Interface Pricing Update and Analysis of Near-Term Solutions

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Why are Interface Prices Important?

- Interface pricing is essential because:
  - ✓ It is the sole means to facilitate efficient power flows between RTOs.
  - ✓ Poor interface pricing can lead to significant uplift costs and other inefficiency.
  - ✓ They are an essential basis for "coordinated transaction scheduling" or "CTS" to maximize the utilization of the interface.
- One of the key components of the interface price is the congestion component, which reflects the estimated effect of transactions on any constraint in an RTO's market that is binding.
  - ✓ If the congestion component is not calculated accurately or neighboring RTOs price the same constraint, the incentive to import or export will be distorted and the transactions will be inefficient.

Why are Interface Prices Important?

To illustrate why interface prices are so important, consider the following day-ahead pricing results from 2015:

- Interface LMPs: PJM = 28.21, MISO = $27.75 **Diff = 1.7%**

  → *Good convergence, but external transactions may not be efficient.*

- Energy Component of LMP: PJM = $33.95, MISO = $26.39 **Diff = 29%**

  → *PJM is running more expensive generation to displace lower-cost MISO generation.*

  → *Why? Because they believe this is relieving congestion.*

- Interface Congestion Component: PJM = -$4.10, MISO = $1.13

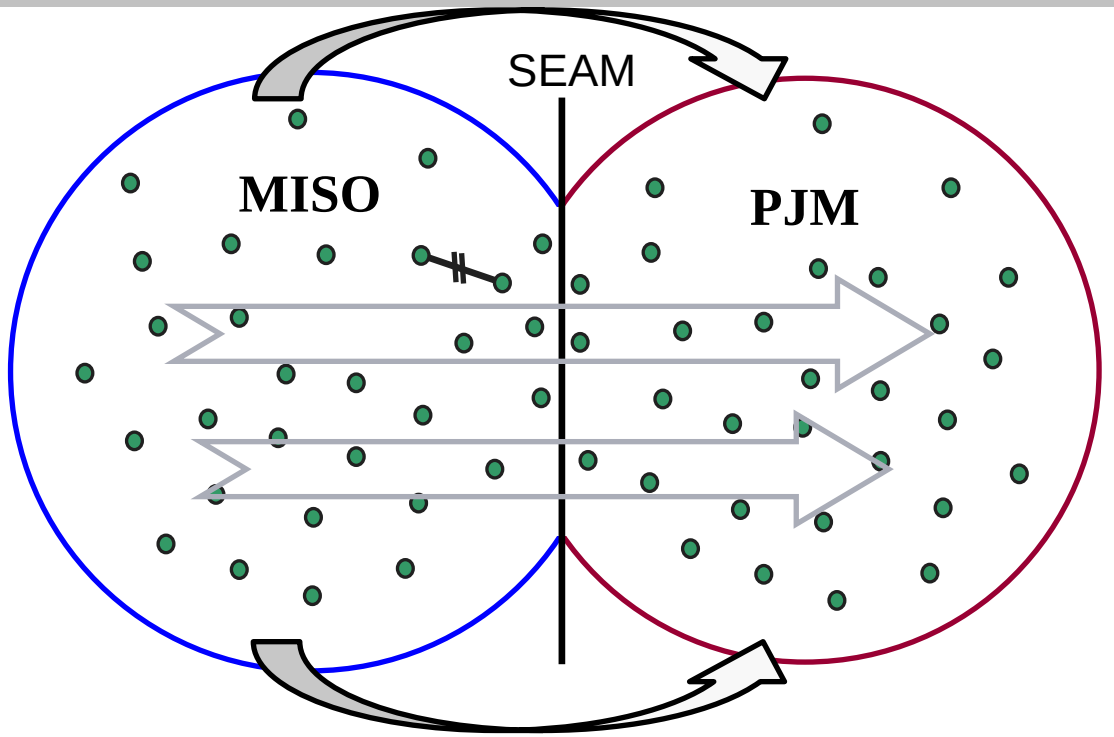
  → *PJM's large congestion price is substantially overstated because of its interface definitions and the limited scope of its transmission model.*

  → *This underscores why interface pricing is so important.*

Calculating the Congestion Component at the Interface

- The congestion included in the interface price should reflect how imports and exports affect the flow over a constraint.
- Calculating the congestion component for a generator is much easier because the RTOs know the source of the power.
- RTOs must assuming a source(s) for an import, which we call the "interface definition".
- RTOs use this assumed source (the interface definition) to estimate how imports (and exports) will affect the flow over a constraint
  - ✓ This effect is called a "shift factor" that indicates the share of the import that will flow over a constraint.
  - ✓ The shift factor is multiplied by the marginal value of the constraint (i.e., the shadow price) to determine the congestion component.
- Much of the debate in this area relates to what interface definition to assume when calculating the congestion.

What is an Interface Definition?



- In reality, when power moves from one area to the other, generators ramp up throughout one area and ramp down throughout the other area (marginal units).
- Assuming realistic sources and sinks for transactions is critical because it determines how the RTO will expect the power flow over the system.

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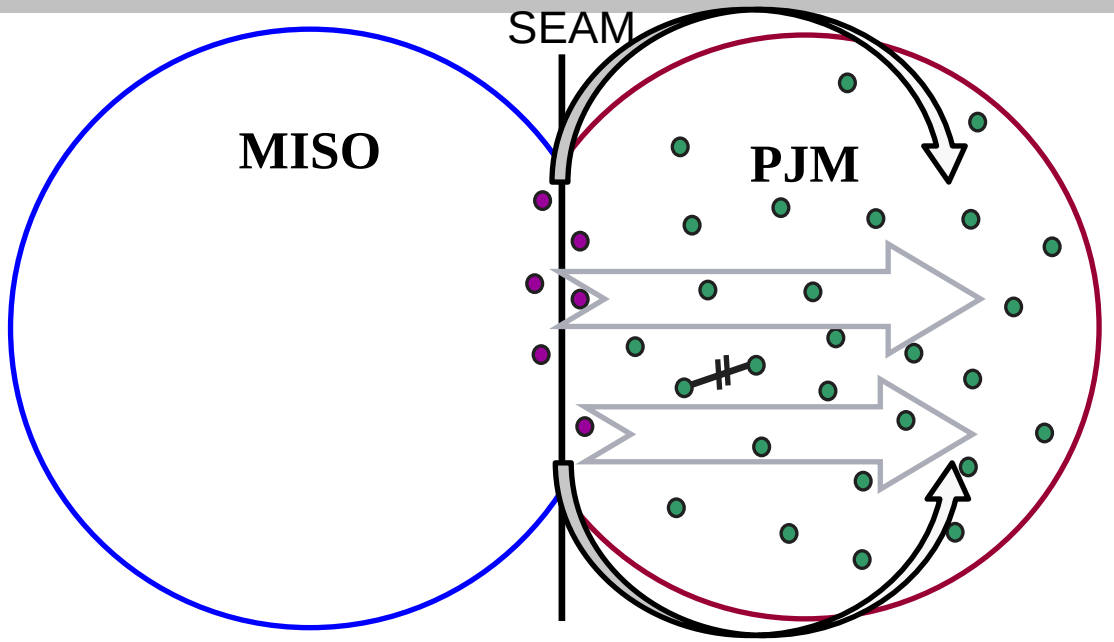
PJM's Interface Definition for Non-M2M Constraints



- PJM advocates using and interface definition comprised of a small number of points at the seam – this substantially changes the estimated flows.
- This approach predictably:
  - ✓ Underestimates the amount of power that will loop outside of the RTOs; and
  - ✓ Overestimate flows over the internal lines, especially ones closer to the seam.
- The may be advocating this because they don't model the network very far into areas outside of MISO.

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Where Does the Power Source in MISO?

- The central issue in determining a reasonable interface definition is to identify where the power sources for exports (or sinks for imports).
- In any interval, the power supporting an export will source at MISO's marginal generators.
- We identified MISO's marginal generators in 2014 (see the table below):
  - ✓ There were many marginal generators in most intervals.
  - ✓ The distribution of the marginal generators was roughly consistent with the distribution of load and generation.
  - ✓ There was no bias for generators located near the PJM seam.
- Based on these results, the Reference Bus (weighted by load) is a reasonable interface definition.

	Source Areas	Generator Share	Load Share
Central Region	**47%**	52%	53%
North Region	**16%**	22%	22%
South Region	**36%**	26%	25%

Interface Pricing Issues to Address

- There are 2 key issues to address related to interface pricing:
  1. Establishing interface definitions that allow the RTOs to calculate accurate congestion components at the interface.
  2. Coordinating the pricing of external constraints because M2M and TLR processes cause both RTO's to price the *same* constraint (which can result in duplicative settlements).
- The RTO's have been discussing two potential long-term solutions:
  - ✓ Allowing the monitoring RTO to fully price its own constraints (i.e., remove all external congestion from each RTO's interface prices) ; and
  - ✓ Establishing a common interface at the seam, resulting in congestion prices from both RTOs for all market-to-market constraints.
  - ✓ The JOA settlements should modified to conform to either approach.
- Because these may be difficult to implement, the RTOs have been discussing short-term options that we are working with MISO to evaluate.

Near-Term Alternatives Evaluated

MISO Incremental Improvement:

- MISO removes congestion price for all external constraints (incl. PJM).
- Pros and Cons:
  - \+ Eliminates redundant payments for PJM M2M constraints;
  - \+ Retains efficient pricing of non-M2M constraints; and
  - – Retains status quo for MISO M2M constraints.

"Collaborative" PJM Interface Approach:

- Both RTO's adopt common interface at the seam.
- Pros and Cons:
  - \+ Eliminates duplicate estimates of physical flow effects on PJM and MISO M2M constraints;
  - – Creates pricing concerns when shadow prices do not converge;
  - – Distorts congestion effects on non-M2M constraints.

Analysis to Evaluate the Short-Term Approaches

- We've evaluated the two approaches, comparing the 10-point common interface PJM currently uses to the MISO incremental approach.
- We evaluated the effects of the approaches on:
  - ✓ The efficiency of the price signal by calculating the average deviation of the congestion incentive (diff. of the 2 CCs) from our ideal benchmark.
  - ✓ The volatility of the price signal, measured by the change in price from before the scheduling deadline (t–30 min.) to when the transaction flows.
- Our analysis is robust and includes:
  - ✓ Each class of constraints affected by the choice of approaches;
  - ✓ Data for every hour and every constraints was included;
  - ✓ Shift factor and prices are based on the RTO's market models;
  - ✓ Timeframe from 2013 to Fall 2015; and
  - ✓ Effects in the day-ahead and real-time markets.

Results of Short-Term Alternative Approaches

	Average Difference from Ideal			Real-Time Volatility			Preferred Approach	
	Status Quo	Common Interface	MISO Increm.	Status Quo	Common Interface	MISO Increm.	Difference from Ideal	Volatility
Real-Time Market								
Total Effects -- All Constraints	**1.40**	**1.58**	**1.29**	**1.86**	**1.82**	**1.63**	Incremental	Incremental
MISO M2M Constraints	1.95	1.49	1.95	2.70	2.92	2.70	Common	Incremental
PJM M2M Constraints	2.95	1.97	2.53	4.37	3.60	2.84	Common	Incremental
MISO Internal Constraints	0.14	0.86	0.14	0.03	0.02	0.03	Incremental	-
Day-Ahead Market								
Total Effects -- All Constraints	**2.55**	**2.11**	**1.83**				Incremental	
MISO M2M Constraints	1.63	1.60	1.63				-	
PJM M2M Constraints	1.21	0.88	0.49				Incremental	
MISO Internal Constraints	0.33	0.89	0.33				Incremental	

RTOs' Analysis and Plans

- The RTOs have collaborated on an analysis using a planning model and partial data on constraints over the past year.
- On the basis of this analysis, MISO is planning on adopting PJM's current 10-point interface as a common interface.
  - ✓ Unfortunately, the RTOs' analysis is incomplete an unreliable.
  - ✓ The planning model used produces results that are not consistent with the RTO's own transmission models, particularly PJMs.
  - ✓ The RTOs' analysis includes only a fraction of the constraints the would affect the interface prices, and very few MISO non-M2M constraints.
- Based on our much more complete analysis, MISO's decision is a mistake.
  - ✓ The MISO incremental approach establishes more stable and efficient price signals overall.
  - ✓ The common interface can only be reasonable if MISO modifies its software to use a different interface for its internal constraints.
  - ✓ MISO must still resolve the pricing issues associated with all other external constraints (non-PJM) that raise costs to MISO's customers.