Con Ed/PSEG Wheel Replacement Proposal

A joint white paper from the New York Independent System Operator and PJM Interconnection

Reposted - Revisions in red font

DRAFT – For Discussion Purposes Only

V 2.0
October 4, 2016

Table of Contents

Background

On April 28, 2016, Con Edison announced its intent to terminate its 1,000 megawatt (MW) long-term firm point-to-point Transmission Service Agreement with PJM that is commonly referred to as the "ConEd/PSEG Wheel", effective May 1, 2017. The non-conforming Wheel service has historically been implemented by the 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 the NYISO and PJM. The Joint Operating Agreement (JOA) between the New York Independent System Operator Inc. and PJM Interconnection (NYISO OATT Section 35.22) governs how NYISO and PJM operate to implement the Wheel. The JOA also governs Market-to-Market (M2M) Coordination between the NYISO and PJM, including several elements related to the ConEd PSEG Wheel. To address NYISO and PJM operations moving forward, the JOA will need to be revised to reflect market and operational changes without the ConEd/PSEG Wheel.

The NYISO and PJM have been developing 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 the Joint Operating Agreement between the New York Independent System Operator Inc. and PJM Interconnection, as well as Attachment B of the NYISO Market Services Tariff.

1. Critical factors to a solution

The following were 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. Definitions

Non-conforming Wheel:
The non-conforming Wheel (as defined in the PJM OATT) is a transmission service contract that physically transfers MWs between NYISO and PJM through a fixed MW level flowing from NYISO to PJM over the JK (Ramapo – Waldwick) interface, and from PJM to NYISO over the ABC (Linden – Goethals and Marion/Hudson – Farragut) interface

JK interface:
Ramapo (NYISO) – Waldwick (PJM) 345 kV interface that is controlled by three parallel PARs at Waldwick 230 kV that are in-series with the JK interface.

ABC interface:
The Linden (PJM) – Goethals (NYISO) 230 kV ("A"), The Hudson (PJM) – Farragut (NYISO) 345 kV ("B") and the Marion (PJM)-Farragut (NYISO) 345 kV ("C") PAR controlled transmission facilities make up the ABC interface.

5018 line:
This is the Hopatcong (PJM) – Ramapo (NYISO) 500 kV PAR controlled facility

Western ties:
The non-PAR controlled free flowing AC ties between NYISO and PJM that are geographically located on the New York to Pennsylvania border. This interface consists of 345 kV, 230 kV and 115 kV transmission facilities.

Operational Base Flow (OBF): A MW offset to account for natural system flows over the JK interface and the ABC interface in order to facilitate the reliable operation of the NYISO and PJM transmission systems.

2. 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 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.

When there are under- or over-deliveries across one interface, the difference can be balanced across the other interfaces.

Below are 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 and 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.

1.1. Interchange Scheduling

4.1.1. Current Process

The proposal to incorporate ABC and JK into the larger PJM-NY AC Proxy Bus definition is similar to 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 of total interchange injected at the Proxy Bus in the Day-Ahead market, and for every MW of incremental change in interchange injected at the Proxy Bus in the Real-time market, 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 (MP) submits an economic offer to import or export energy between PJM and NY, both PJM and NYISO economically evaluate the offer against all other offers from internal 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. The congestion impacts of proposed imports and exports on the PJM transmission system are considered in PJM's market evaluation and are reflected in the Locational Marginal Prices (LMPs) at the NYIS Proxy Bus. In other words, if an export at the Proxy Bus is contributing to congestion on the NY or PJM transmission system, the specific impact of that export on NY or PJM congestion will be reflected in the Keystone Proxy Bus LBMP or NYIS Proxy Bus LMP, respectively. If an export aggravates an internal transmission constraint, the resulting congestion will make the corresponding Proxy Bus LBMP/LMP higher. Thus, the exporter will pay more to export energy out of NY or PJM. If the export relieves an internal NY or PJM transmission constraint, the resulting congestion impact will make the corresponding Proxy Bus LBMP/LMP lower. Thus, the exporter will pay less to export energy out of NY or PJM. 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 initially studied several scenarios with different distribution percentages. Results identified reliability issues in Northern New Jersey as well as delivery limitations when exporting from PJM to the NYISO on the JK interface and when exporting from NYISO to PJM on the ABC interface. The results also showed a lack of operational flexibility as phase angle limitations on the Waldwick PARs did not allow for flows to be adjusted to meet scheduled targets. Further studies were performed to help identify an alternative. These

studies focused on natural system flows with zero interchange scheduled between PJM and NYISO and all interface PARs held at neutral tap. PJM and NYISO have defined a natural flow offset as the Operational Base Flow (OBF) with the intent of applying this base flow to the target flow calculations for the JK and ABC interfaces.

NYISO and PJM have agreed to apply an OBF of 400 MW from NYISO to PJM over the JK interface and 400 MW from PJM to NYISO over the ABC interface in addition to the following interchange percentages: 32% over the 5018 line, 21% over the ABC lines, 15% over the JK lines, and 32% over the Western ties. The LBMPs/LMPs at the NYISO Keystone Proxy Bus and the PJM NYIS Proxy bus will be weighted according to a distribution that includes the expectation that a portion of scheduled interchange will flow over ABC, JK, and 5018. For a discussion of treatment of the interchange percentages when one or more PARs are out of service, please see section 4.4 below.

1.2. Bidding

Market participants (MPs) 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. In the PJM Day-ahead and Real-Time Markets, this will continue to be at the NYIS Proxy bus. While the bidding location for PJM-NY AC interchange will not change, the scheduling and pricing of the Proxy Bus will change to include the impacts of ABC and JK.

1.3. Pricing

The price developed for NYISO's PJM Keystone Proxy Bus and PJM's NYIS Proxy Bus will now be weighted to include the impacts of ABC and JK, much like they are weighted to include the impacts of the 5018 line today. The NYISO and PJM market models will assume, for example, that for every MW of total interchange injected at the Proxy Bus in the Day-Ahead market, and for every MW of incremental change in interchange injected at the Proxy Bus in the Real-time market, 0.32 MW is directed over the 5018 line, 0.21 MW is directed over ABC, 0.15 MW is directed over JK, and the remainder is distributed across the Western ties. The impacts of imports and exports on the NY and PJM transmission systems at the Proxy Buses will be reflected in the LBMPs/LMPs at the Proxy Bus, weighted by the same power flow distribution percentages applied to the interchange in the market models.

1.4. 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:

- Developing a target flow for each PAR controlled facility
- Identifying the cost of congestion that each RTO is experiencing on their respective side of the PAR controlled facilities.
- Informing the operators when and in which direction to take tap moves to shift the flows over these facilities.
- 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 the NYISO-PJM Joint Operating Agreement.

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 MW 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 along with the OBF on the JK and ABC interfaces. For example, if 21% 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 +224.3 MW, *i.e.* ([1300*21%]/3 + 400/3). Consistent with the status quo, 80% of Rockland Electric Company (RECo) load will be included within the target flow toward the NYISO for the 5018 PARs. For example, if the total net interchange was -1,300 MW into PJM and RECo load was 450 MW, then the target flow on 3500 would be -28 MW, *i.e.* ([-1300*32%]/2+[450*80%]/2).

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 33% on the constraint, then the resulting cost of congestion at the A line would be roughly -$50, *i.e.* (-$150*33%). Negative congestion in NYISO's markets increases LBMPs.

PAR(s) Out of Service

If any NY-NJ PAR is out of service, the percentage of interchange normally assumed to flow over that PAR will instead be assumed to flow over the Western Ties. In the event one PAR is out of service on the 5018 interface, the full 80% of RECo load will be shifted to the target flow of the in service 5018 PAR. In the event

both PARs for the 5018 interface are out of service, RECo load will be assumed to be served over the Western Ties.

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 the NYISO-PJM Joint Operating Agreement.

3. Planning

The ConEd PSEG Wheel has historically been modeled in base cases used to perform transmission security, transfer limit, deliverability, economic, and resource adequacy studies.

The ConEd PSEG Wheel was previously 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 a fixed schedule of 1000 MW flowing from PJM to NYISO over the ABC interface.

PJM and NYISO Planning are discussing treatment of the operational concepts in their future planning cases. Both PJM and NYISO planning will address treatment of these Operational concepts as part of their respective planning stakeholder processes

4. Long-term

The proposal outlined within this whitepaper is based on the current technology that exists at the ABC and JK interfaces. The NYISO and PJM would have to revisit this design if the technology is upgraded or replaced.

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 5018, 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.

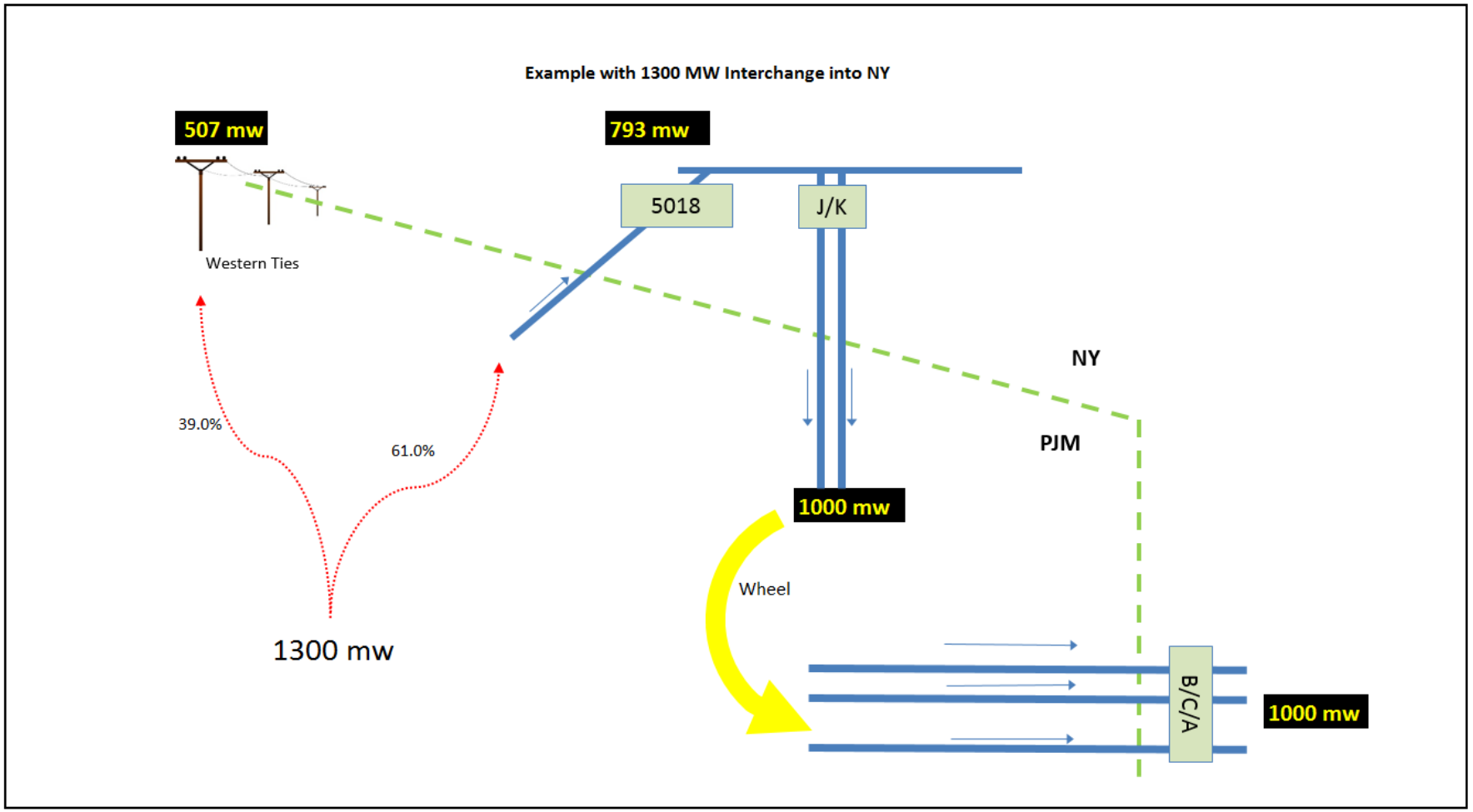

Figure 1: Interchange into NY - Today's view

Figure 2 illustrates an example of the NYISO-PJM proposal for handling interchange once the ConEd PSEG Wheel is no longer in place. This example assumes RECo load is 450 MW.

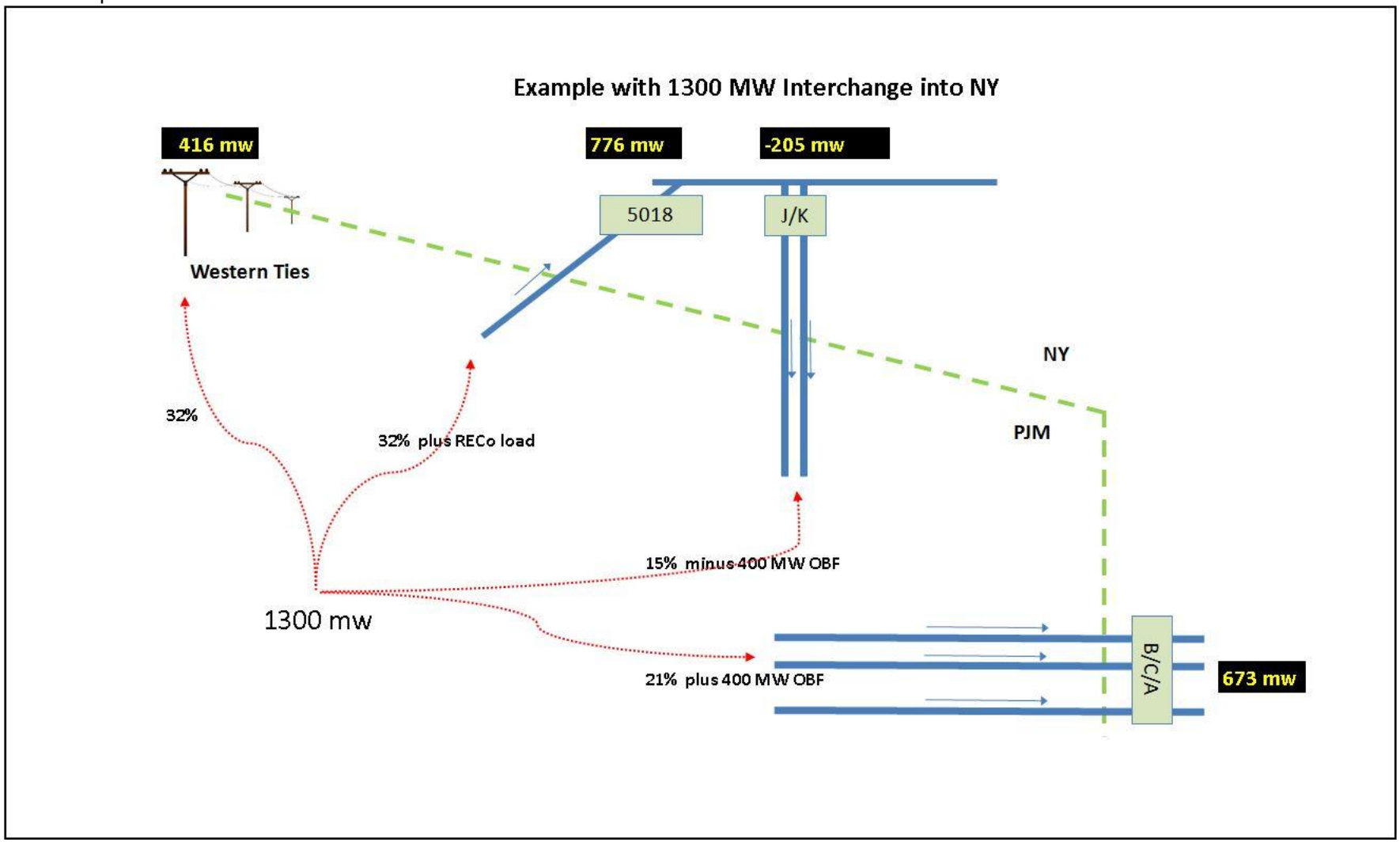

Figure 2: Interchange to NY – Proposed

Figure 3 illustrates the same example as in Figure 2, except in the export direction. This example assumes RECo load is 450 MW.

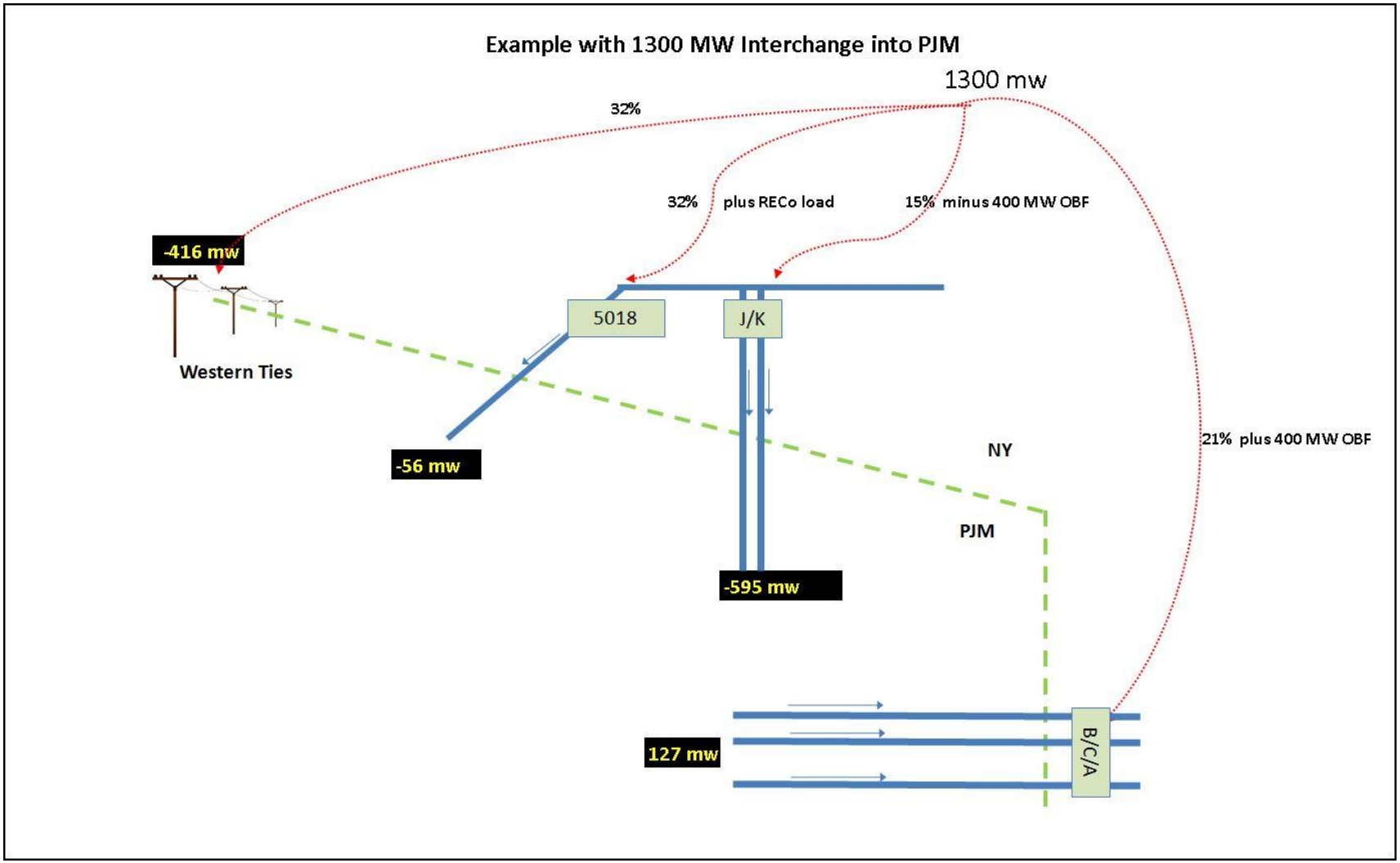

Figure 3: Interchange to PJM – Proposed