PJM Marginal Zone Participation Factor Calculation Method & Applicability to Relevant Calculation

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i) Introduction

'Marginal Zone Participation Factor' and 'Marginal Zones' are terms widely recognized by the Interchange Distribution Calculator (IDC) users and working group. Marginal zone participation factor concept was introduced to calculate more granular and efficient tagged transaction impact with respect to seams (coordinated and reciprocally coordinated) facilities. The aforementioned tagged transactions that are subject to the impact calculation are between external (market based or non-market) entities and a centralized economic generation dispatch based entity. Marginal Zones are defined by market based operating entities in an attempt to adhere to the seams agreements.

ii) Basic Theory

Marginal Zones are developed based on fleets generating asserts that exhibit common characteristics to seams facilities. Marginal Zone Participation Factors are calculated to gauge participation of marginal resources within marginal zones in order to accommodate import or export transaction curtailments. Hence, there exist two sets of Marginal Zone Participation Factors: one set for imports and one set for exports. Every marginal zone will produce an import participation factor and export participation factor every 15 minutes and these participation factors could be understood as common distribution factors representing each marginal zone.

iii) Key Terms

a) Marginal Units – Units that change their output to accommodate import/export changes
b) Mobility Factors – Factor that described whether a unit is flexible (1) or inflexible (0)
c) Real-time Gen – State Estimator (real-time) Generator output data
d) RTSCED – Real-time Security Constrained Economic Dispatch Tool
e) SCED Scenarios – SCED base case, high case (positive bias case) and low case (negative bias case)
f) FFE – Firm Flow Entitlement (Applicable to Reciprocal Flow Gates)
g) FFL – Firm Flow Limit (Applicable to non-Reciprocal Flow Gates)
h) IDC – Interchange Distribution Calculator
i) TLR – Transmission Load Relief (Initiated via IDC)
j) TDF – Transfer Distribution Factor (Impact of transactions calculated in the IDC)

iv) Calculation Details

a) Marginal Zone Participation Factor Details

PJM's Marginal Zone Participation Factor calculation is based on PJM's Real-time Security Constrained Economic Dispatch (RTSCED) solution's marginal unit data. The RTSCED application is the software tool that PJM operators utilize to develop real time dispatch instructions sent to resources under PJM dispatch control. The RTSCED application utilizes input data such as the very short-term load forecast, scheduled interchange, physical unit constraints, etc. in order to look about 15 minutes into the future to determine the optimal dispatch solution and individual unit dispatch instructions transmitted to resources about every five minutes. PJM RTSCED provides 3 scenarios for each solution interval. These 3 scenarios are known as Low, Base and High scenarios. The Base scenario essentially utilizes the input data as it is received from the data sources in order to determine a dispatch solution. The Low (negative bias) and High (positive bias) scenarios are biased with respect to the Base scenario from the standpoint of the amount of load that must be served in the RTO. In other words, the Low scenario determines a dispatch solution assuming that fewer resources will need to be dispatched compared to the Base scenario, while the High scenario determines a dispatch solution assuming that more resources will need to be dispatched compared to the Base scenario. These Low and High scenarios are utilized for the purposes of the Marginal Zone Participation Factor calculation in order to identify the resources that would be on the margin given a loss of RTO exports or a loss of RTO imports. This approach to model export/import impact using RTSCED has been established to complement IDC (Interchange Distribution Calculator) TLR (Transmission Loading Relief) curtailment concept. Following table provides a pictorial view for reader's enhanced understanding of the Marginal Zone Participation Factor Details.

-300 (Export)   +300(Import)
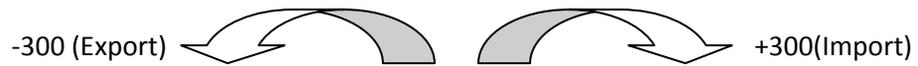
Generator	Low Case Output (MW)	Base Case Output (MW)	High Case Output (MW)
G1	800	1000	1300
G2	900	1000	1000
G3	1000	1000	1000

Table 1

b) Calculating Import and Export Marginal Zone Participation Factors

In Table 1 if RTO were to provide 300MW of exports that the RTO is providing those exports using G1 and G2 at 67% and 33% of participation respectfully. In the same manner one could calculate the import participation as well to be G1 at 100%.
For RTO Imports, associated marginal unit data is utilized to derive a participation factor for each marginal zone. Consider Table 2.

+300(Import)

Generator	Marginal Zone	Base Case Output (MW)	High Case Output (MW)	Import Marginal Zone Participation Factor
G1	MZ1	1000	1300	100%
G2	MZ2	1000	1000	0%
G3	MZ3	1000	1000	0%

Table 2

Table 2 exhibits that the only generator that will participate in the import calculation is G1 and that generator belongs to MZ1 or Marginal Zone 1. There-fore MZ1 will receive 100% import marginal zone participation while MZ2 and MZ3 will receive 0% import marginal zone participation.

For RTO Exports, associated marginal unit data is utilized to derive a participation factor for each marginal zone. Consider Table 3.

-300(Export)

Generator	Marginal Zone	Low Case Output (MW)	Base Case Output (MW)	Export Marginal Zone Participation Factor
G1	MZ1	800	1000	67%
G2	MZ2	900	1000	33%
G3	MZ3	1000	1000	0%

Table 3

Table 3 exhibits that the generators that will participate in the export calculation are G1 and G2. G1 will provide 67% participation and G2 will provide 33% participation. G1 belongs to MZ1 marginal zone and hence the MZ1 export marginal zone participation will be 67%. G2 belongs to MZ2 marginal zone and

hence the MZ2 export marginal zone participation will be 33%. G3's export participation is 0% and hence the MZ3 export marginal zone participation will be 0%.

    c)   Calculating Mobility Factors

Mobility Factor in an import calculation, this calculation will impact Marginal Zone Participation Factor, Market Flow, Firm Flow Entitlement and IDC Transfer Distribution Factor calculations. Mobility Factor for a given generator describes its flexibility. If a generator is flexible then the mobility factor of that resource is 1 and if a generator is in-flexible then the mobility factor of that resource is 0. PJM will calculate mobility factors on a Day-ahead basis and on a Real-time basis to capture generator conditions that impacts Marginal Zone Participation Factor calculations. When calculating mobility factors PJM look for the following characteristics.

    1)   Unit Type
    2)   Unit Status
    3)   Unit Generation Parameters

v) Market Flow Impact

Market flow will be adjusted to accommodate export transactions similar to the following:

$$UnitExpAdj\,Sch_{pn} = \text{Max}\left(0,\ SE1\_GENpn * \left\{1 - \left(\frac{MF_{pn} * PF_{pn} * RTO\_EXP}{\sum_{pn} MF_{pn} * SE1\_GENpn}\right)\right\}\right)$$

$$SE1\_GENpn = \text{Pnode AdjustedGenSchedule}$$

$$MF_{pn} = \text{Pnode Mobility Factor}$$

$$PF_{pn} = \text{Pnode Participation Factor}\ (*\text{Note: } PF_{pn} = PF_{mz})$$

$$RTO\_EXP = \text{RTO Export}$$

Market Flow will be adjusted to accommodate export transactions similar to the following:

$$Load\,Im\,pAdjSch_{pn} = \text{MAX}\left(0,\ SE1\_LOADpn * \left\{1 - \left(\frac{PF_{pn} * RTO\_IMP}{\sum_{pn} SE1\_LOADpn}\right)\right\}\right)$$

$$SE1\_LOADpn = \text{Pnode AdjustedLoadSchedule}$$

$$PF_{pn} = \text{Pnode Participation Factor}\ (*\text{Note: } PF_{pn} = PF_{mz})$$

$$RTO\_IMP = \text{RTO Import}$$

vi) Firm Flow Entitlement/Firm Flow Limit Impact

Marginal Zone Participation factors will impact the FFE/FFL calculations. FFE is calculated for Reciprocal Flow Gates and FFL is calculated for non-Reciprocal Flow Gates.

Recipricol FG

    Fwd FFE = DayAheadGenToLoad + (2DayAheadAllocation - (DayAheadGenToLoad + CurrentRTPointToPoint)
    if((2DayAheadAllocation - (DayAheadGenToLoad + CurrentRTPointToPoint) < 0 the take leser of 2DayAheadAllocation and DayAheadGenToLoad
    FFE in Reverse Direction is the Lesser of the 2 DA Alloc and DA GtL

Non-Recip FG

    FFL = DayAheadGenToLoad + [(2DayAheadGenToLoad + 2DayAheadPointToPoint) - DayAheadGenToLoad +   CurrentRTPointToPoint)]
    [(2DayAheadGenToLoad + 2DayAheadPointToPoint) - (DayAheadGenToLoad + CurrentRTPointToPoint)] will default to 0 if less than 0
    (2DayAheadGenToLoad + 2DayAheadPointToPoint) compared to (FgLimit - TRM - CBM) will take the lesser.

Both FFE and FFL include Current RT Point to Point impact calculation. In order to determine the RT PTP impact OATI will utilize the marginal zone participation factors.

vii) Transfer Distribution Factor (TDF) Impact (IDC Impact)

IDC will produce series of calculations to derive transfer distribution factors that is used in the IDC TLR process. Refer to the following calculations:

1. Compute the GSFs for each generator in the control area

2. Compute the control areas' zonal-TDF:

$$ZTDF_n = (\Sigma_i \, MF_i \times D_i \times W_i \times GSF_i) \, / \, (\Sigma_i \, MF_i \times D_i \times W_i)$$

   Where:

   - $ZTDF_n$ is the zonal-TDF for zone n,
   - MF_i is the mobility factor of generator i in zone n,
   - D_i is the generator i derating factor,
   - W_i is the generator i weighting factor (MBASE), and GSF_i is the generator i GSF.

3. Compute the control areas' TDF:

$$TDF_m = (\Sigma_n \, MZF_n \times ZTDF_n) \, / \, (\Sigma_n \, MZF_n)$$

   Where:

   - TDF_m is the control area TDF for area m,
   - MZF_n is the MARGINAL ZONE factor of zone n, and
   - $ZTDF_n$ is the zone n TDF.

In Step 3 of the TDF calculation, IDC will utilize the MZF, which is the marginal zone participation factor data to derive final TDF values.