Coordinating without the Con Ed/ PSEG Wheel

Joint NYISO/PJM Meeting

(Reposted with minor correction to slide 28)

9/16/2016

KCC

Agenda

- Background
- Study Results
- Operational Rationale, Market Implementation, and Planning Assumptions for:
  - *Operational Base Flow*
  - *Interchange Percentages*
  - *RECo Load Treatment*
  - *M2M PAR Coordination*
- Timeline
- Next Steps

Background

Background

PJM/NYISO Wheel Replacement Protocol Project Overview	
Why was the project started?	ConEd notified involved parties of intention to terminate non-conforming wheeling service on April 28, 2016. PJM and NYISO are working jointly to develop a replacement protocol to address the operational, planning, and market impacts.
What is the wheeling service that is currently in place?	The non-conforming wheeling service has historically been implemented by NYISO and PJM by modeling a fixed 1000 MW 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
When does the replacement protocol have to be in place?	• Current non-conforming wheeling service will end on April 30, 2017. • New protocol must be in place for use on May 1, 2017
What is the impact to Market Participants?	• Primary impact to PSE&G and ConEd as facility owners • Beyond the revised protocol/ market impacts, no changes to OASIS/ Energy Transaction bidding processes

Background

- **Current protocol**
  - ***Real-time Operations***
    - **61% of NY-PJM AC interchange, and 80% of RECo load is applied to the 5018 desired (i.e., target) flow calculation in Real-time Operations**
  - ***Markets:***
    - **NYISO Markets model 61% of the NY-PJM AC Interchange injected at 5018, and 39% at the Western Ties for scheduling and pricing**
    - **PJM Markets model 80% of the NY-PJM AC Interchange injected at the Roseton bus, and 20% injected at the Dunkirk bus for scheduling and pricing**
  - ***Planning:***
    - **Both NYISO and PJM Planning consider NY-PJM interchange and RECo load deliveries consistent with their market models**

Critical Factors for a Near-Term Solution

- Supports reliable operation of the transmission system
- Effectively manages congestion across the region
- Provides for open access and utilization of the facilities to serve the public interest and provide benefit to consumers
- Does not hinder use of the facilities to respond to emergencies in real-time
- Preserves competitive market behaviors
- Can be facilitated with the Phase Angle Regulator (PAR) technology at the ABC, JK, and 5018 interfaces (current equipment for May 1, 2017 implementation)
- Can be implemented in both PJM and NYISO market models

Technology Considerations

- **The following proposal is based on the current technology that exists at the ABC and JK interfaces**
  - ***This protocol may have to be revisited should the technology impacting those interfaces be upgraded or replaced***

Solution Overview

- **Include ABC and JK as part of the NY-PJM AC Interface for interchange scheduling**
  - ***ABC and JK interfaces will be completely incorporated into overall NY-PJM AC Interface for interchange scheduling and pricing purposes***
  - ***A percentage of the overall NY-PJM AC Interchange, as well as a flow offset (referred to as the Operational Base Flow) will be modeled in the NYISO and PJM Markets, and will be included in the real-time desired flow calculations of those facilities***
    - **Details on these concepts are discussed later in this presentation**
- **Add the PARs on ABC and JK to the Market-to-Market PAR Coordination process between NYISO and PJM**
- **PJM to redefine the NYIS Proxy bus Interface definition**

Solution Overview

- **This proposal of combining ABC, JK, 5018 and the Western ties into one aggregate PJM-NY AC Proxy Bus presents several advantages**
  - ***It leverages existing market constructs in both the NYISO and PJM markets***
    - **This increases the likelihood of implementation by May 1st , 2017**
  - ***It can be supported by the PAR technology currently installed on these interfaces***
    - **These PARs are capable of facilitating an aggregate PJM-NY AC Proxy Bus interchange schedule across the ABC, JK, 5018, and the Western ties because when schedules are under- or over- delivered across an interface, the difference is made up across the other interfaces**

Study Results

Studies: PJM System Operations Power Flow Analysis Results

Scenario	Load (MW)	Generation	Outages	Interchange to NYISO (MW)	Interchange to PJM (MW)	Linden VFT	Neptune	HTP	PJM Contingency Criteria	Result
Summer 2016 OATF	157,178	All in Service	All Facilities in Service	2,500	1,500	315 MW to NYISO	660 MW to NYISO	320 MW to NYISO	N-1	Case did not solve
June 1, 2016	122,725	DA/ RT Combustion Turbine Commitment	RT Topology	2,500	1,500	315 MW to NYISO	660 MW to NYISO	320 MW to NYISO	N-1	Cases solve with heavy congestion in Northern NJ
July 25, 2016	151,753	DA/ RT Combustion Turbine Commitment	RT Topology	2,500	1,500	315 MW to NYISO	660 MW to NYISO	320 MW to NYISO	N-1	Cases solve with heavy congestion in Northern NJ

NYISO Operations Studies

- The current protocol has been widely studied and reliably implemented
- The NYISO utilized the 2016 summer operating case as well as the 2017 case from the 2016 Reliability Needs Assessment (RNA) to determine the reliable bounds on the NYISO system for importing to the NYISO on JK and exporting from the NYISO on ABC
- The objective was to develop a proposed protocol that would not limit the PJM/NYISO TTC based on 5018, JK, or ABC flow

NYISO Operations Study Results

- Results identified a lack of angle capability on the Waldwick PARs (JK) to hold flows to zero
- Identified an export limitation on the A, B, C lines to PJM for N-1-1

Definitions

- **The Operational Base Flow (OBF) was determined from the natural system flow that occurs when the PARs are at neutral tap. The natural system flow was determined using EMS and PSS/E applications.**
  - ***The natural system flow results from the existing system configuration. Implementing an OBF preserves reliability and maximizes operational flexibility***
- **Interchange Percentage: percentage of net scheduled interchange applied to each interface (5018, JK, and ABC)**
- **Interface Target Flow: target flow PJM and NYISO System Operators will meet during real-time operations**

Need for an Operational Base Flow

- **Power flow results have identified reliability issues in Northern New Jersey as well as delivery limitations when exporting from PJM to the NYISO on the JK interface**
  - ***Potential for voltage collapse in Northern New Jersey under high load Summer OATF case***
  - ***Forcing flow from 230 kV system to the 345 kV system***
  - ***PAR tap adjustments exhausted prior to achieving desired flow***
  - ***High voltage during light load periods and low interface flows will also be a concern/ consideration***
- **NYISO power flow results have also identified delivery limitations when exporting to PJM on the ABC interface after securing for N-1-1 on the NYISO system, and then attempting further deliveries**

Benefits of the OBF

- Resolves reliability issues in Northern NJ observed in PJM operational studies
- Allows for higher levels of economic interchange to be scheduled over JK and ABC
  - *The OBF allows the NYISO and PJM to reliably meet interchange schedules without crowding out economic interchange transactions*
- The OBF preserves PAR angle capability to achieve target
- Facilitate power flows in a manner that most effectively manages regional congestion
- Supports all of the critical factors of a solution outlined at the beginning of this presentation
- The OBF also provides operational flexibility by maintaining PAR angle capability to respond to emergencies in real-time

Operational Base Flow Analysis

- **The OBF was determined through studies performed by the NYISO and PJM using the following assumptions:**
  - ***Zero net interchange between PJM and the NYISO***
  - ***PARs set to neutral tap setting***
- **The analysis of the NYISO and PJM studies have resulted in a proposed OBF of 400 MW**

Operational Base Flow

- **Given that the OBF is not needed to maintain reliability in NY:**
  - ***The NYISO and PJM are working together to develop appropriate JOA language to clarify the OBF is neither:***
    - **a firm service, nor**
    - **solving a reliability need in NY**
- **As such, the OBF shall not cause the NYISO, or Market Participants as a result of their participation in the NYISO markets, to be subjected to any PJM Regional Transmission Expansion Plan (RTEP) cost allocations**

PJM Market Studies

- **Model Setup**

Input	Existing	Proposed
RECO Load	80% on 5018	80% on 5018
AC Interchange	61% 5018, 39% Western Ties	15% JK, 32% 5018, 21% ABC, 32% Western Ties
Wheel	1000 In/out	None

- **Market Impacts***

		PJM Simulated Market Impacts		
Protocol Assumption	Operational Base Flow MWs applied into PJM (JK interface) and out to NYISO (ABC Interface)	Productions Costs	Congestion Costs	Load Payments
A	0/0	1.23%	2.14%	0.39%
B	-400 / 400	1.22%	1.80%	0.40%
C	-1000 / 1000	1.23%	1.16%	0.40%

*Utilized PROMOD Production Cost Simulation tool. Positive represents increase relative to existing

NYISO Market Studies

- **NYISO re-ran several Day-Ahead cases, varying the assumptions as follows:**

Case#	Load	Interchange Percentage (ABC/JK/5018)	OBF	Import or Export case?	Interchange difference between production and re-run	Constraint/Shadow Price differences between production and re-run
Case 1	Light	18%/18%/32%	0	Importing	Directionally same in all hours.	Similar
Case 2	Light	18%/18%/32%	0	Exporting	Directionally same in all hours.	Similar
Case 3	High	18%/18%/32%	0	Both	Directionally same except one hour.	Similar
Case 4	High	26%/10%/32%	0	Both	Directionally same except one hour.	Similar
Case 5	High	18%/18%/32%	0	Importing	Directionally same in all hours.	Similar except off-peak where additional in-city constraints were observed.
Case 6	Above avg.	21%/15%/32%	400	Exporting	Directionally same in all hours.	Similar

- **Please note that the re-runs used original bids submitted under the current production market structure and should not be used to predict market outcomes under the new rules. They are useful, however, to evaluate how the solution performs in the absence of the ConEd/PSEG Wheel.**

RECo Load Treatment

Treatment of RECo

- **The NYISO and PJM currently incorporate 80% of RECo load into the 5018 Interface Target Flow used in Real-time Operations**
  - ***The NYISO and PJM continue to discuss how RECo load will be incorporated into the Interface Target Flow moving forward***

Interchange Percentages

OBF and Interchange Percentages

- **The OBF will be applied to the JK and ABC interfaces as a starting point for determination of the Interface Target Flow**
  - ***The Interchange Percentage values will be applied on top of the OBF at all times to determine the Interface Target Flow value***

Determination of Interchange Percentages

- The NYISO and PJM independently conducted PSS/E and DA rerun studies to determine interchange percentages for 5018, ABC, JK, and the Western ties
- As discussed, studies indicated the need for an OBF
  - *Subsequent studies determined the maximum amount of MW flow that could be sent over the JK, ABC, and 5018 interfaces*
    - This MW flow in conjunction with the OBF was used to establish the interchange percentages

Interchange Percentages

- **Proposing a combination of two concepts:**
  - ***Account for an Operational Base Flow (OBF) as a starting point***
  - ***Apply an interchange percentage distributed to each PAR:***

Line	Line Percent Distribution	PAR	PAR Percent Distribution
5018	32%	3500	16%
		4500	16%
A	21%	A	7%
B		B	7%
C		C	7%
JK	15%	E	5%
		F	5%
		O	5%
Western Ties	32%	N/A	N/A

- **The percentages above would change absent an OBF based on current system topology**

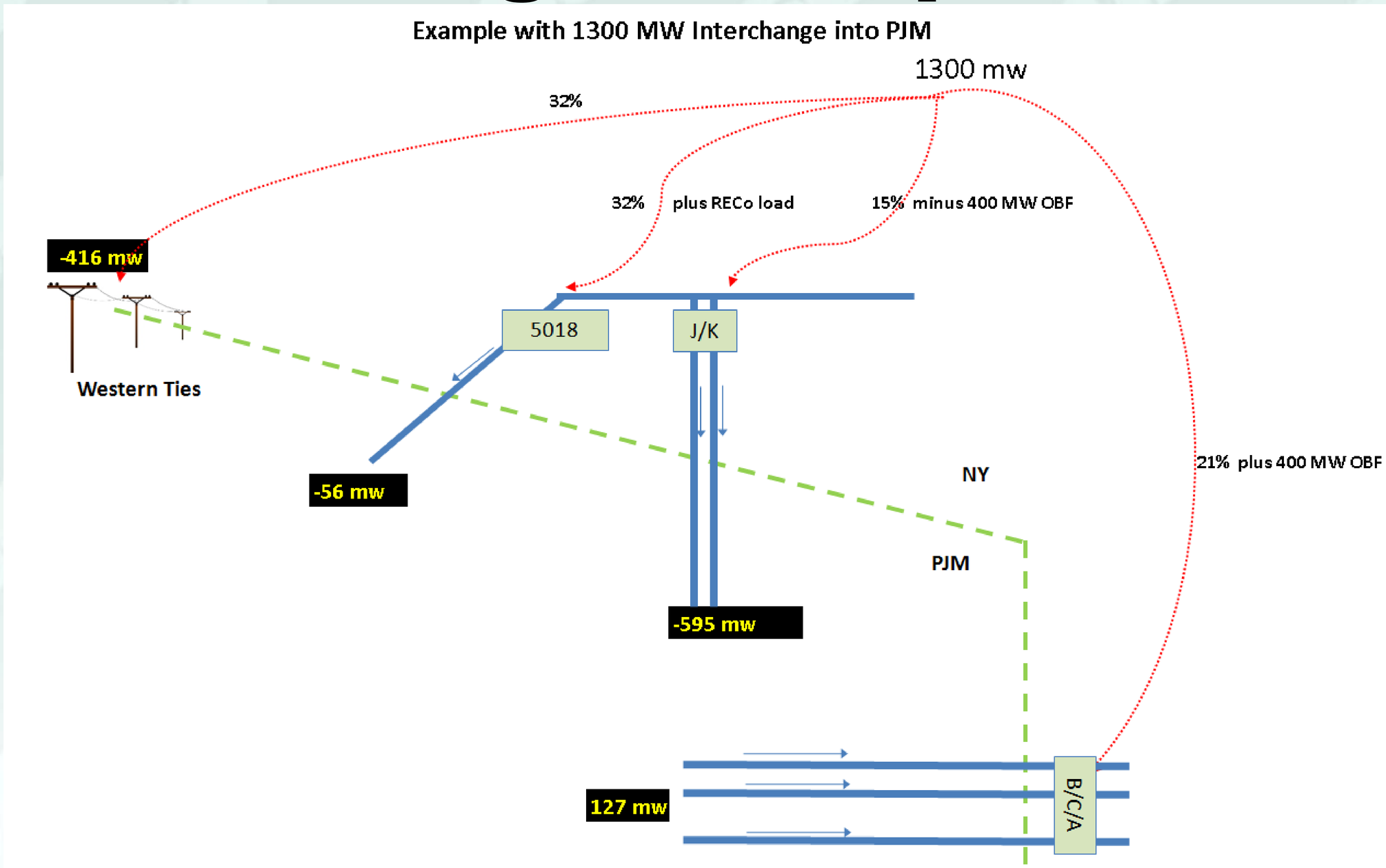
Interchange Example to PJM

- **-1300 MW Interchange (Export to PJM)**
  - ***Example assumes RECo load is 450 MW***

Line	Line Percent Distribution	Interchange (MW)	80% RECo (MW)	Operational Base Flow (MW)	Total Interface Target (MW)
5018	32%	-416	360	0	-56
ABC	21%	-273	0	400	127
JK	15%	-195	0	-400	-595
Western Ties	32%	-416	0	0	-416
	Total:	-1300	360	0	-940

$$Target_{PARx} = (PARx\ Interchange\ Factor + RECo\ Load + Operational\ Base\ Flow)$$

Interchange Example to PJM



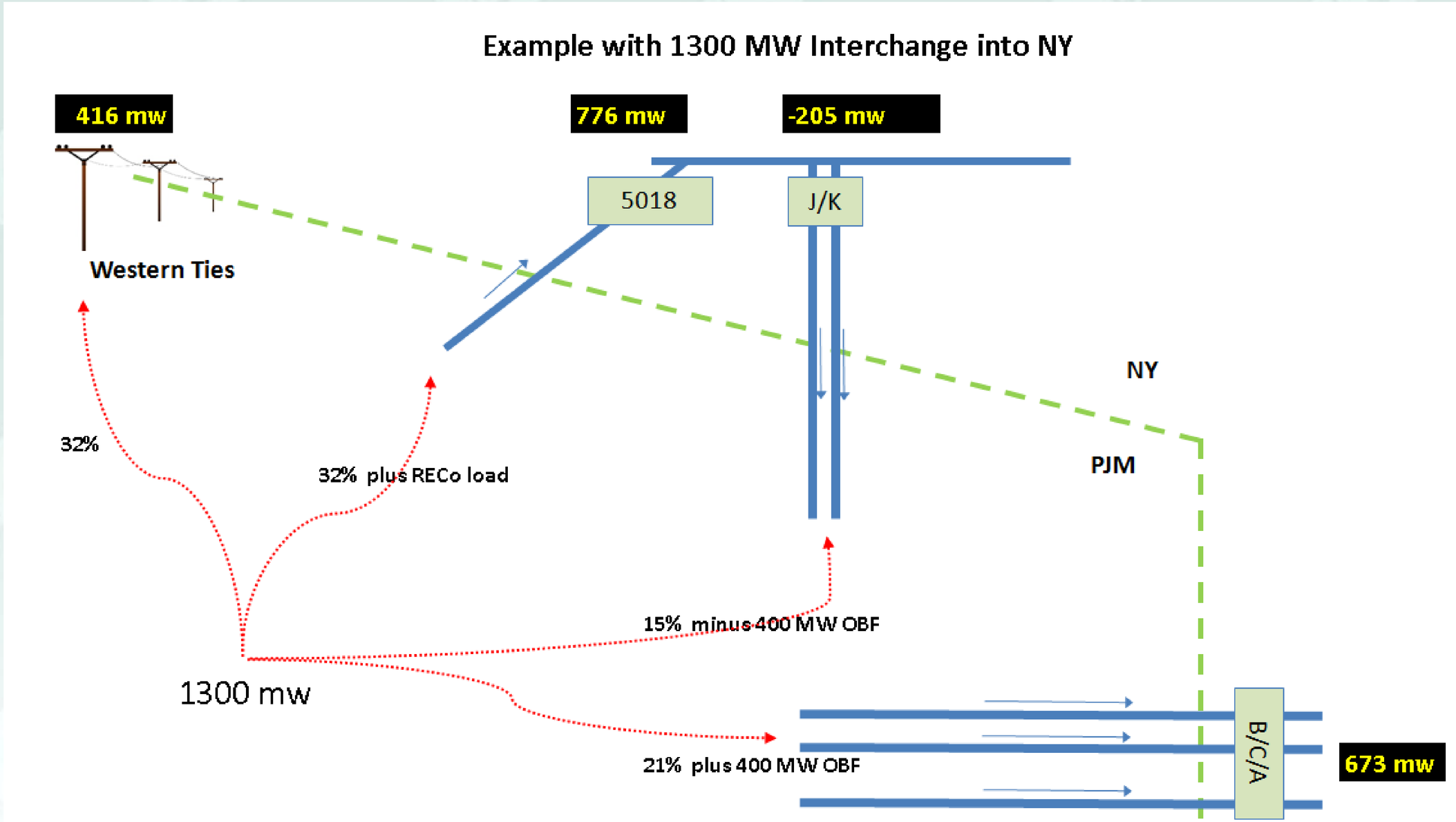
Interchange Example to NY

- **1300 MW Interchange (Import to NY)**
  - ***Example assumes RECo load is 450 MW***

Line	Line Percent Distribution	Interchange (MW)	80% RECo (MW)	Operational Base Flow (MW)	Total Interface Target (MW)
5018	32%	416	360	0	776
ABC	21%	273	0	400	673
JK	15%	195	0	-400	-205
Western Ties	32%	416	0	0	416
	Total:	1300	360	0	1660

$Target_{PARx}$ = (PARx Interchange Factor + RECo Load + Operational Base Flow)

Interchange Example to NY



Planning Assumption Impacts

- Following implementation of the new protocol described in this presentation, NYISO and PJM planning studies will assume the OBF and interchange percentages for future studies until appropriate long-term planning assumptions have been determined

M2M PAR Coordination

M2M PAR Coordination Flowgates

- **With the addition of the ABC and JK PARs into M2M PAR Coordination, the NYISO and PJM will be evaluating existing and new coordinated transmission constraints**
  - ***This evaluation will be done under the current flowgate qualification procedure as defined in the Joint Operating Agreement (JOA)****

*See OATT section 35.23, Attachment CC, Schedule D – Market-to-Market Coordination Process

M2M PAR Coordination Settlements

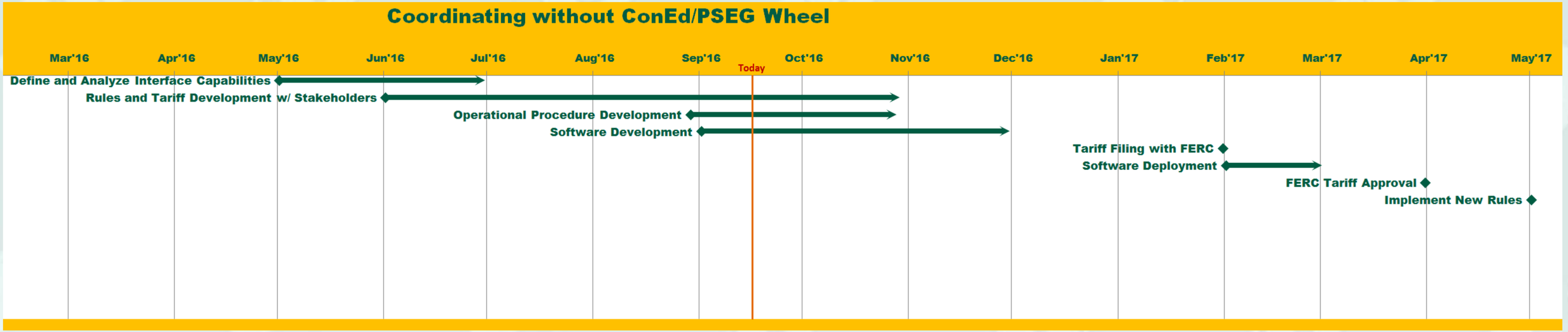
- **M2M Settlements will be based on the net effect of the operation of all PARs on an RTO's system similar to the way settlements are calculated today on the 3500 and 4500 PARs**
  - ***Under M2M PAR Coordination today each ISO/RTO is not charged for over-deliveries that aggravate congestion***
    - **The NYISO and PJM are discussing continuing this practice going forward**
- **A high level example of the calculation of M2M PAR coordination settlements is included in Appendix II**

Long Term

- **The NYISO and PJM proposal is based on current grid equipment**
  - ***If the technology in use changes, then the NYISO and PJM would have to revisit this design***
- **In the future, if the PARs at the ABC, JK, and 5018 interfaces are upgraded in a manner that allowed them to effectively implement interface-specific interchange schedules, then such modeling is possible within the NYISO's market structure**
  - ***This proposal does not preclude the ABC or JK interfaces from being modeled as distinct Proxy Buses if the PAR technology is upgraded***

Timeline/ Next Steps

Timeline



Date	Task
5/1/2016	Define and Analyze Interface Capabilities
6/1/2016	Rules and Tariff Development w/ Stakeholders
8/29/2016	Operational Procedure Development
9/1/2016	Software Development
1/31/2017	Tariff Filing with FERC
February 2017	Software Deployment
3/31/2017	FERC Tariff Approval
5/1/2017	Implement New Rules

Next Steps

- ✓ **September 16th Joint NYISO/PJM Meeting**
  - ✓ ***Continue proposal discussion***
- **September 29th MIWG**
  - ***Continue proposal discussion***
- **PJM's October Committee Meetings**
  - ***October 4th OC – proposal update***
  - ***October 5th MIC – proposal update***
  - ***October 6th PC – proposal update***
- **October/ November MIWG**
  - ***Discuss draft tariff language***
- **PJM's November Committee Meetings**
  - ***Review PJM/NYISO JOA language updates***
- **December BIC/MC**
  - ***Vote on draft tariff language***
- **January 2017**
  - ***Seek Board Approval***
  - ***File with FERC (Joint Filing)***
- **May 1, 2017 Implementation**

Appendix I: Current Process

Current Process

- **Currently, interchange between NY and PJM is expected to flow according to the pre-set distribution of 61% over 5018, and 39% over the Western ties**
  - ***This distribution is explicitly modeled in the NYISO's Day Ahead and Real Time markets***
  - ***Interchange is also automatically distributed from 5018 to the ABC and JK lines when the PARs on the transmission lines between New York and New Jersey are unable to maintain the desired flow (i.e., when flows across the 5018 are at limits)***
- **When a market participant submits an economic offer to schedule energy between PJM and NY, NYISO and PJM economically evaluate the offer against:**
  - ***Offers from internal NY and PJM generators***
  - ***Import/export offers at other proxy buses, and***
  - ***Price sensitive bids and offers***
- **The congestion impacts of proposed imports and exports on the NY and PJM transmission system are considered in the NYISO's and PJM's market evaluations and are reflected in the NYISO LBMPs at the Keystone proxy bus or PJM LMPs at the NYIS proxy bus, respectively**

M2M Coordination

- **Key steps in M2M PAR Coordination are outlined below**
  - ***A complete description of these rules is included in the Joint Operating Agreement***

RT Target Flow Calculated for each PAR

- Derived in part based on the static interchange percentage distributions modeled in the market software

Cost of Congestion

- RT cost of congestion at each PAR Controlled line is the sum of the products of the PAR's shift factor on the shadow price of each active constraint

TAP signals

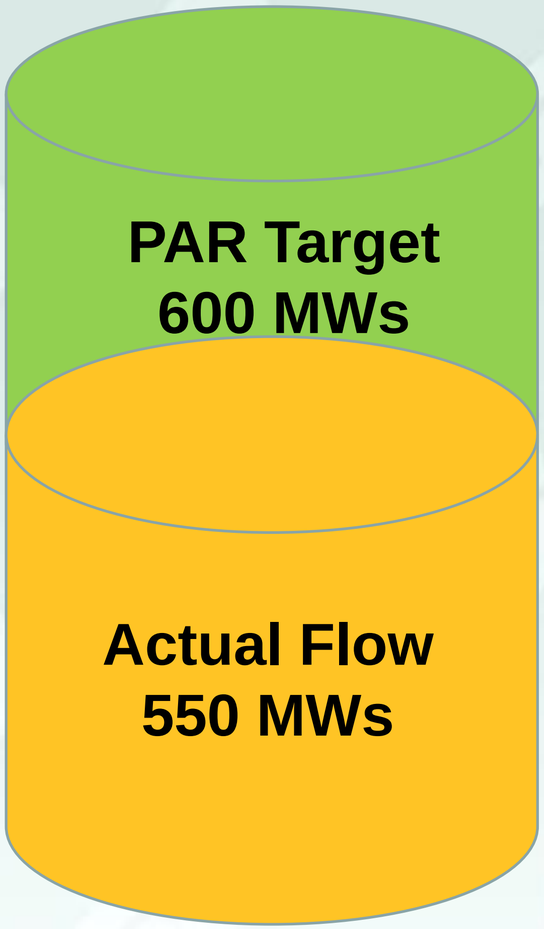
- The software will indicate to Ops the direction in which tap moves would be beneficial to minimize regional congestion by redistributing flows across the various AC interfaces between NY and PJM

RTO-to-RTO settlements

- Settlements between NYISO and PJM may occur when any over/under deliveries on the PAR controlled lines are increasing congestion in one region (compared to target flows)

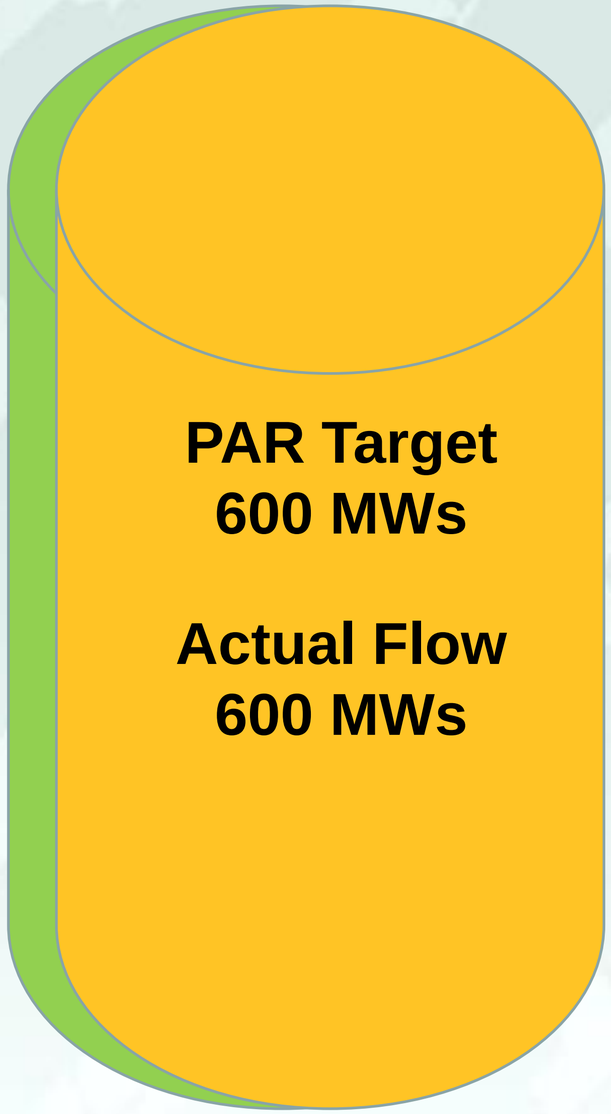
Appendix II – Proposed M2M PAR Coordination Settlement Examples

M2M PAR Coordination Settlements: Example



- There are several M2M flowgates within PJM and NY that are constrained
  - *Cost of NY overuse = $120/MWh*
  - *Cost of PJM overuse = $230/ MWh*
  - *PAR Actual Flow = 550 MWs*
  - *PAR Target Flow = 600 MWs*
- PAR actual flow < PAR Target Flow
  - *PJM is overusing NY's transmission system*
- PAR settlement is:
  - *(Cost of PJM overuse * PAR overuse)*
  - *($230/MWh * 50 MWs) = $11,500/h paid to NYISO*

M2M PAR Coordination Settlements: Example



- After the PAR has been moved
  - *Cost of NY overuse = $170/ MWh*
  - *Cost of PJM overuse = $175/ MWh*
  - *PAR Actual Flow = 600 MWs*
  - *PAR Target Flow = 600 MWs*
- PAR Actual Flow = PAR Target Flow
  - *No overuse is occurring*
- PAR Settlement is $0

The Mission of the New York Independent System Operator, in collaboration with its stakeholders, is to serve the public interest and provide benefit to consumers by:

- ***Maintaining and enhancing regional reliability***
- ***Operating open, fair and competitive wholesale electricity markets***
- ***Planning the power system for the future***
- ***Providing factual information to policy makers, stakeholders and investors in the power system***

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