	$10 to $20	$13.96	$12.85	$13.90	$13.81
	$5 to $10	$6.99	$7.03	$7.01	$7.00
	$0 to $5	$1.20	$1.24	$1.58	$1.33
	$0 to -$5	$1.07	$1.12	$1.48	$1.22
	-$5 to -$10	$6.92	$7.14	$6.72	$6.93
	-$10 to -$20	$13.76	$13.84	$14.60	$14.21
	< -$20	$48.79	$61.42	$61.04	$56.19
Interval	Range of Price Differences	Jan	Feb	Mar	YTD Avg
~ 45 Minutes Prior to Real-Time	> $20	$129.62	$27.09	$39.66	$89.57
	$10 to $20	$13.93	$13.48	$13.42	$13.66
	$5 to $10	$6.94	$6.85	$7.11	$7.01
	$0 to $5	$1.16	$1.22	$1.54	$1.30
	$0 to -$5	$1.09	$1.21	$1.49	$1.26
	-$5 to -$10	$7.05	$7.01	$6.87	$6.96
	-$10 to -$20	$13.89	$13.71	$14.01	$13.91
	< -$20	$55.02	$54.95	$61.58	$58.05
Interval	Range of Price Differences	Jan	Feb	Mar	YTD Avg
~ 90 Minutes Prior to Real-Time	> $20	$119.08	$33.83	$42.81	$87.36
	$10 to $20	$12.58	$13.63	$13.59	$13.21
	$5 to $10	$7.00	$6.54	$7.03	$6.92
	$0 to $5	$1.26	$1.35	$1.61	$1.41
	$0 to -$5	$1.30	$1.39	$1.61	$1.42
	-$5 to -$10	$6.98	$7.01	$6.99	$6.99
	-$10 to -$20	$14.12	$13.90	$13.95	$13.99
	< -$20	$56.42	$59.93	$60.23	$58.71
Interval	Range of Price Differences	Jan	Feb	Mar	YTD Avg
~ 135 Minutes Prior to Real-Time	> $20	$106.59	$28.28	$34.69	$64.47
	$10 to $20	$14.50	$12.23	$13.70	$13.64
	$5 to $10	$7.33	$7.14	$7.12	$7.19
	$0 to $5	$1.31	$1.47	$1.75	$1.51
	$0 to -$5	$1.45	$1.56	$1.72	$1.57
	-$5 to -$10	$7.06	$7.18	$7.08	$7.09
	-$10 to -$20	$14.00	$13.85	$13.79	$13.88
	< -$20	$56.09	$54.70	$58.99	$57.23

bids. Figure 9-14 also shows the percent of cleared bids that resulted in flows consistent and inconsistent with price differences.

Figure 9-14 Monthly cleared PJM/NYIS CTS bid volume: November 1, 2014 through March 31, 2017



The data reviewed show that ITSCED is not a highly accurate predictor of the real-time PJM/NYIS interface prices. If this remains true, it will limit the effectiveness of CTS in improving interface pricing between PJM and NYISO.

Reserving Ramp on the PJM/NYISO Interface

Prior to the implementation of CTS, PJM held ramp space for all transactions submitted between PJM and the NYISO as soon as the NERC Tag was approved. At that time, once transactions were evaluated by the NYISO through their real-time market clearing process, any adjustments made to the submitted transactions would be reflected on the NERC Tags and the PJM ramp was adjusted accordingly.

As part of this process, PJM was often required to make adjustments to transactions on its other interfaces in order to bring total system ramp back to within its limit. The default ramp limit in PJM is +/- 1,000 MW. For example, the ramp in a given interval is currently -1,000 MW, consisting of 2,000 MW of imports from the NYISO to PJM and 3,000 MW of exports from PJM on its other interfaces. If, through the NYISO real-time market clearing process, the NYISO only approves 1,000 MW of the imports, the other 1,000 MW of import transactions from the NYISO would be curtailed. The ramp in this interval would then be -2,000 MW, consisting of the 1,000 MW of cleared imports from the NYISO to PJM and 3,000 MW of exports from PJM on its other interfaces. PJM would then be required to curtail an additional 1,000 MW of exports at its other interface to bring the limit back to within +/- 1,000. These curtailments were made on a last in first out basis as determined by the timestamp on the NERC Tag.

With the implementation of the CTS product with the NYISO, PJM modified how ramp is handled at the PJM/NYISO Interface. Effective November 4, 2014, PJM no longer holds ramp room for any transactions submitted between PJM and the NYISO at the time of submission. Only after the NYISO completes its real-time market clearing process, and communicates the results to PJM, does PJM perform a ramp evaluation on transactions scheduled with the NYISO. If, in the event the NYISO market clearing process would violate ramp, PJM would make additional adjustments based on a last-in first-out basis as determined by the timestamp on the NERC Tag. This process prevents the transactions scheduled at the PJM/NYISO interface from holding (or creating) ramp until NYISO has completed its economic evaluation and the transactions are approved through the NYISO market clearing process.

PJM and MISO Coordinated Interchange Transaction Proposal

PJM and MISO have proposed the implementation of coordinated interchange transactions, similar to the PJM/NYISO approach, through the Joint and Common Market Initiative. While the mechanics of transaction evaluation have yet to be determined, the coordinated transaction scheduling (CTS) proposal would provide the option for market participants to submit intra-hour transactions between the MISO and PJM that include an interface spread bid on which transactions are evaluated. Similar to the PJM/NYISO approach, the evaluation would be based, in part, on the forward-looking prices as determined by PJM's intermediate term security constrained economic dispatch tool (ITSCED). Unlike the PJM/NYISO CTS process in which the NYISO performs the evaluation, the PJM/MISO CTS process will use a joint clearing process in which both RTOs will share forward looking prices. MISO does not currently have an application comparable to PJM's ITSCED to provide forward-looking prices but is developing a tool.

To evaluate the accuracy of ITSCED forecasts, the forecasted PJM/MISO interface price for each 15 minute interval from ITSCED was compared to the actual real-time interface LMP for the first three months of 2017. Table 9-46 shows that over all 12 forecast ranges, ITSCED predicted the real-time PJM/MISO interface LMP within the range of $0.00 to $5.00 in 40.3 percent of all intervals. In those intervals, the average price difference between the ITSCED forecasted LMP and the actual real-time LMP was $1.31. In 4.8 percent of all intervals, the absolute value of the average price difference between the ITSCED forecasted LMP and the actual real-time interface LMP was greater than $20.00. The average price differences were $43.54 when the price difference was greater than $20.00, and $53.55 when the price difference was greater than -$20.00.

Table 9-46 Differences between forecast and actual PJM/MISO interface prices: January 1 through March 31, 2017

Range of Price Differences	Percent of All Intervals	Average Price Difference
> $20	2.0%	$43.54
$10 to $20	3.1%	$13.76
$5 to $10	6.1%	$7.03
$0 to $5	40.3%	$1.31
$0 to -$5	39.5%	$1.28
-$5 to -$10	4.2%	$6.94
-$10 to -$20	2.0%	$13.93
< -$20	2.8%	$53.55

Table 9-47 shows how the accuracy of the ITSCED forecasted LMPs change as the cases approach real-time. In the final ITSCED results prior to real time, in 78.8 percent of all intervals, the average price difference between the ITSCED forecasted LMP and the actual real-time interface LMP fell within +/- $5.00 of the actual PJM/MISO interface real-time LMP, compared to 78.6 percent in the 135 minute ahead ITSCED results.

Table 9-47 Differences between forecast and actual PJM/MISO interface prices: January 1 through March 31, 2017

	~ 135 Minutes Prior to Real-Time		~ 90 Minutes Prior to Real-Time		~ 45 Minutes Prior to Real-Time		~ 30 Minutes Prior to Real-Time	
Range of Price Differences	Percent of Intervals	Average Price Difference	Percent of Intervals	Average Price Difference	Percent of Intervals	Average Price Difference	Percent of Intervals	Average Price Difference
> $20	1.5%	$34.29	1.2%	$37.16	0.9%	$40.35	3.5%	$50.52
$10 to $20	3.6%	$13.77	2.7%	$13.52	2.5%	$13.63	3.6%	$14.10
$5 to $10	5.8%	$7.19	5.7%	$6.92	5.9%	$6.94	6.7%	$7.05
$0 to $5	32.4%	$1.37	41.8%	$1.32	45.6%	$1.26	45.4%	$1.29
$0 to -$5	46.2%	$1.42	39.1%	$1.25	36.9%	$1.17	33.4%	$1.15
-$5 to -$10	5.4%	$6.86	4.4%	$6.87	3.6%	$6.92	3.4%	$7.09
-$10 to -$20	2.2%	$13.71	2.0%	$13.77	1.8%	$13.76	1.8%	$14.07
< -$20	3.0%	$52.60	2.9%	$52.80	2.7%	$54.72	2.3%	$55.78

In 5.8 percent of the intervals in the thirty-minute ahead forecast, the absolute value of the average price difference between the ITSCED forecasted LMP and the actual real-time interface LMP was greater than $20.00, the average price differences were $50.52 when the price difference was greater than $20.00, and $55.78 when the price difference was greater than -$20.00.

Table 9-48 and Table 9-49 show the monthly differences between forecasted and actual PJM/MISO interface prices. Analysis of the data on a monthly basis shows that there is a decline in the accuracy of the ITSCED forecast ability during periods of cold and hot weather.

Table 9-48 Monthly Differences between forecast and actual PJM/MISO interface prices (percent of intervals): January 1 through March 31, 2017

Interval	Range of Price Differences	Jan	Feb	Mar	YTD Avg
~ 30 Minutes Prior to Real-Time	> $20	3.4%	1.6%	5.3%	3.5%
	$10 to $20	3.4%	1.1%	6.2%	3.6%
	$5 to $10	5.7%	3.7%	10.3%	6.7%
	$0 to $5	48.7%	48.7%	39.0%	45.4%
	$0 to -$5	32.9%	39.9%	27.9%	33.4%
	-$5 to -$10	2.2%	2.8%	5.0%	3.4%
	-$10 to -$20	1.5%	0.9%	3.0%	1.8%
	< -$20	2.1%	1.3%	3.3%	2.3%
Interval	Range of Price Differences	Jan	Feb	Mar	YTD Avg
~ 45 Minutes Prior to Real-Time	> $20	0.7%	0.2%	1.7%	0.9%
	$10 to $20	2.7%	0.5%	4.2%	2.5%
	$5 to $10	5.0%	3.1%	9.3%	5.9%
	$0 to $5	47.0%	48.0%	41.9%	45.6%
	$0 to -$5	37.3%	42.6%	31.4%	36.9%
	-$5 to -$10	3.1%	2.7%	5.0%	3.6%
	-$10 to -$20	1.5%	1.2%	2.8%	1.8%
	< -$20	2.7%	1.7%	3.7%	2.7%
Interval	Range of Price Differences	Jan	Feb	Mar	YTD Avg
~ 90 Minutes Prior to Real-Time	> $20	1.1%	0.2%	2.2%	1.2%
	$10 to $20	2.4%	1.0%	4.8%	2.7%
	$5 to $10	3.9%	3.4%	9.6%	5.7%
	$0 to $5	40.5%	45.7%	39.6%	41.8%
	$0 to -$5	42.9%	43.3%	31.6%	39.1%
	-$5 to -$10	4.3%	3.4%	5.5%	4.4%
	-$10 to -$20	2.0%	1.3%	2.7%	2.0%
	< -$20	3.0%	1.7%	3.9%	2.9%
Interval	Range of Price Differences	Jan	Feb	Mar	YTD Avg
~ 135 Minutes Prior to Real-Time	> $20	1.6%	0.3%	2.5%	1.5%
	$10 to $20	3.6%	1.5%	5.5%	3.6%
	$5 to $10	4.9%	3.8%	8.5%	5.8%
	$0 to $5	31.9%	36.0%	29.6%	32.4%
	$0 to -$5	48.2%	51.6%	39.2%	46.2%
	-$5 to -$10	4.6%	4.1%	7.2%	5.4%
	-$10 to -$20	2.3%	1.1%	3.2%	2.2%
	< -$20	2.9%	1.7%	4.2%	3.0%

Table 9-49 Monthly differences between forecast and actual PJM/MISO interface prices (average price difference): January 1 through March 31, 2017

Interval	Range of Price Differences	Jan	Feb	Mar	YTD Avg
~ 30 Minutes Prior to Real-Time	> $20	$43.86	$42.30	$57.15	$50.52
	$10 to $20	$13.89	$13.95	$14.25	$14.10
	$5 to $10	$7.11	$6.92	$7.06	$7.05
	$0 to $5	$1.17	$1.10	$1.67	$1.29
	$0 to -$5	$0.99	$1.03	$1.48	$1.15
	-$5 to -$10	$7.19	$6.96	$7.12	$7.09
	-$10 to -$20	$14.04	$14.32	$14.02	$14.07
	< -$20	$60.49	$50.06	$54.83	$55.78
Interval	Range of Price Differences	Jan	Feb	Mar	YTD Avg
~ 45 Minutes Prior to Real-Time	> $20	$42.79	$34.22	$40.06	$40.35
	$10 to $20	$13.11	$14.62	$13.86	$13.63
	$5 to $10	$6.98	$6.60	$7.02	$6.94
	$0 to $5	$1.05	$1.07	$1.70	$1.26
	$0 to -$5	$1.01	$1.11	$1.44	$1.17
	-$5 to -$10	$7.09	$6.91	$6.83	$6.92
	-$10 to -$20	$13.69	$13.42	$13.91	$13.76
	< -$20	$57.60	$47.03	$55.84	$54.72
Interval	Range of Price Differences	Jan	Feb	Mar	YTD Avg
~ 90 Minutes Prior to Real-Time	> $20	$33.41	$37.26	$39.08	$37.16
	$10 to $20	$13.60	$13.14	$13.55	$13.52
	$5 to $10	$6.95	$6.75	$6.96	$6.92
	$0 to $5	$1.12	$1.10	$1.76	$1.32
	$0 to -$5	$1.11	$1.23	$1.48	$1.25
	-$5 to -$10	$7.00	$6.84	$6.79	$6.87
	-$10 to -$20	$14.11	$13.10	$13.80	$13.77
	< -$20	$55.41	$47.69	$52.80	$52.80
Interval	Range of Price Differences	Jan	Feb	Mar	YTD Avg
~ 135 Minutes Prior to Real-Time	> $20	$32.31	$38.91	$35.10	$34.29
	$10 to $20	$14.39	$12.96	$13.54	$13.77
	$5 to $10	$7.07	$7.28	$7.21	$7.19
	$0 to $5	$1.15	$1.16	$1.84	$1.37
	$0 to -$5	$1.26	$1.39	$1.65	$1.42
	-$5 to -$10	$6.90	$6.82	$6.86	$6.86
	-$10 to -$20	$13.64	$12.97	$14.00	$13.71
	< -$20	$56.50	$46.86	$52.01	$52.60

The data reviewed show that ITSCED is not a highly accurate predictor of the real-time PJM/MISO interface prices. If this remains true, it will limit the effectiveness of CTS in improving interface pricing between PJM and MISO.

Willing to Pay Congestion and Not Willing to Pay Congestion

When reserving nonfirm transmission, market participants have the option to choose whether or not they are willing to pay congestion. When the market participant elects to pay congestion, PJM operators redispatch the system if necessary to allow the energy transaction to continue to flow. The system redispatch often creates price separation across buses on the PJM system. The difference in LMPs between two buses in PJM is the congestion cost (and losses) that the market participant pays in order for their transaction to continue to flow.

The MMU recommended that PJM modify the not willing to pay congestion product to address the issues of uncollected congestion charges. The MMU recommended charging market participants for any congestion incurred while the transaction is loaded, regardless of their election of transmission service, and restricting the use of not willing to pay congestion transactions (as well as all other real-time external energy transactions) to transactions at interfaces.

On April 12, 2011, the PJM Market Implementation Committee (MIC) endorsed the changes recommended by the MMU. The elimination of internal sources and sinks on transmission reservations addressed most of the MMU concerns, as there can no longer be uncollected congestion charges for imports to PJM or exports from PJM. There is still potential exposure to uncollected congestion charges in wheel through transactions, and the MMU will continue to evaluate if additional mitigation measures would be appropriate to address this exposure.

Table 9-50 shows that since the inception of the business rule change on April 12, 2013, there was uncollected congestion in only one month, January 2016. The negative congestion means that market participants who used the not willing to pay congestion transmission option for their wheel through transactions had transactions that flowed in the direction opposite to congestion. When market participants use the not willing to pay congestion product, it also means that they are not willing to receive congestion credits, which was the case in January 2016.

Table 9-50 Monthly uncollected congestion charges: January 1, 2010 through March 31, 2017

Month	2010	2011	2012	2013	2014	2015	2016	2017
Jan	$148,764	$3,102	$0	$5	$0	$0	($44)	$0
Feb	$542,575	$1,567	($15)	$249	$0	$0	$0	$0
Mar	$287,417	$0	$0	$0	$0	$0	$0	$0
Apr	$31,255	$4,767	($68)	($3,114)	$0	$0	$0	
May	$41,025	$0	($27)	$0	$0	$0	$0	
Jun	$169,197	$1,354	$78	$0	$0	$0	$0	
Jul	$827,617	$1,115	$0	$0	$0	$0	$0	
Aug	$731,539	$37	$0	$0	$0	$0	$0	
Sep	$119,162	$0	$0	$0	$0	$0	$0	
Oct	$257,448	($31,443)	($6,870)	$0	$0	$0	$0	
Nov	$30,843	($795)	($4,678)	$0	$0	$0	$0	
Dec	$127,176	($659)	($209)	$0	$0	$0	$0	
Total	$3,314,018	($20,955)	($11,789)	($2,860)	$0	$0	($44)	$0

Spot Imports

Prior to April 1, 2007, PJM did not limit nonfirm service imports that were willing to pay congestion, including spot imports, secondary network service imports and bilateral imports using nonfirm point-to-point service. Spot market imports, nonfirm point-to-point and network services that are willing to pay congestion, all termed willing to pay congestion (WPC), were part of the PJM LMP energy market design implemented on April 1, 1998. Under this approach, market participants could offer energy into or bid to buy from the PJM spot market at the border/interface as price takers without restrictions based on estimated available transmission capability (ATC). Price and PJM system conditions, rather than ATC, were the only limits on interchange.

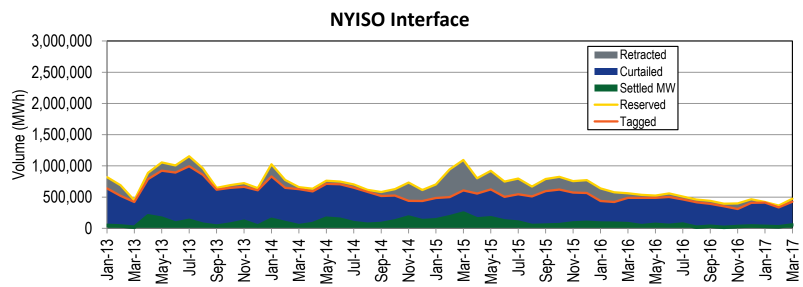
However, PJM has interpreted its JOA with MISO to require restrictions on spot imports and exports although MISO has not implemented a corresponding restriction.[87] The result is that the availability of spot import service is limited by ATC and not all spot transactions are approved. Spot import service (a network service) is provided at no charge to the market participant offering into the PJM spot market.

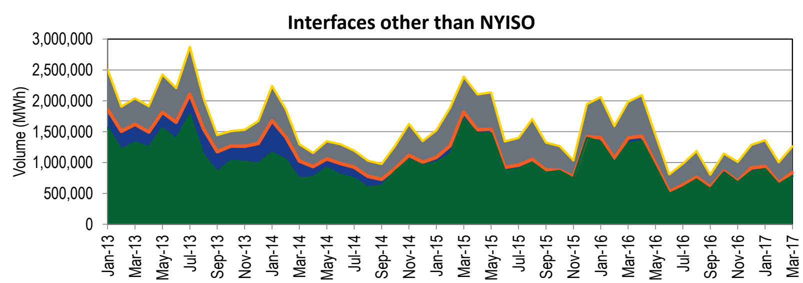
The spot import rules provide incentives to hoard spot import capability. In response to market participant complaints regarding the inability to acquire spot import service after this rule change on April 1, 2007, changes were made to the spot import service effective May 1, 2008.[88] These changes limited spot imports to only hourly reservations and caused spot import service to expire if not associated with a valid NERC Tag within two hours when reserved the day prior to the scheduled flow or within 30 minutes when reserved on the day of the scheduled flow.

These changes did not fully resolve the issue. In the *2008 State of the Market Report for PJM*, the MMU recommended that PJM reconsider whether a new approach to limiting spot import service is required or whether a return to the prior policy with an explicit system of managing related congestion is preferable. PJM and the MMU jointly addressed this issue through the stakeholder process, recommending that all unused spot import service be retracted if not tagged within 30 minutes from the queue time of the reservations intraday, and two hours when queued the day prior. On June 23, 2009, PJM implemented the new business rules.

Figure 9-15 shows the spot import service use for the NYISO Interface, and for all other interfaces, from January 1, 2013 through March 31, 2017. The yellow line shows the total monthly MWh of spot import service reserved and the orange line shows the total monthly MWh of tagged spot import service. The gray shaded area between the yellow and orange lines represents the MWh of retracted spot import service and may represent potential hoarding volumes. This ATC was initially reserved, but not tagged (used). It is possible that in some instances the reserved transmission consisted of the only available ATC which could have been used by another market participant had it not been reserved and not used. The blue shaded area between the orange line and green shaded area represents the MWh of curtailed transactions using spot import service. This area may also represent hoarding opportunities, particularly at the NYISO Interface. In this instance, it is possible that while the market participant reserved and scheduled the transmission, they may have submitted purposely uneconomic bids in the NYISO market so that their transaction would be curtailed, yet their transmission would not be retracted. The NYISO allows for market participants to modify their bids on an hourly basis, so these market participants can hold their transmission service and evaluate their bids hourly, while withholding the transmission from other market participants that may wish to use it. The green shaded area represents the total settled MWh of spot import service. Figure 9-15 shows that while there are proportionally fewer retracted MWh on the NYISO Interface than on all other interfaces, the NYISO has proportionally more curtailed MWh. This is a result of the NYISO market clearing process.

Figure 9-15 Spot import service use: January 1, 2013 through March 31, 2017





87 See OASIS "Modifications to the Practices of Non-Firm and Spot Market Import Service," (April 20, 2007) <http://www.pjm.com/~/media/etools/oasis/wpc-white-paper.ashx>.
88 See OASIS "Regional Transmission and Energy Scheduling Practices," (March 31, 2016) <http://www.pjm.com/~/media/etools/oasis/regional-practices-clean-pdf.ashx>.

The MMU continues to recommend that PJM permit unlimited spot market imports (as well as all nonfirm point-to-point willing to pay congestion imports and exports) at all PJM interfaces.

Interchange Optimization

When PJM prices are higher than prices in surrounding balancing authorities, imports will flow into PJM until the prices are approximately equal. This is an appropriate market response to price differentials. Given the nature of interface pricing and the treatment of interface transactions, it is not possible for PJM system operators to reliably predict the quantity or sustainability of such imports. The inability to predict interchange volumes creates additional challenges for PJM dispatch in trying to meet loads, especially on high-load days. If all external transactions were submitted as real-time dispatchable transactions during emergency conditions, PJM would be able to include interchange transactions in its supply stack, and dispatch only enough interchange to meet the demand.

The MMU recommends that the submission deadline for real-time dispatchable transactions be modified from 1800 on the prior day to three hours prior to the requested start time, and that the minimum duration be modified from one hour to 15 minutes.[89] These changes would give PJM a more flexible product that could be used to meet load based on economic dispatch rather than guessing the sensitivity of the transactions to price changes.

In addition to changing prices, transmission line loading relief procedures (TLRs), market participants' curtailments for economic reasons, and external balancing authority curtailments affect the duration of interchange transactions.

The MMU recommends that PJM explore an interchange optimization solution with its neighboring balancing authorities that would remove the need for market participants to schedule physical transactions across seams. Such a solution would include an optimized, but limited, joint dispatch approach that uses supply curves and treats seams between balancing authorities as constraints, similar to other constraints within an LMP market.

89 The minimum duration for a real-time dispatchable transaction was modified to 15 minutes as per FERC Order 764.

Interchange Cap During Emergency Conditions

An interchange cap is a limit on the level of interchange permitted for nondispatchable energy using spot import or hourly point-to-point transmission. An interchange cap is a nonmarket intervention which should be a temporary solution and should be replaced with a market-based solution as soon as possible. Since the approval of this process on October 30, 2014, PJM has not yet needed to implement an interchange cap.

The purpose of the interchange cap is to help ensure that actual interchange more closely meets operators' expectations of interchange levels when internal PJM resources, e.g. CTs or demand response, were dispatched to meet the peak load. Once these resources have been called on, PJM must honor their minimum operating constraints regardless of whether additional interchange then materializes; therefore any interchange received in excess of what was expected can have a suppressive effect on energy and reserve pricing and result in increased uplift.

PJM will notify market participants of the possible use of the interchange cap the day before. The interchange cap will be implemented for the forecasted peak and surrounding hours during emergency conditions.

The interchange cap will limit the acceptance of spot import and hourly nonfirm point to point interchange (imports and exports) not submitted as real-time with price transactions once net interchange has reached the interchange cap value. Spot imports and hourly nonfirm point to point transactions submitted prior to the implementation of the interchange cap will not be limited. In addition, schedules with firm or network designated transmission service will not be limited either, regardless of whether net interchange is at or above the cap.

The calculation of the interchange cap is based on the operator expectation of interchange at the time the cap is calculated plus an additional margin.

The margin is set at 700 MW, which is half of the largest contingency on the system. The additional margin also allows interchange to adjust to the loss of a unit or deviation between actual load and forecasted load. The interchange cap is based on the maximum sustainable interchange from PJM reliability studies.

45 Minute Schedule Duration Rule

PJM limits the change in interchange volumes on 15 minute intervals. These changes are referred to as ramp. The purpose of imposing a ramp limit is to help ensure the reliable operation of the PJM system. The 1,000 MW ramp limit per 15 minute interval was based on the availability of ramping capability by generators in the PJM system. The limit is consistent with the view that the available generation in the PJM system can only move 1,000 MW over any 15 minute period. The PJM ramp limit is designed to limit the change in the amount of imports or exports in each 15 minute interval to account for the physical characteristics of the generation to respond to changes in the level of imports and exports. For example, if at 0800 the sum of all external transactions were -3,000 MW (negative sign indicates net exporting), the limit for 0815 would be -2,000 MW to -4,000 MW. In other words, the starting or ending of transactions would be limited so that the overall change from the previous 15 minute period would not exceed 1,000 MW in either direction.

In 2008, there was an increase in 15 minute external energy transactions that caused swings in imports and exports submitted in response to intra-hour LMP changes. This activity was due to market participants' ability to observe price differences between RTOs in the first third of the hour, and predict the direction of the price difference on an hourly integrated basis. Large quantities of MW would then be scheduled between the RTOs for the last 15 minute interval to capture those hourly integrated price differences with relatively little risk of prices changing. This increase in interchange on 15 minute intervals created operational control issues, and in some cases led to an increase in uplift charges due to calling on resources with minimum run times greater than 15 minutes needed to support the interchange transactions. As a result, a new business rule was proposed and approved that required all transactions to be at least 45 minutes in duration.

On June 22, 2012, FERC issued Order No. 764, which required transmission providers to give transmission customers the option to schedule transmission service at 15 minute intervals to reflect more accurate power production forecasts, load and system conditions.[90] [91] On April 17, 2014, FERC issued its order which found that PJM's 45 minute duration rule was inconsistent with Order 764.[92]

PJM and the MMU issued a statement indicating ongoing concern about market participants' scheduling behavior, and a commitment to address any scheduling behavior that raises operational or market manipulation concerns.[93]

MISO Multi-Value Project Usage Rate ("MUR")

A multi-value project (MVP) is a project, as defined by MISO, that enables the reliable and economic delivery of energy in support of public policy needs, provides multiple types of regional economic value or provides a combination of regional reliability and economic value.[94] On July 15, 2010, MISO submitted revisions to the MISO Tariff to implement criteria for identifying and allocating the costs of MVPs.[95] On December 16, 2010, the Commission accepted the proposed MVP charge for export and wheel-through transactions, except for transactions that sink in PJM.[96] The Commission stated that MISO had not shown that their proposal did not constitute a resumption of rate pancaking along the MISO-PJM seam. Following the December 16, 2010, Order, MISO began applying a multi-value usage rate (MUR) to monthly net actual energy withdrawals, export schedules and through schedules with the exception of transactions sinking in PJM. The MUR charge was applied to the relevant transactions in addition to the applicable transmission, ancillary service and network upgrade charges.

90 *Integration of Variable Energy Resources*, Order No. 764, 139 FERC ¶ 61,246 (2012), order on reh'g, Order No. 764-A, 141 FERC ¶ 61231 (2012).
91 Order No. 764 at P 51.
92 *See Id.* at P 12.
93 *See* joint statement of PJM and the MMU re Interchange Scheduling issued July 29, 2014, which can be accessed at: <http://www.monitoringanalytics.com/reports/Market_Messages/Messages/PJM_IMM_Statement_on_Interchange_Scheduling_20140729.pdf>.
94 See MISO, "Multi Value Project Portfolio Analysis," <https://www.misoenergy.org/Planning/TransmissionExpansionPlanning/Pages/MVPAnalysis.aspx>.
95 See Midwest Independent Transmission Operator Inc. filing, Docket No. ER10-1791-000 (July 15, 2010).
96 133 FERC ¶ 61,221 (2010); *order on reh'g*, 137 FERC ¶ 61,074 (2011).

On June 7, 2014, the U.S. Court of Appeals for the Seventh Circuit granted a petition for review regarding the Commission's determination in the MVP Order and MVP Rehearing Order.[97] The Court ordered the Commission to consider on remand whether, in light of current conditions, what if any limitations on export pricing to PJM by MISO are justified.[98] The Seventh Circuit highlighted the fact that at the time of the Commission's decision to prohibit rate pancaking on transactions between MISO and PJM, all of MISO's transmission projects were local and provided only local benefits.[99]

On July 13, 2016, FERC issued an Order permitting MISO to collect charges associated with MVPs for all transactions sinking in PJM, effective immediately.[100] The July 13th Order noted that in light of "the development of large scale wind generation capable of serving both MISO's and its neighbors' energy policy requirements in the western areas of MISO; the reported need of PJM entities to access those resources; and the reported need for MISO to build new transmission facilities to deliver the output of those resources within MISO for export... it is appropriate to allow MISO to assess the MVP usage charge for transmission service used to export to PJM just as MISO assesses the MVP usage charge for transmission service used to export energy to other regions."[101] Table 9-51 shows the projected usage rate to be collected for all wheels through and exports from MISO, including those that sink in PJM, for 2017 through 2036.[102] It is not clear whether the MUR charge has affected interchange volumes from MISO into PJM.

Table 9-51 MISO Projected Multi Value Project Usage Rate: 2017 through 2036

Year	Total Indicative MVP Usage Rate ($/MWh)
2017	$1.39
2018	$1.63
2019	$1.84
2020	$1.86
2021	$1.90
2022	$1.89
2023	$1.88
2024	$1.87
2025	$1.84
2026	$1.81
2027	$1.78
2028	$1.75
2029	$1.72
2030	$1.69
2031	$1.66
2032	$1.63
2033	$1.60
2034	$1.57
2035	$1.54
2036	$1.52

97 Illinois Commerce Commission, et al. v. FERC, 721 F.3d 764, 778–780 (7th Cir. 2013).
98 *Id.* at 780.
99 *Id.* at 779.
100 156 FERC ¶ 61,034 (2016).
101 *Id.* at P 55.
102 See MISO, "Schedule 26A Indicative Annual Charges," (August 29, 2016) <https://www.misoenergy.org/_layouts/miso/ecm/redirect.aspx?id=230305>.