

Market-to-Market Coordination with PJM

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Agenda

- ◆ Background
- ◆ Tariff Amendments
 - *MST Section 5*
 - *PJM-NY JOA Body – Updates to OATT Attachment CC*
 - *New M2M Schedule D of OATT Attachment CC*
- ◆ Next Steps
- ◆ Appendix of M2M Concepts and Examples

Background

- ◆ On January 12, 2010, the NYISO filed a report with FERC describing the Broader Regional Markets suite of solutions, including Market-to-Market Coordination, to address loop flows
- ◆ FERC ordered the NYISO to complete Market-to-Market by the end of Q4 2012
- ◆ On March 31, May 26, August 29, September 26, October 19, and October 27, 2011, the NYISO discussed the status of M2M Coordination with PJM at the MIWG
- ◆ On October 12, 2011, the NYISO discussed the status of M2M Coordination with PJM at the BIC
- ◆ On July 21, and November 3, 2011, the NYISO and PJM held a Joint Stakeholder meeting to discuss the status of M2M Coordination

Tariff Amendments

- ◆ MST Section 5
- ◆ PJM – NYISO JOA
 - *Updates to OATT Attachment CC including a new M2M Schedule to the OATT Attachment CC*
- ◆ The tariff amendments are documented separately

MST Section 5

- ◆ Removed language regarding the Interregional Congestion Management Pilot Program in MST Section 5.1.2

OATT Attachment CC Body

- ◆ NYISO – PJM JOA Body Changes
 - Ministerial Changes throughout
 - Added section briefly describing M2M
 - Added M2M to the dispute resolution process
 - Added Billing Section to more fully describe the invoicing and payment process

OATT Attachment CC

M2M Process - Schedule D

- ◆ Description of M2M process
- ◆ Description of M2M Flowgates
 - Description of M2M Flowgate Studies
- ◆ Determination of Market Flow
- ◆ Determination of Entitlements

OATT Attachment CC M2M Process – Schedule D (cont.)

- ◆ Real-Time Coordination Process
 - *Re-Dispatch Coordination*
 - *Ramapo PAR Coordination*
- ◆ Real-Time Settlements
- ◆ When Redispatch is Insufficient
- ◆ Appropriate Use of M2M
- ◆ Change Management Process

Next Steps

- ◆ Please provide any comments to Mike DeSocio (mdesocio@nyiso.com) by November 30, 2011
- ◆ Continue to work with PJM on M2M software integration
- ◆ File tariff and JOA revisions by EOY 2011

Appendix

- ◆ Purpose
- ◆ Refresher – Key Concepts
- ◆ M2M Flowgate Tests
- ◆ M2M Entitlements
- ◆ M2M Re-Dispatch and Ramapo Coordination
- ◆ M2M Re-Dispatch Example
- ◆ M2M Re-Dispatch Settlement Examples
- ◆ M2M Ramapo Example
- ◆ M2M Ramapo Settlement Examples

Purpose

- ◆ Market to Market (M2M) provides the ability for the NYISO to request assistance from a neighbor, through re-dispatch and PAR control actions, to solve a NYISO constraint at a lower cost, thereby reducing the overall cost of congestion

Re-Dispatch Key Concepts

Real Time / Market-to-Market Coordination

- A mechanism for NYISO and PJM to provide more cost effective management of constraints from a larger pool of resources

Monitoring RTO (MRTO)

- The RTO that has the primary responsibility for monitoring and control of a coordinated Flowgate

Non-Monitoring RTO (NMRTO)

- The RTO that does not have the primary responsibility for monitoring and control of a Flowgate, but does have resources that impact the Flowgate

Re-Dispatch Key Concepts

Market Flow

- The flow in MW on a Flowgate that is caused by all real-time control actions to serve load in the RTO footprint

M2M Flowgate

- A Flowgate that may be significantly impacted by the dispatch of generation serving load in an adjacent market or impacted by Ramapo PAR control

Entitlements

- Predetermined MW amount that a market entity is entitled to per Flowgate based on its historical impacts to that Flowgate. In the M2M process, real time usage is compared to entitlement to determine settlement

Ramapo Key Concepts

Ramapo Target

- The desired flow across the Ramapo PARs. The target will be the sum of (a) 61% of PJM-NY Net Scheduled Interchange over the AC ties, and (b) 72% of the difference of JK and ABC off-schedule flows.

Ramapo Overuse

- The difference of actual flow across the Ramapo PARs less the Ramapo Target.

Cost of PJM Overuse

- The sum of impact of Ramapo PARs (in the form of a shift factor) on a M2M Flowgate multiplied by that M2M Flowgate's Shadow Price for every binding NY M2M Flowgate.

Cost of NY Overuse

- The sum of impact of Ramapo PARs (in the form of a shift factor) on a M2M Flowgate multiplied by that M2M Flowgate's Shadow Price for every binding PJM M2M Flowgate.

M2M Flowgate Tests

- ◆ M2M Flowgates are determined through a set of tests
 - *Non-Monitoring RTO Generation Impact \geq Defined Threshold on the Monitoring RTO Flowgate*
 - *Ramapo PAR OTDF \geq Defined Threshold on the Monitoring RTO Flowgate*
- ◆ Flowgates that pass either test are eligible for Ramapo PAR coordination and are identified as M2M Flowgates
 - *Additionally, M2M Flowgates that pass the Non-Monitoring RTO Generation Impact test above are eligible for re-dispatch coordination*
- ◆ A list of M2M Flowgates will be posted on the NYISO and PJM websites

M2M Entitlements

- ◆ M2M Entitlements will be based on determining the historic impacts of the Non-Monitoring RTO's generation on the Monitoring RTO's Flowgates
- ◆ M2M Entitlement will be determined using the Market Flow Calculation where:
 - Shift Factors will be determined using a mutually agreed upon representation of the Eastern Interconnection where all normally in-service facilities are modeled as in-service
 - 2009 through 2011 Generation and Load Data
 - Perfect PAR Control exists

M2M Entitlements

- ◆ M2M Entitlements will be determined based on four separate periods for each hour of a seven day week
 - Period 1: December, January, and February
 - Period 2: March, April, and May
 - Period 3: June, July, and August
 - Period 4: September, October, and November

- ◆ Example. To determine the M2M Entitlement for a particular M2M Flowgate that will be used for every Tuesday at Hour 3 within Period 1:
 - Compute the Hour 3 Market Flow for that M2M Flowgate, for each Tuesday in December, January, and February, for 2009 through 2011; and
 - Then average those Market Flows

M2M Entitlements

- ◆ M2M Entitlements will be determine once and then adjusted as new Transmission facilities are placed in-service
 - The adjustment for new Transmission facilities will be based on how the new Transmission facility changes the distribution of flow between NYISO and PJM
- ◆ M2M Entitlements are determined for M2M Flowgates that are eligible for M2M Re-Dispatch Coordination

M2M Entitlements

- ◆ The initial M2M Entitlement calculations will be performed, and the results mutually agreed to by both NYISO and PJM
- ◆ Later, the Monitoring RTO will calculate changes to the Non-Monitoring RTO's entitlement. The Non-Monitoring RTO will have the opportunity to dispute any entitlement calculation that it doesn't agree with.
- ◆ The mutually agreed initial M2M Entitlements determination will be completed in 2012 prior to implementing M2M with PJM

M2M Entitlement Impacts

- ◆ It is expected that the Day Ahead and Real-Time Market LBMPs will continue to converge with M2M in place
 - *To the extent that Real-Time congestion patterns change as a result of M2M, the NYISO envisions that Day Ahead congestion patterns will also change to match Real-Time*
 - *The NYISO does not envision reducing Day Ahead or Real-Time transfer capability to accommodate M2M Operation or Entitlements*
 - *The NYISO may elect to model PJM M2M Flowgate constraints in its Day Ahead Market in the event that the NYISO is consistently being requested to provide re-dispatch relief for those M2M Flowgates*

M2M Re-Dispatch Coordination Overview

- ◆ Requires manual coordination of NYISO and PJM Operations
 - *M2M activation notifications will be done manually when an M2M Flowgate is constrained*
 - *A subset of M2M Flowgates will be eligible for re-dispatch coordination*
 - This subset is determined through the M2M Flowgate Tests
- ◆ Once re-dispatch has been activated, an automated exchange of data will be coordinated and used for M2M re-dispatch:
 - *M2M Flowgate ID, M2M Flowgate Shadow Price, M2M Flowgate Market Flow*

(Note: A Flowgate is also known as a transmission constraint.)

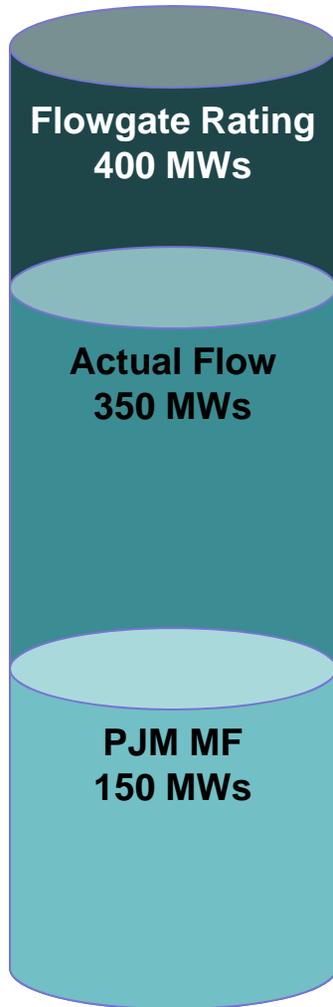
M2M Ramapo Coordination Overview

- ◆ M2M Flowgates and Ramapo Operation
 - *Impacts on all M2M Flowgates will be considered for Ramapo Operation*
- ◆ Market Flow Calculation Adjustment
 - *Market Flow Calculation will separate out the impacts of generation dispatch and PAR schedule impacts on each M2M Flowgate*
- ◆ Does not require manual activation to invoke M2M Coordination
 - *Ramapo PAR coordination is already a manual action*

Settlement

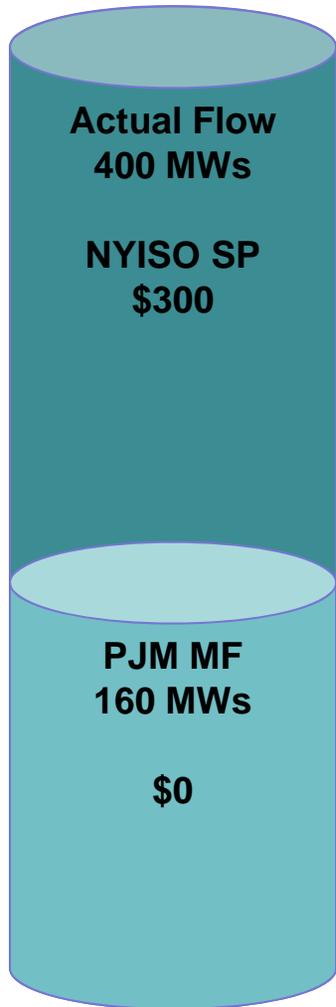
- ◆ The NYISO is performing the settlement calculations for both NY and PJM
 - *The NYISO will produce invoices for PJM indicating the amount payable to/receivable from PJM*
- ◆ The settlement calculation will be based on interval level data
- ◆ M2M Settlement includes:
 - *M2M Re-dispatch Coordination*
 - *M2M Ramapo Coordination*

M2M Re-Dispatch Example



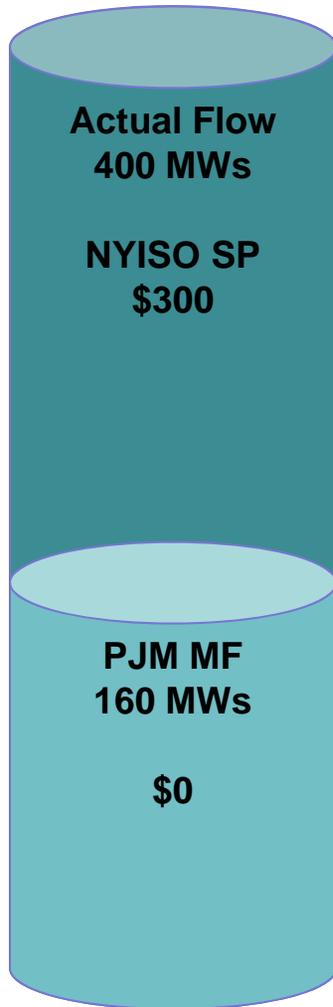
- ◆ Initial Conditions
- ◆ A NYISO M2M Flowgate is being monitored in real-time
 - NYISO is the MRTO
 - PJM is the NMRTO
 - M2M Flowgate Rating = 400 MWs
 - Actual Flow = 350 MWs
 - PJM Market Flow = 150 MWs
 - M2M Flowgate is not constrained

M2M Re-Dispatch Example



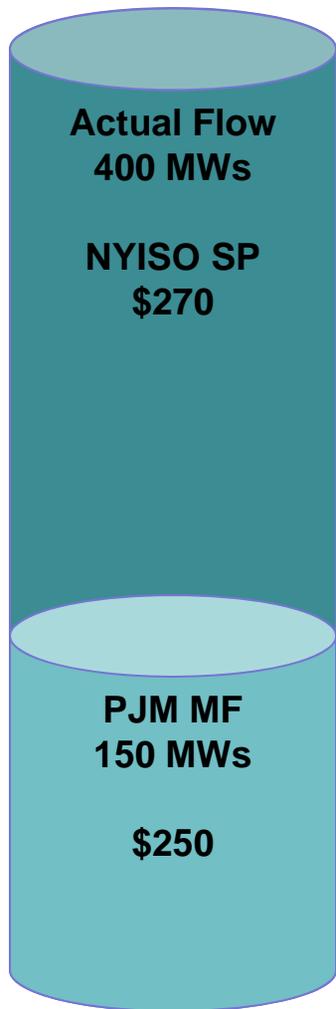
- ◆ Step 1
- ◆ NYISO M2M Flowgate becomes constrained
 - M2M Flowgate Rating = 400 MWs
 - Actual Flow = 400 MWs
 - PJM Market Flow = 160 MWs
- ◆ NYISO calculates a shadow price of \$300 based on its redispatch for the M2M Flowgate

M2M Re-Dispatch Example



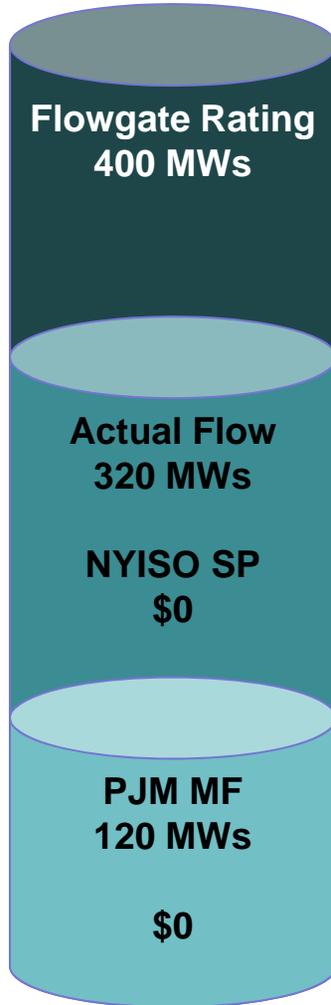
- ◆ **Step 2**
- ◆ **NYISO M2M Flowgate is constrained**
 - Actual Flow = 400 MWs
 - PJM Market Flow = 160 MWs
 - NYISO shadow price = \$300
- ◆ **NYISO requests PJM to redispatch for the M2M Flowgate**
 - NYISO electronically sends the \$300 shadow cost
 - NYISO verbally confirms that PJM is able to enter into M2M with NYISO for this M2M Flowgate
- ◆ **PJM begins redispatching for this M2M Flowgate**
- ◆ **M2M Settlements Begin**

M2M Re-Dispatch Example



- ◆ **Step 3 – this step iterates until M2M ends**
- ◆ **PJM redispatches for this M2M Flowgate**
 - PJM shadow price = \$250
 - PJM Market Flow = 150 MWs
- ◆ **NYISO M2M Flowgate is still constrained**
 - NYISO continues to redispatch
 - Actual Flow = 400 MWs
 - NYISO shadow price = \$270
- ◆ **Automatically, the M2M software continues to update PJM with the latest M2M Flowgate data**
 - NYISO electronically sends the \$270 shadow cost

M2M Re-Dispatch Example

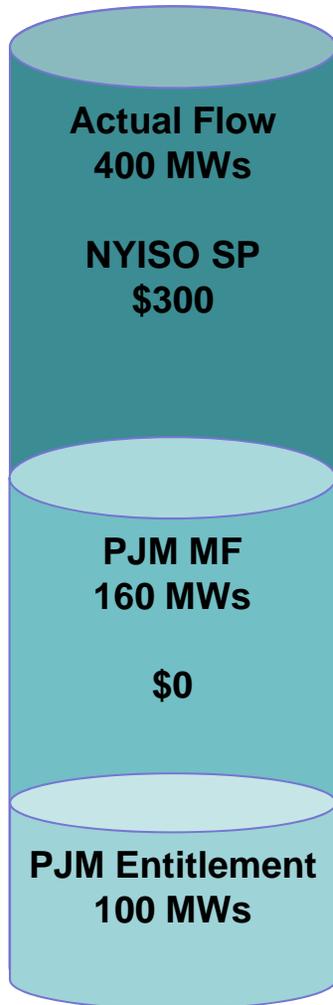


- ◆ **M2M Coordination Process continues until the M2M Flowgate is no longer constrained**
- ◆ **M2M Settlements End**

Re-Dispatch Settlement

- ◆ M2M Re-dispatch Coordination
 - *Settlements are based on:*
 - M2M Flowgate Market Flow
 - M2M Flowgate Shadow Price
 - M2M Entitlements for the M2M Flowgate
 - *Settlements occur when Real-Time M2M Coordination was invoked for a M2M Flowgate*

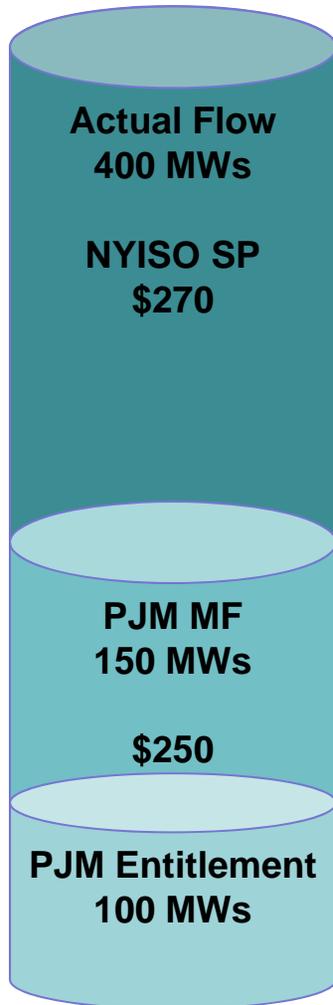
M2M Re-Dispatch Settlement



Example 1

- ◆ **NYISO M2M Flowgate is constrained**
 - Actual Flow = 400 MWs
 - PJM Market Flow = 160 MWs
 - NYISO shadow price = \$300
- ◆ **PJM begins redispatching for this M2M Flowgate**
- ◆ **M2M Settlements Begin**
 - PJM Entitlement = 100 MWs
 - PJM is over its entitlement
 - PJM pays $(160 \text{ MWs} - 100 \text{ MWs}) \times \300 or \$18,000.00

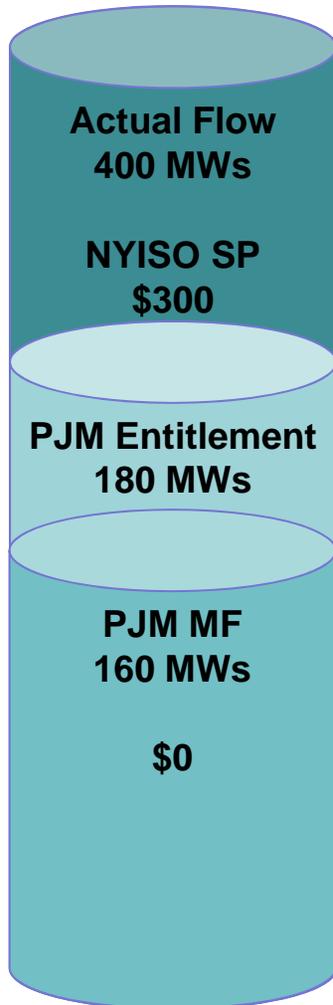
M2M Re-Dispatch Settlement



Example 1 (cont.)

- ◆ **PJM redispatches for this M2M Flowgate**
 - PJM shadow price = \$250
 - PJM Market Flow = 150 MWs
- ◆ **NYISO M2M Flowgate is still constrained**
 - NYISO continues to redispatch
 - Actual Flow = 400 MWs
 - NYISO shadow price = \$270
- ◆ **M2M Settlement**
 - PJM Entitlement = 100 MWs
 - PJM is over its entitlement
 - PJM pays $(150 \text{ MWs} - 100 \text{ MWs}) \times \270 or \$13,500.00

M2M Re-Dispatch Settlement



Example 2

- ◆ **NYISO M2M Flowgate is constrained**
 - Actual Flow = 400 MWs
 - PJM Market Flow = 160 MWs
 - NYISO shadow price = \$300
- ◆ **PJM begins redispatching for this M2M Flowgate**
- ◆ **M2M Settlements Begin**
 - PJM Entitlement = 180 MWs
 - PJM is under its entitlement
 - NY pays $(180 \text{ MWs} - 160 \text{ MWs}) * \0 or \$0.00

M2M Re-Dispatch Settlement

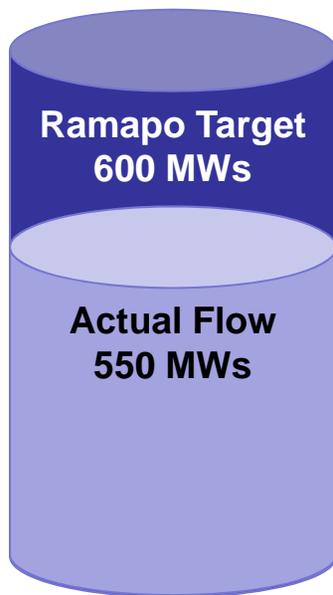


Example 2 (cont.)

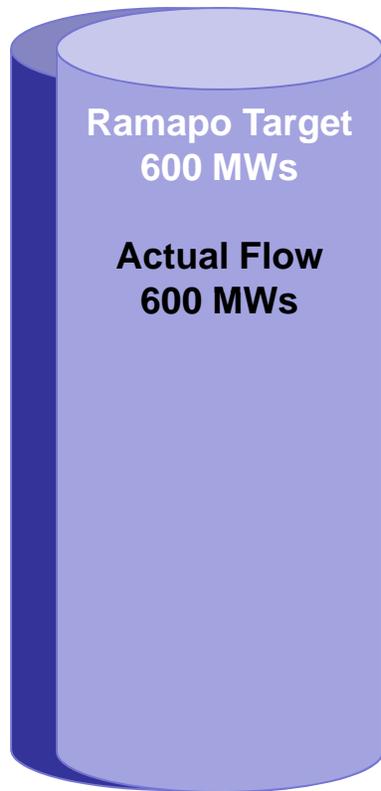
- ◆ **PJM redispatches for this M2M Flowgate**
 - PJM shadow price = \$250
 - PJM Market Flow = 150 MWs
- ◆ **NYISO M2M Flowgate is still constrained**
 - NYISO continues to redispatch
 - Actual Flow = 400 MWs
 - NYISO shadow price = \$270
- ◆ **M2M Settlement**
 - PJM Entitlement = 180 MWs
 - PJM is under its entitlement
 - NY pays $(180 \text{ MWs} - 150 \text{ MWs}) * \250 or \$7,500.00

M2M Ramapo Example

- ◆ **Initial Conditions**
- ◆ **There are several M2M Flowgates within PJM and NY that are constrained**
 - **Cost of NY Overuse = \$120/MWH**
 - **Cost of PJM Overuse = \$230/MWH**
 - **Ramapo Actual Flow = 550MWs**
 - **Ramapo Target Flow = 600MWs**
- ◆ **Since the Cost of PJM Overuse is greater than the Cost of NY Overuse, Ramapo would be operated to cause more flow into NY over Ramapo in this example**



M2M Ramapo Example



- ◆ Ramapo Operation
- ◆ Since the Cost of PJM Overuse is greater than the Cost of NY Overuse, Ramapo would be operated to cause more flow into NY over Ramapo
- ◆ After Ramapo has been moved
 - Cost of NY Overuse = \$170/MWH
 - Cost of PJM Overuse = \$175/MWH
 - Ramapo Actual Flow = 600MWs
 - Ramapo Target Flow = 600MWs

Ramapo Settlement

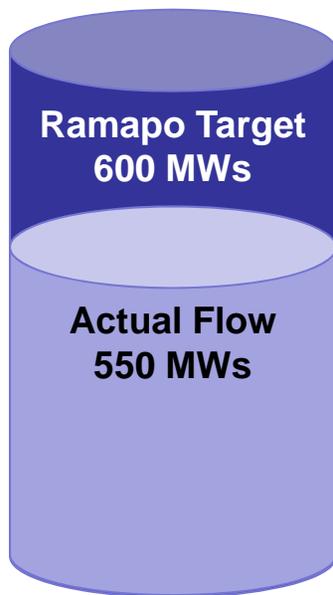
◆ M2M Ramapo Coordination

■ *Settlements are based on:*

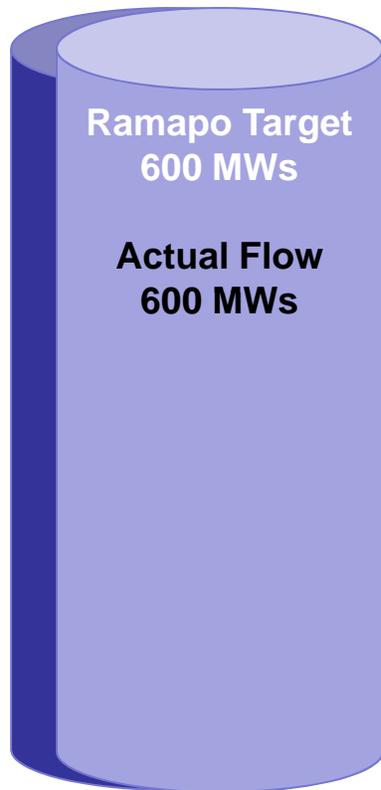
- Ramapo Overuse - the difference of actual flow across the Ramapo PARs less the Ramapo Target
- Cost of Overuse - the incremental cost of congestion for all binding M2M Flowgates at Ramapo

M2M Ramapo Settlement

- ◆ **Example 1**
- ◆ **There are several M2M Flowgates within PJM and NY that are constrained**
 - **Cost of NY Overuse = \$120/MWH**
 - **Cost of PJM Overuse = \$230/MWH**
 - **Ramapo Actual Flow = 550MWs**
 - **Ramapo Target Flow = 600MWs**
- ◆ **Ramapo Actual Flow < Ramapo Target Flow**
 - **PJM is Overusing NY's Transmission System**
- ◆ **Ramapo Settlement is:**
 - **Cost of PJM Overuse X Ramapo Overuse**
 - **\$230/MWH X 50MWs = \$11,500/H**



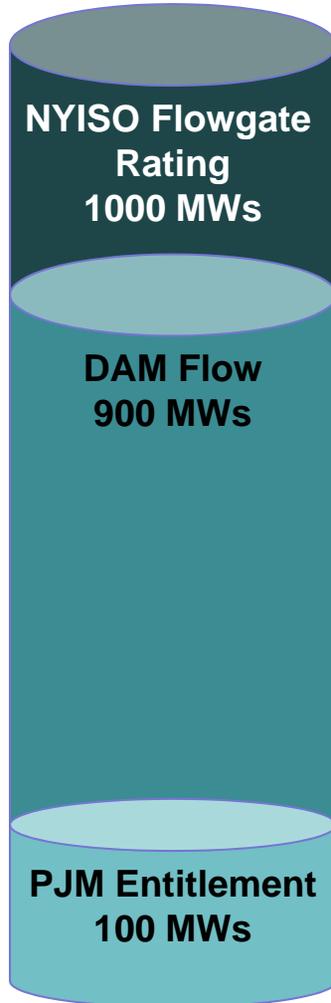
M2M Ramapo Settlement



- ◆ **Example 2**
- ◆ **After Ramapo has been moved**
 - **Cost of NY Overuse = \$170/MWH**
 - **Cost of PJM Overuse = \$175/MWH**
 - **Ramapo Actual Flow = 600MWs**
 - **Ramapo Target Flow = 600MWs**
- ◆ **Ramapo Actual Flow = Ramapo Target Flow**
 - **No overuse is occurring**
- ◆ **Ramapo Settlement is:**
 - **\$0**

M2M Example 1

The NYISO does NOT recommend this approach Day Ahead



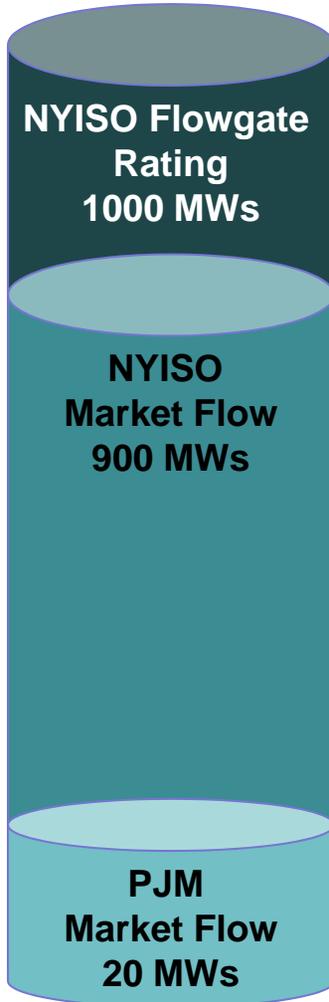
- ◆ Day Ahead the NYISO will continue to apply a Lake Erie Circulation (“LEC”) assumption
 - M2M Flowgate is a NYISO Facility
 - M2M Flowgate Rating is 1000MWs
 - PJM Entitlement is 100MWs
 - NYISO Reduces Rating to 900MWs
- ◆ M2M Flowgate IS constrained in DAM, M2M Flowgate constrained flow for DAM is 900MWs (including LEC assumption)
 - NYISO DA Shadow Price for the M2M Flowgate is \$30



M2M Example 1

Real-Time

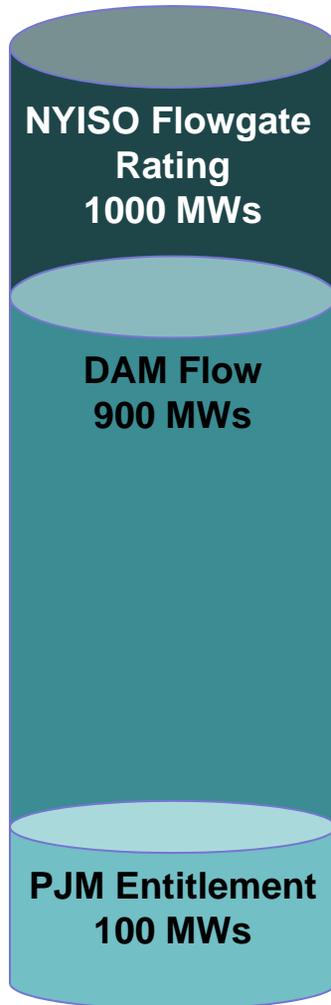
- ◆ M2M Flowgate Rating is 1000MWs
- ◆ NYISO Market Flow is 900MWs
- ◆ PJM Market Flow is 20MWs
- ◆ M2M Flowgate is NOT constrained



M2M Example 1

Settlement Results

- ◆ RT was NOT constrained, no M2M settlements
- ◆ DA was over constrained leading to overstated DA congestion rents
- ◆ Including both LEC assumption and PJM Entitlements in the DAM results in double counting parallel flow impacts from PJM



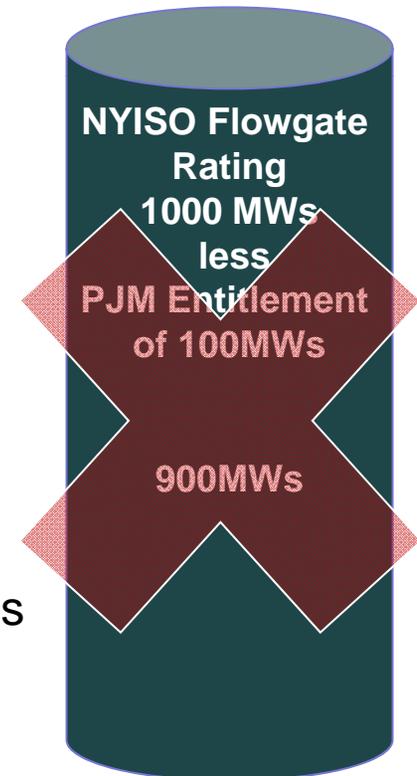
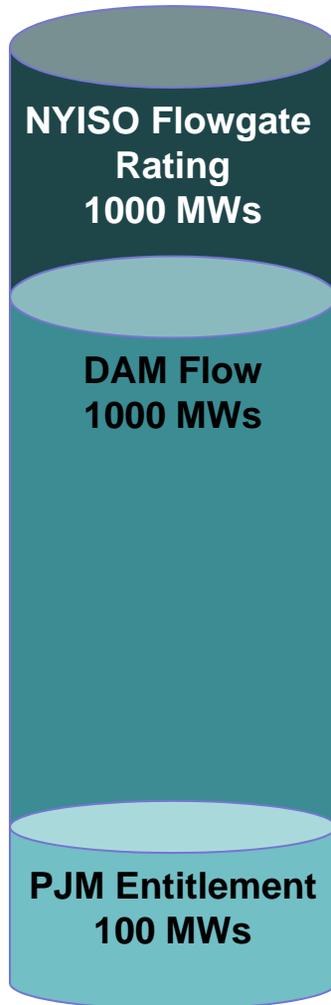
M2M Example 2

The NYISO recommends this approach

Continuing to include only the LEC assumption more efficiently captures all neighboring market impacts on NY constraints.

Day Ahead

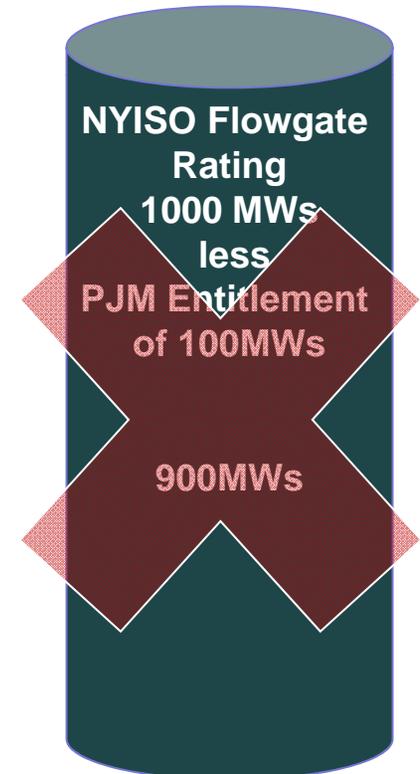
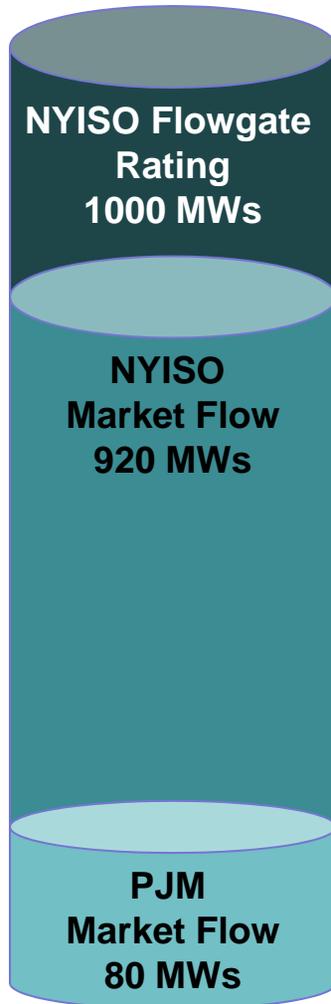
- ◆ Day Ahead the NYISO will continue to apply a LEC assumption
 - M2M Flowgate is a NYISO Facility
 - M2M Flowgate Rating is 1000MWs
 - PJM Entitlement is 100MWs
- ◆ M2M Flowgate is constrained in DAM, M2M Flowgate constrained flow for DAM is 1000MWs (including LEC assumption)
 - NYISO DA Shadow Price for the M2M Flowgate is \$20



M2M Example 2

Real-Time

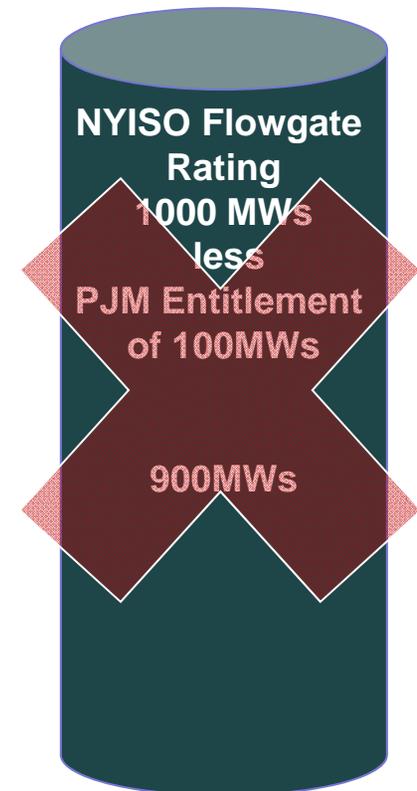
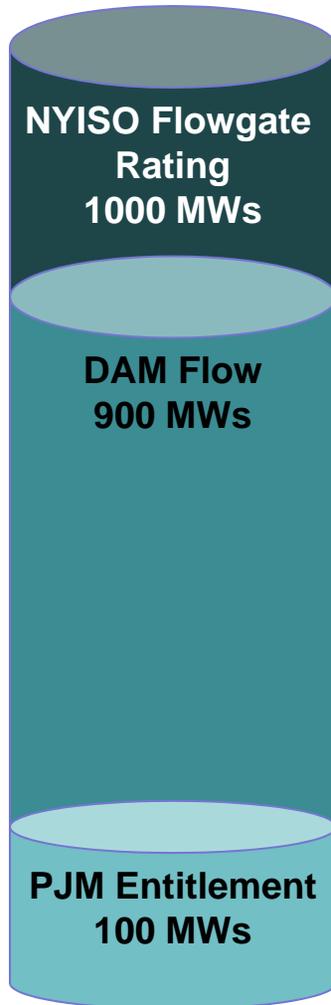
- ◆ M2M Flowgate Rating is 1000MWs
- ◆ NYISO Market Flow is 920MWs
- ◆ PJM Market Flow is 80MWs
- ◆ M2M Flowgate IS constrained
 - NYISO RT Shadow Price for the M2M Flowgate is \$15



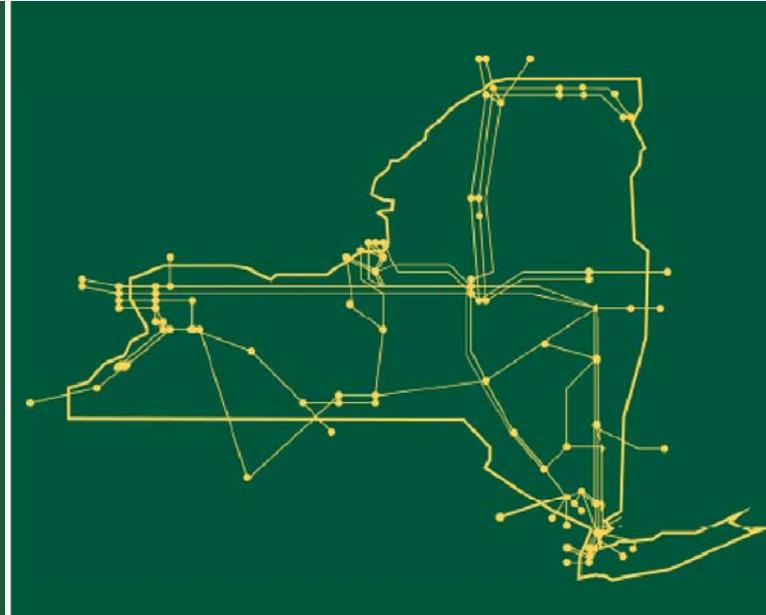
M2M Example 2

Settlement Results

- ◆ RT was constrained, M2M settlements apply
 - PJM Market Flow is 80MWs
 - PJM Entitlement is 100MWs
 - NYISO pays PJM: $20\text{MWs} \times \$15/\text{MWh} = \$300/\text{h}$
- ◆ DA was constrained
- ◆ Including only the LEC assumption in the DAM results in more efficient use of the transmission system



The New York Independent System Operator (NYISO) is a not-for-profit corporation responsible for operating the state's bulk electricity grid, administering New York's competitive wholesale electricity markets, conducting comprehensive long-term planning for the state's electric power system, and advancing the technological infrastructure of the electric system serving the Empire State.



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