



PJM Interface Price Definition Methodology

1 Proxy Pricing

For transactions that either source or sink outside of the PJM footprint, a means to price the transactions at the PJM boarder is required. A proxy price for transactions to and from external control areas and PJM is created from a set of external buses. The proxy price is often referred to as an interface price. The term *interface price* will be used in this document instead of proxy price.

The challenge is creating an interface price that is made up of external pricing points that not only accurately represents the tie line flows between the two areas, but also produces the correct pricing signals.

2 Interface Names

The first step in this process is to identify all adjacent control areas. These will serve as the basis for interface prices. The abbreviation of the adjacent control area is used as the name for the interface price. For example, in determining the interface prices for the New York RTO, the NY control area is adjacent to PJM. The abbreviation of the NY control area, “NYIS”, was used as the name for that interface price.

3 Control Area Mapping

Using standard power flow analysis tools, transactions to and from each external control area are simulated in order to obtain distribution factor data. This distribution factor data is then analyzed to determine through which adjacent control area the majority of flow will occur. By calculating the correlation coefficient of the external area distribution factor with the distribution factor for each of the adjacent control areas, the mapping of all external control area with one of the adjacent control areas can be determined.

4 Combining Interfaces

The distribution factor analysis may show that certain adjacent control areas have a coherent response on the ties with PJM. If this is observed, then the adjacent control areas can be “combined” to use a common definition. The definition can be external pricing points from just one adjacent control area or a combination of external pricing points in both of the adjacent control areas. The analysis for the ComEd integration showed that certain adjacent control areas showed a coherent response to other adjacent



control areas. The MidAmerican Energy Company, MEC, and Alliant Gas & Electric West, ALTW, is an example where the definition for each interface is the same and composed of a combination of external pricing points from both adjacent control areas.

Furthermore, the analysis for the AEP and Dayton integration showed a great deal of adjacent control areas having coherent responses on the ties between the adjacent control area and PJM. Because of the large number of adjacent control areas and the amount of adjacent control areas that showed coherent responses on the PJM ties, interface pricing points were created that represented several adjacent control areas. The external pricing points from each adjacent control area in these grouping were used to define the interface price. The Southwest interface price is an example of this single interface price used to represent several adjacent control areas.

5 Non Adjacent Interfaces

There have been situations where a transaction from an external control area results in similar tie line flows on multiple interfaces. When the multiple interfaces do not share the same interface price definition, additional analysis is needed to determine if an additional interface is needed to represent the transaction. This situation is evident when the correlation coefficients of an external control area are similar to one or more adjacent control areas. The additional interface would model the combined effect of transactions from the external area across the various PJM tie lines as seen in the correlation coefficient analysis. An example of this situation exists in the Ontario Independent Market Operator (IMO) interface.

6 Interface Price Calculation

Given that the interface proxy price is defined as a combination of several individual pricing nodes or external pricing points, within the external area, a means of determining the weighting of the external pricing points is needed. Originally, the external pricing points used in the calculation of an interface price were given equal weighting. However, because these interface prices could reflect large geographic areas, the equal weightings could result in prices that don't accurately reflect the system conditions.

For example, the interface price for the NYISO is calculated from two external pricing points within the NYISO area. One pricing node, Roseton, is located in the eastern part of the state, north of New Jersey and the NYC area. The other pricing node, Dunkirk, is located in the western part of New York State. Using equal weightings for these two external pricing points would not allow the interface price to accurately reflect constrained conditions between PJM and the NYISO. If there were increased flows between PJM and NYISO in the New Jersey and New York area, the equal weightings would mean a much lower interface price would be calculated than truly existed. Therefore, calculating interface prices using a dynamic means of weighting the external pricing points was needed.



7 Dynamic Definition Process

The dynamic interface pricing calculation uses actual system conditions to determine a set of weighting factors for each external pricing point in an interface price definition. The weighting factors are determined in such a manner that the interface price reflects actual system conditions. The process requires defining a set of tie lines, assigning external pricing points to the tie lines, and then dynamically calculating the weightings.

7.1 Tie Lines

The tie lines used in the dynamic weighting calculation are obtained from the list of all tie lines between PJM and the external control area. From the list of all tie lines and using system topology a sub set of major tie lines are determined. This sub set of tie lines includes the dominate transmission lines (usually 765 kV, 500 kV, 345 kV, and 230 kV) along with any lower voltage tie lines that are needed to gain enough tie flow information to properly weight each external pricing point.

7.2 Tie Line Association

Each external pricing point in an interface definition is associated with one of the tie lines defined. The sensitivity of the tie lines to an injection at each external pricing point is used to determine the association. Each external pricing point must have at least one associated tie line but in most cases has multiple tie line associations.

7.3 Dynamic Weighting Calculation

The dynamic weighting calculation uses the actual tie line flow and tie line ratings to determine a relative loading level for each external pricing point in the interface definition. Once this node loading level is calculated, they are normalized in order to obtain the final weighting factors.

For each external pricing point, n , determine the relative loading level by taking the sum of the tie line flows divided by the sum of tie line ratings for all associated tie lines.

$$NodeLoading_n = \frac{\sum_l TieLine_l^{flow}}{\sum_l TieLine_l^{rating}} \quad (1)$$

Where l is a list of all tie lines associated with interface pricing node n .

The final weightings for the external pricing points are determined by normalizing the $NodeLoading_n$ percentages calculated for the interface.



$$Weighting_n = \frac{NodeLoading_n}{\sum_n NodeLoading_n} \quad (2)$$

7.4 Example Calculation

For example, an interface is defined by two external pricing points A and B with pricing node A having tie lines 1 and 2 associated with it and pricing node B being associated with tie lines 3, 4 and 5. Tie lines 1 and 2 each have a 100 MW rating and actual flows of 90 and 95 respectively. Tie lines 3, 4 and 5 have ratings of 200, 500, and 300 with actual flows of 100, 230 and 160 respectively. Using equation 1 we get the following node loading levels

$$NodeLoading_A = \frac{90 + 95}{100 + 100} = \frac{185}{200} = 92.50\%$$

$$NodeLoading_B = \frac{100 + 230 + 160}{200 + 500 + 300} = \frac{490}{1000} = 49.00\%$$

From these node loading levels we then normalize the values for each external pricing point to obtain the final weighting factors.

$$Weighting_A = \frac{92.50}{92.50 + 49.00} = 65.37\%$$

$$Weighting_B = \frac{49.00}{92.50 + 49.00} = 34.63\%$$