Con Ed/PSEG Wheel Replacement Proposal

A white paper from the New York Independent System Operator

DRAFT – For Discussion Purposes Only

V 1.0
July 18, 2016

Table of Contents

1. Background

On April 28, 2016, Con Edison announced its intent to terminate its 1,000 MW long-term firm point-to-point Transmission Service Agreement with PJM that is commonly referred to as the "ConEd/PSEG Wheel", effective May 1st, 2017. The Wheel has historically been implemented by NYISO and PJM by modeling 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. The MW schedule is determined via a daily MW election made by Con Edison and communicated to NYISO and PJM. The NYISO tariff (OATT Section 35.22) governs how NYISO and PJM operate to implement the Wheel. OATT Section 35.23 which governs Market to Market Coordination between NYISO and PJM, includes several elements related to the ConEd PSEG Wheel. To address NYISO and PJM operations moving forward, these OATT sections will need to be revised to reflect operations without the ConEd/PSEG Wheel.

The NYISO has been working with PJM to develop alternative designs for utilizing the ABC and JK interfaces upon expiration of the ConEd/PSEG Wheel effective May 1, 2017. NYISO and PJM must determine how to provide open access transmission service between the two areas, and how to best utilize the ABC and JK interfaces in a reliable and efficient manner that serves the public interest. The scheduling and pricing approach to determine interchange schedules is governed by NYISO Market Services Tariff Attachment B

2. Critical factors to a solution

The following have been identified as the necessary factors for any solution, particularly one that must be in place by May 1, 2017:

- 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 and JK interfaces (current equipment for May 1, 2017)
- Can be implemented in both PJM and NYISO market models

3. Proposal Overview

To satisfy all of the critical factors needed for a solution by May 1, 2017, NYISO and PJM propose to add the JK and ABC lines into the single PJM-NY AC Proxy Bus definition that already includes the 5018 line and the Western ties. NYISO and PJM also propose to implement Market-to-Market PAR coordination using the PARs installed on the lines comprising both the JK and ABC interfaces, similar to what is currently done at 5018.

This proposal of combining ABC, JK, 5018, and the Western ties into one aggregate PJM-NY AC Proxy Bus definition presents several advantages. First, it leverages existing market constructs that exist in both NYISO and PJM markets, and therefore, can likely be implemented by May 1, 2017. Second, it can be supported by the existing PAR technology and associated devices that are currently installed at the ABC and JK interfaces. The NYISO and PJM do not believe it would be appropriate to implement each of the ABC and JK interfaces as distinct proxy buses given the existing equipment. The PARs currently installed at the ABC and JK interfaces generally provide control for the Operators to manage flows within a tolerance but cannot adequately effectuate individual interchange schedules at each interface. They are, however, capable of facilitating an aggregate PJM-NY AC Proxy Bus interchange schedule across the ABC, JK, 5018, and the Western ties because when there are under- or over-deliveries across one interface, the difference can be balanced across the other interfaces.

Below are the key attributes of the equipment required to effectuate individual interchange schedules and allow ABC and JK to stand as their own distinct, schedulable proxy buses. Although these attributes are written to address PARs specifically, these concepts could be generally applied to other technology types.

- Automatic control capability - The PARs would need to automatically control flows with no limit on the number of adjustments that could be taken to keep up with interface-specific interchange schedules. Currently, all PAR tap changes to adjust flows require manual operator actions.
- Control precision - The PARs would need the capability to provide more granular adjustments to power flows. Currently, the tap step changes are large at —approximately 80 MW per adjustment. The PJM PAR task force determined the step changes would need to be closer to 20 MW per tap step to consider implementing interface-specific scheduling.
    - *See PJM PAR task force on PAR criteria necessary to be considered a controllable AC facility: http://www.pjm.com/~/media/committees-groups/committees/pc/20151203/20151203-item-05-partf-final-proposal-report.ashx*
- Equipment Availability – The PARs should be able to be exercised to control flows on each interface without significant risk of compromising equipment. Currently, the PARs are operated with limitations of 20 taps/day & 400 taps/month. These limitations would be exhausted more

quickly with individual interchange schedules rather than combining under a single proxy + M2M concept.

- Control Range – Sufficient angle capability is needed to manage flows over a range of conditions. The PARs that are currently in place lack the angle capability that would be necessary to adequately implement individual interchange at the ABC or the JK interfaces.
- Ability to Align Flows to Schedules – In order to establish effective market signals, the actual flows need to align with schedules. The current equipment does not allow schedules to be effectively aligned with actual flows on an individual interface basis, potentially creating financial gaming opportunities.

By combining Market-to-Market PAR coordination with the aggregate scheduling of the ABC, JK and 5018 facilities, the NYISO and PJM can effectuate aggregate interchange schedules across the PJM-NY AC Proxy Bus, in a manner that also permits them to manage congestion at each of the individual interfaces.

4. Proposal Details

4.1. Interchange Scheduling

4.1.1. Current Process

The easiest way to think about the proposal to incorporate ABC and JK into the larger PJM-NY AC Proxy Bus definition is to consider the way interchange is currently implemented at the Proxy Bus. 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. The NYISO's market models assume that for every MW injected at the Proxy Bus, 0.61 MW is directed over the 5018 line, and the remainder is directed to flow over the Western Ties between NYISO and PJM.

When a market participant submits an economic offer to import or export energy between PJM and NY, NYISO economically evaluates the offer against all other offers from internal NY generators, against offers to import and export energy at other proxy buses, and against price sensitive load offers. The congestion impacts of proposed imports and exports on the NY transmission system are considered in the NYISO's market evaluation and are reflected in the Locational Based Marginal Prices (LBMPs) at the Keystone Proxy Bus. In other words, if an export at the Keystone Proxy Bus is contributing to congestion on the NY transmission system, the specific impact of that export on NY congestion will be reflected in the Keystone Proxy Bus LBMP. If an export aggravates an internal NY transmission constraint, the resulting congestion will make the corresponding Keystone Proxy Bus LBMP higher. Thus, the exporter will pay more to export energy out of NY. If the export relieves an internal NY transmission constraint, the resulting congestion impact will make the corresponding

Keystone Proxy Bus LBMP lower. Thus, the exporter will pay less to export energy out of NY. The same concept applies to imports, only in reverse.

4.1.2. Proposed Process

The proposal for replacing the ConEd/PSEG wheel leverages the same modeling concepts used today by explicitly including ABC and JK in the distribution of expected PJM-NY AC interchange. Instead of the 61%/39% over 5018 and the Western ties respectively, as is done today, the proposal will result in scheduled flows distributed over the 5018, ABC, JK and Western Ties according to a pre-determined static distribution. It is very important for determination of expected power flows to be consistent across the various NYISO and PJM markets to create certainty for market participants as well as to minimize uplift. NYISO and PJM will review their determination of expected power flows after implementation and may make adjustments if greater efficiency is identified. Any adjustments, however, must be made with consideration to PJM and NYISO's FTC/TCC markets, Day-Ahead markets, and Real-time markets. NYISO and PJM are studying several scenarios with different distribution percentages. For illustration purposes within this paper, one of the study scenarios is shown as 32%, 18%, 18%, and 32% over the 5018 line, ABC lines, JK lines, and the Western ties respectively. The LBMPs at the Keystone Proxy Bus will now be weighted according to a distribution that includes the expectation that a portion of scheduled interchange will flow over ABC and JK.

4.2. Bidding

Market Participants will continue to bid in the same manner as they do today. Specifically, there will continue to be a single bidding point for PJM-NY AC Interchange. In the NYISO Day-Ahead and Real-time Markets, this will continue to be at the PJM Keystone Proxy Bus. While the bidding location for PJM-NY AC interchange will not change, the scheduling and pricing of this Proxy Bus will change to include the impacts of ABC and JK.

4.3. Pricing

The price developed for NYISO's PJM Keystone Proxy Bus will now be weighted to include the impacts of ABC and JK, much like it is weighted to include the impacts of the 5018 line today. The NYISO market models will assume, for example, that for every MW injected at its PJM Keystone Proxy Bus, 0.32 MW is directed over the 5018 line, 0.18 MW is directed over ABC, 0.18 MW is directed over JK, and the remainder is distributed across the Western ties. The impacts of imports and exports on the NY transmission system at this Proxy Bus will be reflected in the LBMPs at the PJM Keystone Proxy Bus, weighted by the same power flow distribution percentages applied to the interchange in the NYISO's market models.

4.4. Market-to-Market PAR Coordination

The proposal also includes adding the PARs at ABC and JK into the M2M PAR Coordination program between NYISO and PJM. M2M PAR coordination is a real-time operations mechanism that signals the PJM and NYISO operators when and in which direction taps should be taken on PAR Controlled lines in order to minimize regional congestion. It includes rules governing settlements between the NYISO and PJM in the event that the operation of the PARs is causing congestion in one or both regions.

M2M PAR Coordination involves the following key steps:

1. Developing a target flow on a PAR controlled facilities.
2. Identifying the cost of congestion that each RTO is experiencing on their respective side of the PAR controlled facilities.
3. Informing the operators when and in which direction to take tap moves to shift the flows over these facilities.
4. Calculate settlements between PJM and NYISO when congestion exists on impacted facilities and any over/under deliveries on the PAR controlled lines are increasing congestion in one region. There are numerous rules governing when settlements should or should not apply. The rules are set forth in Section 35.23 of the NYISO's OATT.

The PARs at the ABC and JK interfaces are currently not directly part of M2M PAR Coordination because the primary objective of operating those facilities under the ConEd/PSEG Wheel was to deliver the Wheel over each interface. Without the Wheel, it will now be possible to utilize the ABC and JK PARs and interfaces to help minimize congestion in the PJM and NYISO regions in much the same manner as is currently done using the Ramapo PARs and the 5018 line. Here's how:

Target Flow

A real-time target flow will be calculated for each PAR. This target flow will be derived based in part on the static interchange percentage distributions modeled in the market software. For example, if 18% of total net interchange was modeled to flow over ABC, and the desired net interchange (DNI) was 1,300 MW into NY, then the target flow over the PAR on the A line would be +78 MW ([1300*18%]/3).

Cost of Congestion

The real-time cost of congestion at each PAR Controlled line is simply the sum of the products of the PAR's shift factor on the shadow price of each active constraint. For example, if the NYISO Central East VC constraint is active with a shadow price of -$150, and the A line PAR has a shift factor of

30% on the constraint, then the resulting cost of congestion at the A line would be -$50 (-$150*30%). Negative congestion in NYISO's markets increase LBMPs.

TAP signals

The software will signal to the operators 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. For example, if the NYISO cost of congestion at the A line was -$50, while the PJM cost of congestion at the A line was -$75, the operators would be signaled to take tap moves towards PJM over the A line, since PJM is experiencing higher levels of congestion than NYISO. These tap moves would redistribute the flows across the A line and the other NY-PJM AC facilities (5018, J line, K line, B line, C line and the Western Ties).

RTO-to-RTO settlements

Settlements between NYISO and PJM may occur when over or under deliveries on the PAR controlled lines are increasing congestion in one region, compared to target flows. For example, if flows over the A line are 20 MW below the A line target flow, and NY is experiencing congestion at the A line in the amount of -$50, then a settlement from PJM to NY would be calculated in the amount of $1000 per hour (-20 MW * -$50). This is only a simplified example, as there are numerous rules governing when settlements for M2M PAR Coordination on the 5018 line should or should not apply. Many of these rules are expected to be retained and extended to the PAR Controlled lines at ABC and JK. The currently effective rules are set forth in Section 35.23 of the NYISO's OATT.

5. Planning

The ConEd PESG wheel has historically been modeled in base cases used to perform transmission security, transfer limit, and transmission and resource adequacy studies.

The ConEd PSEG wheel is currently modeled by NYISO and PJM in their planning study power flow base cases by implementing a fixed schedule of 1000 MW flowing from NYISO to PJM over the JK interface and the same 1000 MW level flowing from PJM to NYISO over the ABC interface. For transmission security analysis, the 5018 line was represented with a schedule of 80% of RECO load, consistent with the terms of the current JOA. To represent the wheel cancellation in the power flow, the base cases were modified to represent zero scheduled flow on the JK and ABC interfaces and the same 5018 schedule as before.

To represent the expected impact of the wheel cancellation on transfer limits in the Reliability Needs Assessment (RNA) and Installed Reserve Margin (IRM) resource adequacy studies, distribution factors were initially determined for these impacted paths and other free flowing lines comprising the PJM to NY interface. Based on this analysis, an emergency assistance level of 1000 MW from PJM to NY would distribute over these three PAR controlled interfaces with the individual distribution being

approximately 280 MW for the 5018 line, 200 MW for the JK interface, and 200 MW for the ABC lines. For NY to PJM East, the transfer limits were set to zero on the JK and ABC lines and the 5018 line was as before. These values will be used for the transfer limits on these interfaces for the MARS assessments. These values are subject to change in the future, but provide a starting point for the IRM and RNA studies conducted this year.

6. Long-term

If the PAR Controlled lines at ABC, JK, or 5018 were upgraded in a manner that allowed them to effectively implement an interface-specific interchange schedule, such modeling is possible within the NYISO's market structure. Nothing about this proposal would preclude the ABC or JK interfaces from being modeled as distinct Proxy Buses if the technology were to be upgraded. Please refer to the earlier section of this paper which outlines some of the limitations of the current technology on these PAR Controlled lines.

Appendix A – Examples

Figure 1 illustrates an example of how interchange at the Keystone Proxy Bus is handled today, along with the ConEd PSEG Wheel, in the NYISO Day Ahead and Real-time markets.

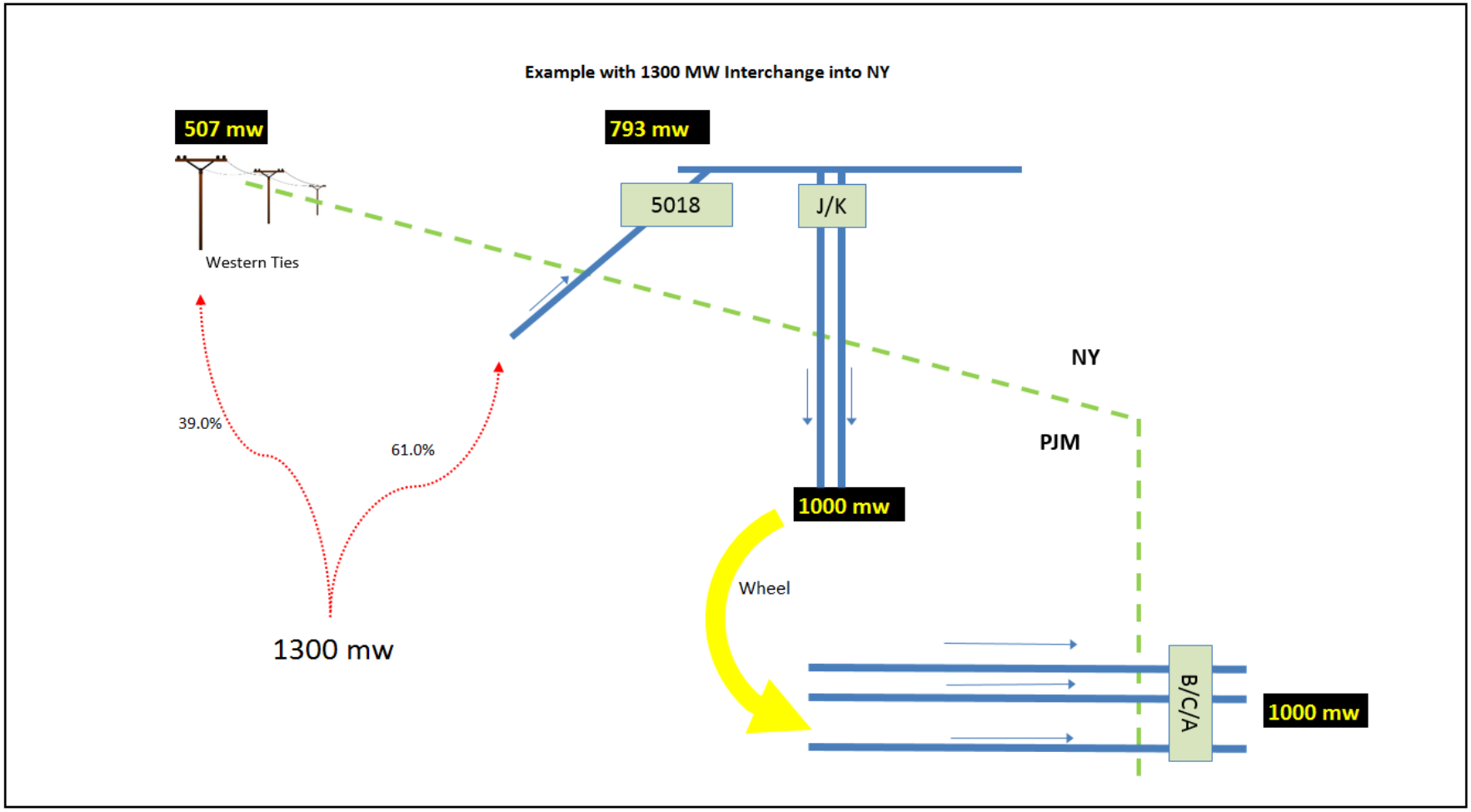

Figure 1: Interchange into NY - Today's view

Figure 2 illustrates an example of the NYISO-PJM proposal for handling interchange once the ConEd PSEG Wheel is no longer in place.

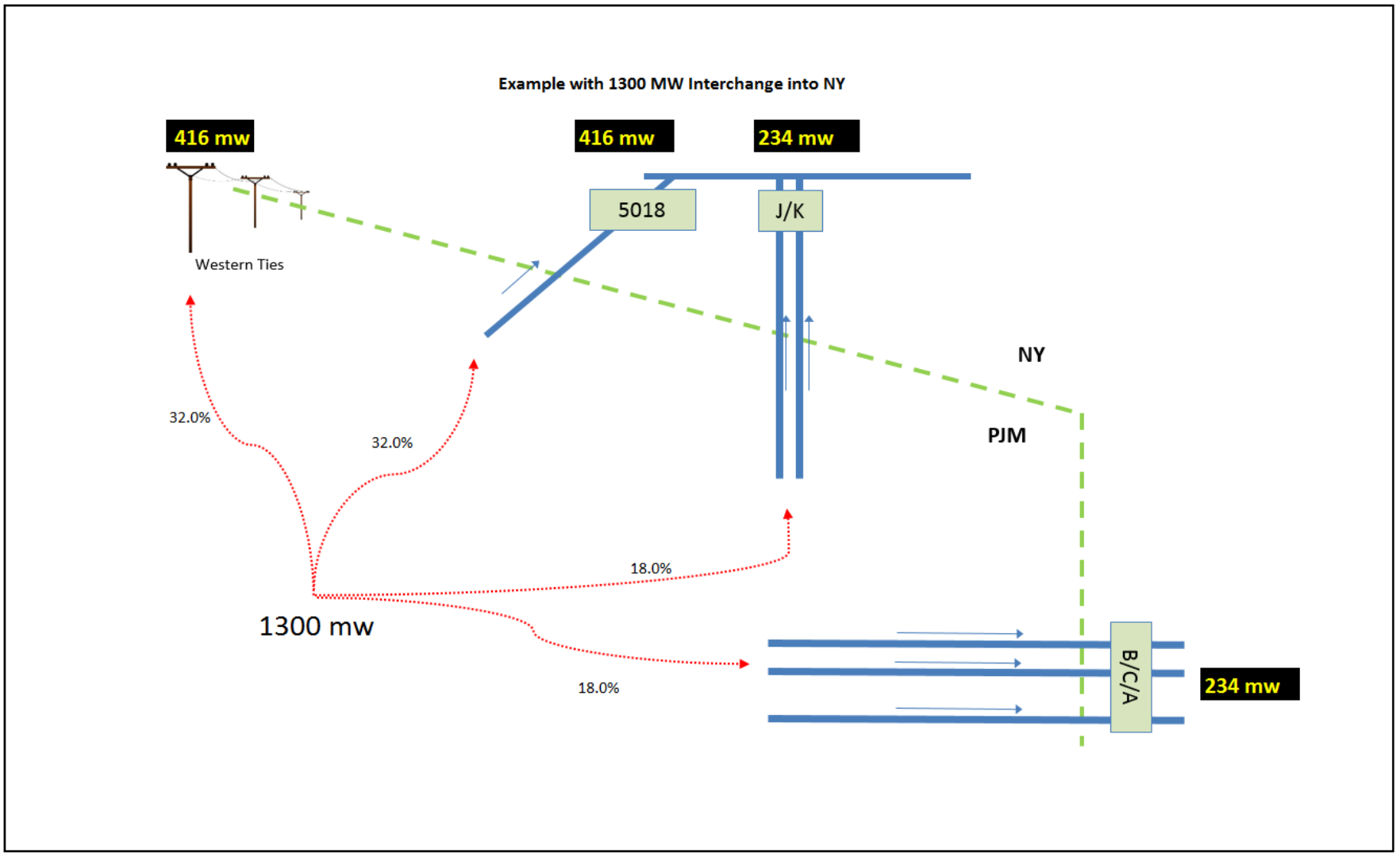

Figure 2: Interchange to NY – Proposed

Figure 3 illustrates the same example as in Figure 2, except in the export direction.

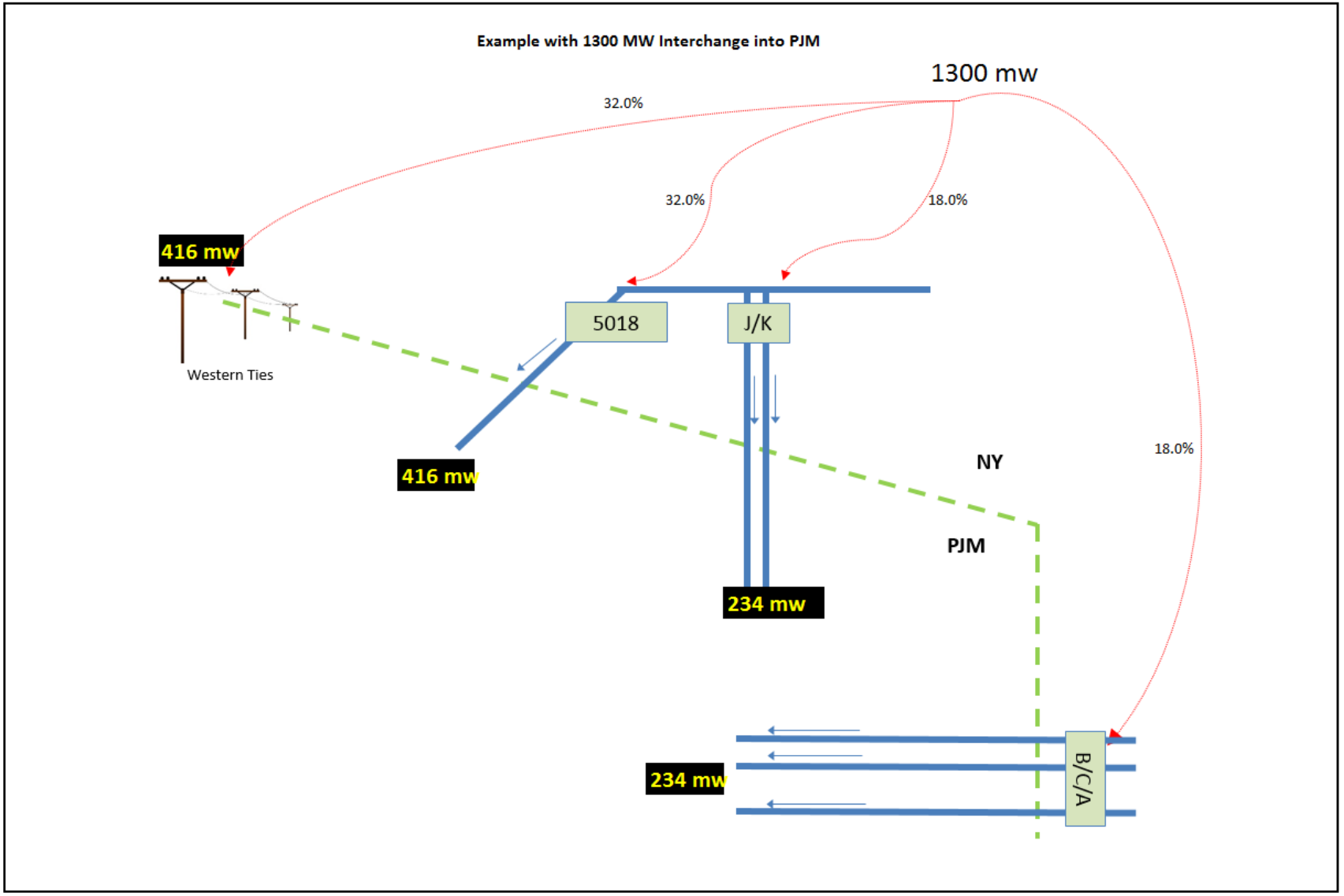

Figure 3: Interchange to PJM – Proposed

Figure 4 illustrates an example of M2M PAR Coordination on all of the PAR Controlled lines. The target flows are based in part on the previously mentioned interchange distribution percentage.

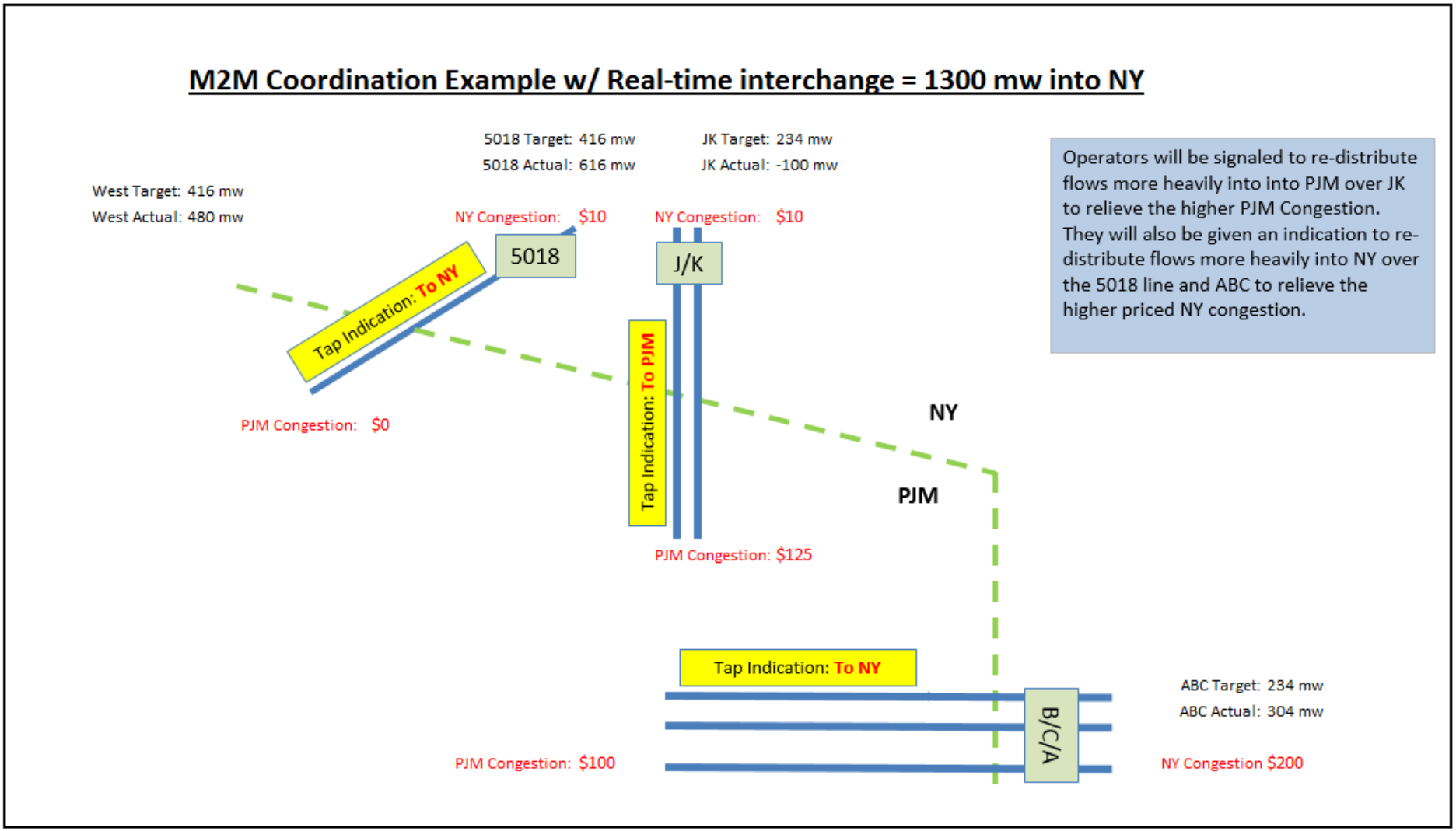

Figure 4 – M2M Example - Proposed