

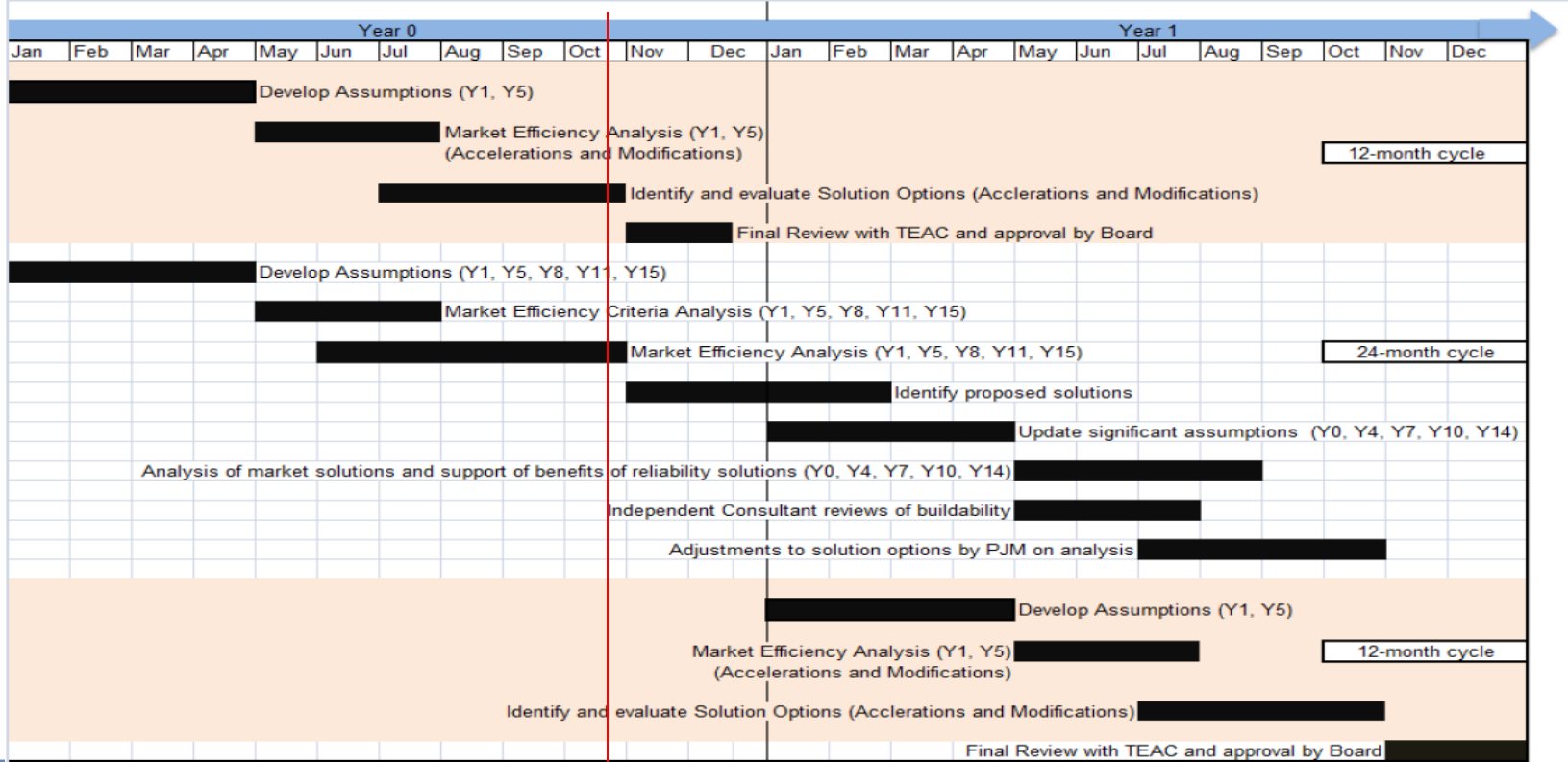


Transmission Expansion Advisory Committee Market Efficiency Update

October 25, 2016

- Overview of the 2016/2017 Market Efficiency Base Case
- Congestion Results
 - Review simulated congestion results
 - M2M Constraints
- Proposal Analysis Process Overview
- Next Steps

Market Efficiency Timeline





2016-2017 24-Month Market Efficiency Cycle Timeline

Item	Schedule
Long Term Proposal Window	November 2016 - February 2017
Analysis of Proposed Solutions	March 2017 - November 2017
Determination of Final Projects	December 2017

- Market Efficiency cases (first draft) were posted on 09/14/2016
 - PROMOD cases, and supporting documentation were posted on Market Efficiency Web page
 - <http://www.pjm.com/planning/rtep-development/market-efficiency.aspx>
- Proposal window to open on November 1, 2016
 - PJM received stakeholder feedback on PROMOD model by October 15, 2016
 - Base Congestion Results posted
 - PJM is in the process of concluding the problem statement
 - Final Base Case to be posted before November 1, 2016
- Market Efficiency Questions
 - Send to the RTEP e-mail distribution (rtep@pjm.com) with “Market Efficiency” in the subject line header

- Base case updates based on stakeholders feedback:
 - PJM Generator Data
 - MISO Flowgates
 - External Model
- Additional base case updates:
 - Reactive Limits
 - PS North Wheel Reform
- Files to be posted by November 1, 2016:
 - Market Efficiency Test Case and Test Results
 - Market Efficiency Benefit/Cost Evaluation Spreadsheet
 - ARR Allocation MW Spreadsheet
 - Case Descriptions

Congestion Results Overview

Simulated Base Case Congestion

- Includes congestion results for simulation years 2017, 2021, 2024 and 2027
- System congestion has declined due to RTEP enhancements, lower load forecast and fuel price impacts
- Base congestion results posted on Market Efficiency website at below link:
 - <http://pjm.com/~media/planning/rtep-dev/market-efficiency/2016-market-efficiency-analysis-base-congestion-results.ashx>

Simulated Energy Market Congestion Results

Constraint	kV	FromArea	ToArea	Type	Historical	2017 (\$mil)	2021 (\$mil)	2024 (\$mil)	2027 (\$mil)	Avg 2021, 2024 (\$mil)
AP South Interface				INTERFACE	Yes	\$ 33.2	\$ 34.5	\$ 30.5	\$ 32.3	\$ 32.5
Bagley to Graceton 230kV	230/230	BGE	BGE	PJM FG	Yes	\$ 12.5	\$ 24.3	\$ 38.6	\$ 44.6	\$ 31.4
5004/5005 Interface				INTERFACE	Yes	\$ 25.4	\$ 31.7	\$ 19.7	\$ 16.4	\$ 25.7
Graceton to Conaston 230kV	230/230	BGE	BGE	PJM FG		\$ 15.8	\$ 26.2	\$ 24.1	\$ 19.1	\$ 25.1
Susquehanna to Harwood 230 kV	230/230	PLGRP	PLGRP	PJM FG		\$ -	\$ 6.0	\$ 8.1	\$ 6.6	\$ 7.0
R11 Ring Bus A to Red Oak A 230kV	230/230	JCPL	JCPL	PJM FG		\$ -	\$ 3.0	\$ 5.2	\$ 7.3	\$ 4.1
Central Interface				INTERFACE	Yes	\$ 4.3	\$ 4.2	\$ 3.1	\$ 3.9	\$ 3.7
Peach Bottom to Conastone 500 kV	500/500	BGE	PECO	PJM FG	Yes	\$ 40.0	\$ 1.4	\$ 5.7	\$ 1.7	\$ 3.6
AEP-DOM Interface				INTERFACE	Yes	\$ 0.1	\$ 1.2	\$ 3.6	\$ 8.5	\$ 2.4
15U.S.A.P. to Peters 138 kV	138/138	APS	DUQ	PJM FG		\$ 3.5	\$ 1.0	\$ 2.2	\$ 5.3	\$ 1.6
Maple to Hoytdale 138 kV	138/138	FE-ATSI	FE-ATSI	PJM FG		\$ 0.3	\$ 1.0	\$ 1.5	\$ 2.3	\$ 1.2
N Philadelphia 8 to Master 230kV	230/230	PECO	PECO	PJM FG		\$ -	\$ 0.6	\$ 1.9	\$ 0.7	\$ 1.2
Bosserman to Olive 138kV	138/138	AEP	AEP	M2M	Yes	\$ -	\$ 0.2	\$ 2.2	\$ 3.3	\$ 1.2
Edwards Ferry to Dickerson Station "D" 230 kV	230/230	PEPCO	DOM	PJM FG		\$ 1.6	\$ 1.0	\$ 0.8	\$ 0.3	\$ 0.9
Roseland to Cedar Grove 230 kV	230/230	PSEG	PSEG	PJM FG		\$ -	\$ 0.6	\$ 0.6	\$ 0.4	\$ 0.6
Furnace Run TR 500/230 kV	230/500	PECO	PECO	PJM TR		\$ -	\$ 0.2	\$ 0.6	\$ 0.2	\$ 0.4
NWest to Conastone 230 kV	230/230	BGE	BGE	PJM FG	Yes	\$ -	\$ 0.1	\$ 0.6	\$ 0.4	\$ 0.3
South Christiansburg to Claytor Lake 138 kV	138/138	AEP	AEP	PJM FG		\$ 0.1	\$ 0.2	\$ 0.4	\$ 0.2	\$ 0.3
Pumphrey TR 230/115 kV	230/115	BGE	BGE	PJM FG		\$ 0.0	\$ 0.6	\$ 0.1	\$ 0.1	\$ 0.3
Proffit DP to Charlottesville 230 kV	230/230	DOM	DOM	PJM FG		\$ 0.5	\$ 0.4	\$ 0.2	\$ 0.1	\$ 0.3

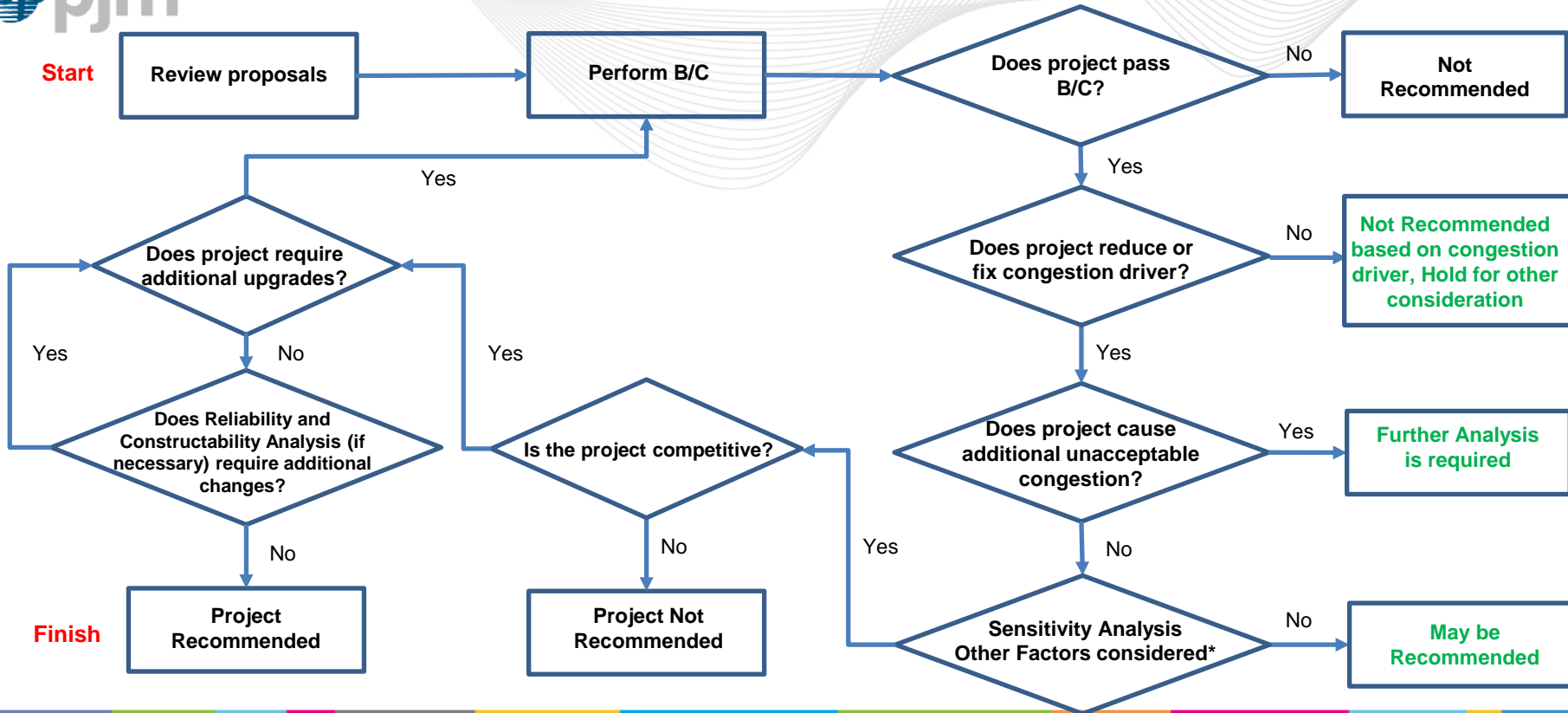
Note: Congestion shown for top 20 PJM constraints sorted by average congestion for years 2021 and 2024

- Targeted Market Efficiency Projects (TMEP) are not included in the long term window
- Per PJM - MISO JOA, Interregional Proposals must be submitted to both PJM and MISO Regional Windows
- PJM and MISO will follow the effective JOA language when analyzing and recommending Interregional Proposals

Proposal Analysis - Process Overview

- Step 1: Review submitted project data
 - PJM will contact project sponsor for further clarification as needed
- Step 2: First pass of project evaluations assuming proposer supplied data
- Step 3: Group projects by target congestion driver
- Step 4: Perform detailed analysis
 - Analyze proposals including mid cycle incremental updates
 - Sensitivity runs: load forecast, gas forecast, etc.

Project Selection – Multiple Proposals per Congestion Driver



* Other factors considered such as PJM Overall Production Cost, load Payments, and congestion

Objective of PJM Market Efficiency:

Operating Agreement : 1.5.7 (b) *Following PJM Board consideration of the assumptions, the Office of the Interconnection shall perform a market efficiency analysis to compare the costs and benefits of: (i) accelerating reliability-based enhancements or expansions already included in the Regional Transmission Plan that if accelerated also could relieve one or more economic constraints; (ii) modifying reliability-based enhancements or expansions already included in the Regional Transmission Plan that as modified would relieve one or more economic constraints; and (iii) adding new enhancements or expansions that could relieve one or more economic constraints, but for which no reliability-based need has been identified. Economic constraints include, but are not limited to, constraints that cause: (1) significant historical gross congestion; (2) pro-ration of Stage 1B ARR requests as described in section 7.4.2(c) of Schedule 1 of this Agreement; or (3) significant simulated congestion as forecasted in the market efficiency analysis. The timeline for the market efficiency analysis and comparison of the costs and benefits for items 1.5.7(b)(i-iii) is described in the PJM Manuals.*

1.5.7 (c) *The process for conducting the market efficiency analysis described in subsection (b) above shall include the following: (i) The Office of the Interconnection shall identify and provide to the Transmission Expansion Advisory Committee a list of economic constraints to be evaluated in the market efficiency analysis.*

Economic Justification for Market Efficiency

1.5.6 Development of the Recommended Regional Transmission Expansion Plan.

(h) The recommended plan shall identify enhancements and expansions that relieve transmission constraints and which, **in the judgment of the Office of the Interconnection, are economically justified.** Such economic expansions and enhancements shall be developed in accordance with the procedures, criteria and analyses described in Sections 1.5.7 and 1.5.8 of this Schedule 6.



Proposal Selection Criteria

- Project must reduce or relieve economic congestion on identified PJM constraints.
- Project 's Benefit/Cost Ratio >1.25 .
 - Various scenario analysis may be performed
- Cost
 - Consistent with the OA Schedule 6 section 1.5.7 (g), for a Market Efficiency proposal with costs in excess of \$50 million, an independent review of such costs will be performed.
- Projects may be further analyzed for other secondary considerations
 - Zonal/Total Savings
 - Risk Evaluation
 - Sensitivity Evaluation
 - Reliability Impacts

- Primary (Tariff – OA Schedule 6 section 1.5.7) :
 - Benefits (d)
 - $B/C \geq 1.25$
 - Total Cost (g)
 - Accuracy when the cost $\geq \$50M$

- Other (Tariff - OA Schedule 6 section 1.5.7) :
 - Zonal/Total Savings Metrics (e)
 - Energy Production Cost (Fuel, Variable)
 - Load Energy Payments (MW X LMP)
 - Auction Revenue Rights Credits ($\Delta \text{ARR} * \Delta \text{LMP}$)
 - Capacity Credits
 - Risks
 - Constructability (Siting, Permitting)
 - Cost Accuracy
 - Schedule

- Other (Tariff – OA Schedule 6 Section 1.5.3)
 - Sensitivities for modeling assumption variations
 - Load Forecast Variations
 - Transfer Level Variations
 - Fuel Cost Forecast Variations
 - Generation/DR Levels (i.e. retirements)
 - Scenario Analyses
 - Constructability
 - Public Policy Objectives (i.e. renewable penetration)

Sensitivity	Range
Load Sensitivity	Plus or Minus 2%
Gas Sensitivity	Plus or Minus \$1
Potential FSA Sensitivity	To be decided

Milestone	Schedule 2016
Post Problem Statement and Congestion Drivers	End of October
Post Final Market Efficiency 2016/17 Base Case	End of October
Post Required Documentation	End of October
Proposal Window opens	November 1
PJM Review for Acceleration Candidates	November-December

Questions?

Email: RTEP@pjm.com


Appendix A

Market Efficiency Data Posting

- Market Efficiency Web Page located at <http://www.pjm.com/planning/rtep-development/market-efficiency.aspx>
- Market Efficiency Case Files (first draft posted on 09/14/2016)
 - Access requires CEII access approval (execute PJM CEII NDA and fill out PJM CEII Request Form)
 - Note: the access request must indicate “2016/17 RTEP Proposal Window”
 - Access requires Vendor (ABB) approval that the requester is a licensee of PROMOD confirmation
 - Access requires MISO CEII approval with access confirmed by PJM
 - No confidential data provided or used in analysis (i.e. actual bid data)
 - XML Format
- Posted Reference Files
 - Steps to run Model Document
 - Input Assumptions Summary
- Market Efficiency Questions
 - Please send to the RTEP e-mail distribution (rtep@pjm.com) with “Market Efficiency” in the subject line header

Appendix B

2015 Historical Congestion



2015 Historical Market Congestion – Top 20 Congestion Causing Constraints

Rank	Constraint	Type	Location	Approximate total Market Congestion (\$)*	% of Total Congestion*	Comment
1	Conastone - Northwest	Line	BGE	\$108.80	7.9%	RTEP upgrades expected to reduce congestion (B0497, B1016, B1251). Partial congestion is outage related (work on BAGLEY-GRACETON).
2	Bagley - Graceton	Line	BGE	\$107.90	7.8%	RTEP upgrades expected to reduce congestion (B0497, B1016, B1251).
3	5004/5005 Interface	Interface	500	\$89.00	6.4%	West - East Transfers.
4	Bedington - Black Oak	Interface	500	\$87.60	6.3%	West - East Transfers.; Future reactive upgrades expected to reduce congestion.
5	Cherry Valley TX	Flowgate	MISO	\$79.60	5.7%	Market to Market Congestion. Partial congestion is outage related (work on 156 CHERRY 45TR81 CT).
6	AP South	Interface	500	\$56.20	4.1%	West - East Transfers; Future reactive upgrades expected to reduce congestion
7	AEP - DOM	Interface	500	\$52.40	3.8%	West - East Transfers; Future reactive upgrades expected to reduce congestion.
8	Joshua Falls	Transformer	AEP	\$44.00	3.2%	
9	Bergen - New Milford	Line	PSEG	(\$43.50)	-3.10%	Congestion is outage related (work on ESSEX-KEARNY, BERGEN-SADDLEBR). Existing PSEG upgrades expected to alleviate future congestion.
10	Person - Halifax	Flowgate	MISO	\$40.00	2.9%	Market to Market Congestion.

*Data from 2015 Market Analytics State of Market Report



2015 Historical Market Congestion – Top 20 Congestion Causing Constraints

Rank	Constraint	Type	Location	Approximate total Market Congestion (\$)*	% of Total Congestion*	Comment
11	Maywood - Saddlebrook	Line	PSEG	(\$23.40)	-1.70%	Congestion is outage related (work on BERGEN-SADDLEBR). Existing PSEG upgrades expected to alleviate future congestion.
12	East	Interface	500	\$22.60	1.6%	West - East Transfers.
13	Easton	Transformer	DPL	\$21.90	1.6%	Congestion is outage related (work on IBCORN-PRICE).
14	Glenarm - Windy Edge	Line	BGE	\$20.50	1.5%	
15	Oak Grove - Galesburg	Flowgate	MISO	\$19.70	1.4%	Market to Market Congestion.
16	Mahans Lane - Tidd	Line	AEP	\$19.60	1.4%	Partial congestion is outage related (work on COLLIER-TIDD). RTEP upgrade expected to reduce future congestion (b2445).
17	East Danville - Banister	Line	AEP	\$19.10	1.4%	RTEP upgrade expected to reduce congestion (b2375).
18	49th Street - Hoboken	Line	PSEG	(\$18.80)	-1.40%	Congestion is outage related (work on ESSEX-KEARNY, BERGEN-SADDLEBR). Existing PSEG upgrades expected to alleviate future congestion.
19	BCPEP	Interface	Pepco	\$18.40	1.3%	RTEP upgrades expected to reduce future congestion (B2443, B2443.3).
20	Braidwood - East Frankfort	Line	ComEd	\$18.10	1.3%	Market to Market Congestion. Partial congestion is outage related (work on CHERRY 45TR81 CT).
Top 20				\$739.70		
Total Congestion				\$1,385.3		

*Data from 2015 Market Monitor