



FTR Market Analysis for Financial Risk Mitigation

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June 25, 2019

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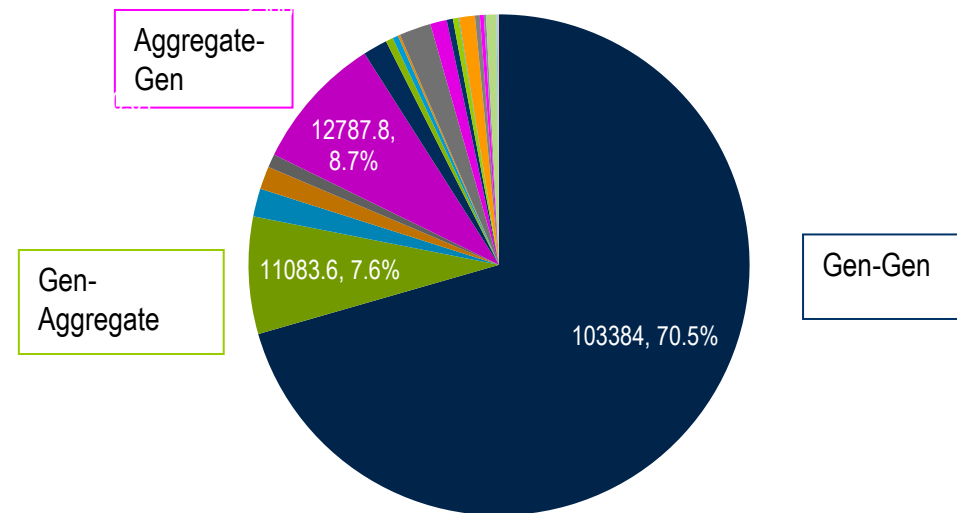
The purpose of this presentation is to share the results of analysis and potential recommendations on how to mitigate risk in the FTR market through:

- Concept of a rolling monthly auction
- Impact analysis of aligning FTR biddable points with day-ahead and real-time physical energy transactions
- FTR Software existing capabilities and potential enhancements

- PJM FTR group performed multiple analyses utilizing study cases derived from:
 - 18/21 long-term auction
 - 18/19 annual auction
 - 2018 JUN BOPP auction
- Key takeaways:
 - Replacing Annual, BOPP, and Long-term auction with monthly auctions will maximize “mark-to-auction” capabilities and modeling capabilities
 - Analysis shows alignment of biddable points aligns FTR and DA constraints which mitigates risk through converging auction prices to their expected value over time

- Promotes enrichment of forward pricing information
 - Better liquidity, price discovery, more granular modeling
- Maximizes “mark-to-auction” credit policy utilization
 - Quicker / more accurate valuation of existing FTR portfolios and corresponding collateral coverage
- Can be implemented with minimum impact to existing ARR annual process
 - Valuation of ARRs would need to change due to the elimination of an annual auction

GreenHat was able to amass an extremely large portfolio which mainly consisted of low-collateral FTRs and FTRs that did not align with actual physical delivery paths



18-19 GreenHat Portfolio Net MW by Path Type

Alignment of FTR with day-ahead and real-time physical constraints

Improved FTR auction case performance

Increased value and prevailing flow across physical delivery paths

Anticipated increased competition along physical delivery paths



Alignment of Constraints – Annual Auction

18/19 Annual Auction Round Binding Constraint Details

Study Case:

Valid sources: Hubs, Interfaces, Zones, Gen Aggregates, Gens

Valid sinks: Hubs, Interfaces, Zones, Load Aggregates

Number of Unique Binding Constraints	Base Case	Study Case	DA 18/19 Planning Period (more than 50 hours, worst case)	Constraints Removed from Base Case/New Study Constraints that did not bind in DA
Round 1	479	180	275	254
Round 2	588	224	275	283
Round 3	629	225	275	303
Round 4	575	207	275	272



Alignment of Constraints – Long-term Auction

18/21 Long Term Auction Round 3 Binding Constraint Details

Study Case:

Valid sources: Hubs, Interfaces, Zones, Gen Aggregates, Gens

Valid sinks: Hubs, Interfaces, Zones, Load Aggregates

Number of Unique Binding Constraints	Base Case	Study Case	DA 18/19 Planning Period (more than 50 hours, worst case)	Constraints Removed from Base Case/New Study Constraints that did not bind in DA
YR1	880	400	275	487
YR2	818	354	275	500
YR3	685	245	275	427



Alignment of Constraints – June BOPP Auction

18/19 JUN BOPP Binding Constraint Details

Study Case:

Valid sources: Hubs, Interfaces, Zones, Gen Aggregates, Gens

Valid sinks: Hubs, Interfaces, Zones, Load Aggregates

Number of Unique Binding Constraints	Base Case	Study Case	DA 18/19 Planning Period (more than 50 hours, worst case)	Constraints Removed from Base Case/New Study Constraints that did not bind in DA
JUN	460	174	275	212
JUL	396	194	275	160
AUG	389	194	275	148

Study Case 1: Bids not on below paths removed

Valid sources: Hubs, Interfaces, Zones, Gen Aggregates, Gens

Valid sinks: Hubs, Interfaces, Zones, Load Aggregates

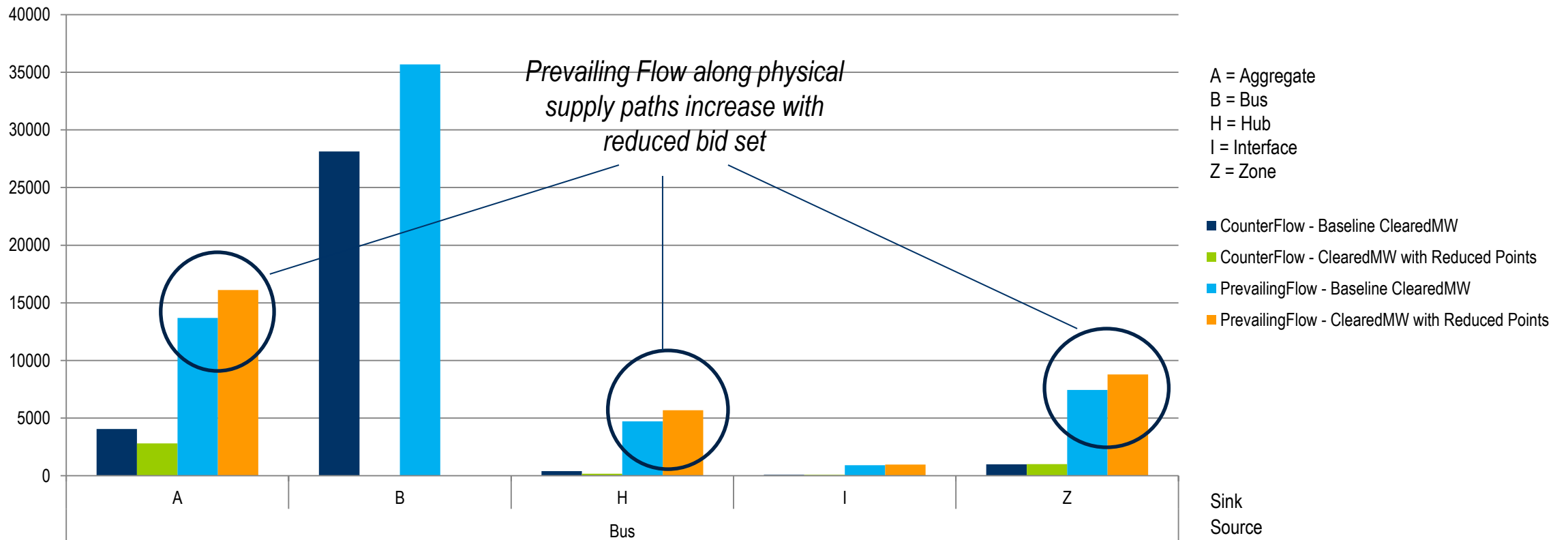
Study Case 2: Bids “backfilled” with above valid paths, i.e. same bid count and MW count from base case

Isolates impacts of added constraints caused by nodal paths

	Base Case	Study Case 1	Study Case 2
FTR 18/21 Long-Term Round 3 Case Solve Time	22:17:28	05:24:40	09:56:51
FTR 18/19 Annual Round 1 Case Solve Time	02:54:42	01:49:59	02:38:36

Nodal bids do not appear to provide meaningful counter flow along physical delivery paths

18/19 Annual Auction Round 1 Cleared MW by Path Type



Case time reduces by 30% on average in the Annual Auction, 5% in the Monthly Auction

Net Auction Revenue collected is reduced by \$6.5M on average in the Annual Auction

No increased risk of a default is apparent by eliminating FTR Options

Expanded Option Paths and Bids will severely increase case execution time

- Maximum cases that can be run simultaneously is **12**
 - All must be single powerflow model, e.g. no overlapping periods
- Average case solve time for a simple period is 3 hours
- Average case solve time for an overlapping period is between 6-12 hours
- Long Term cases average solve time is roughly 7-20 hours

Elimination of Annual Auction concerns

Reduced bid set: Inability to price specific branches in the FTR market may lead to inefficient pricing