



Transmission Expansion Advisory Committee Meeting

2010 Market Efficiency Analysis Results

September 8, 2010



Transmission Topology and Constraints

- Power flow Cases
 - 2010 power flow case to represent today's "as-is" system
 - 2014 RTEP power flow case to represent future system
 - Scenario 1 without MAPP, PATH, Branchburg-Roseland-Hudson, Susquehanna-Roseland backbone upgrades.
 - Scenario 2 without Branchburg-Roseland-Hudson upgrade
- Thermal Constraints
 - monitor/contingency pairs
 - NERC Book of Flowgates
 - Planning study results
 - Historical PJM congestion events
- Voltage Constraints
 - PJM reactive interface limits
 - MW limits based on historical values for "as-is" case adjusted for future upgrade impacts in 2014 case

- **Market Efficiency Runs**

Study Year	2010	2013	2016	2019	2024
System Topology	2010 As-Is Model	2014 topology without MAPP, PATH, Branchburg-Roseland-Hudson, Susquehanna-Roseland	2014 topology Without Branchburg-Roseland-Hudson	2014 topology Without Branchburg-Roseland-Hudson	2014 topology Without Branchburg-Roseland-Hudson

- **2010 and 2013 Study Years**

- Compare Market Congestion for As-Is vs. Future topology
- Estimates economic impact of future upgrades

- **Future Study Years**

- Compare Market Congestion using expected topology for study year
- Review results to identify future constraints causing significant congestion



Market Simulation Results 2010 Generation and Load Scenario

Constraint	2010 As-Is System Topology		2014 System Topology (without PATH, MAPP, Susquehanna-Roseland, Branchburg-Roseland-Hudson)	
	Frequency (Hours)	Market Congestion (\$millions)	Frequency (Hours)	Market Congestion (\$millions)
AP - South Interface	4605	\$401.9	4128	\$458.4
01BLACKO - 01BEDNGT	3745	\$359.9	10	\$0.4
50045005 Interface	3634	\$287.6	611	\$31.5
01DOUBS - 01DOUBS	470	\$198.7	0	\$0.0
8LEXNGTN - 8DOOMS	595	\$129.5	333	\$55.8
01PRNTY - 8MT STM	1511	\$61.8	0	\$0.0
ALTOONA - BEAR RCK	2212	\$54.5	2405	\$60.5
05CLOVRD - 8LEXNGTN	1181	\$44.0	885	\$19.9
E FRA; B - CRETE;BP	1615	\$29.2	1700	\$32.3
8MT STM (T157 TAP) - 01DOUBS	131	\$18.0	79	\$17.0
15ELRM 5 - 01MITCHL	1752	\$13.1	1895	\$15.3
Eastern Interface	278	\$11.7	1249	\$87.2
WATER;3B - W DEK;3T	51	\$8.0	51	\$9.4
6CLOVER - 8CLOVER	198	\$7.1	905	\$30.2
02SAMMIS - 01WYLIE	774	\$6.8	183	\$0.8
01BEDNGT - 01HARMNY	49	\$5.0	0	\$0.0
Central Interface	164	\$4.3	848	\$33.7
05EUGENE - 05DEQUIN	10	\$3.5	0	\$0.0
SLINE; R - 17WOLFLK	479	\$2.3	490	\$2.4
FAIRLWN1 - SADDLBK	1146	\$2.2	0	\$0.0
EDDYSTN3 - ISLANDR6	15	\$1.7	0	\$0.0
CDR GV F - CLIFTN K	3557	\$1.5	7283	\$15.4
01WYLIE - 01WYLIE	68	\$1.3	498	\$9.9
JUNI BU2 - DAUP TR2	7	\$1.2	31	\$1.6
CAYUGA; - PONTI; B	12	\$1.1	0	\$0.0
BAY0NDUM - PVSC	2211	\$1.1	0	\$0.0
01CABOT - 01CABOT	9	\$1.0	0	\$0.0
ALTOONA - RAYSTOWN	180	\$1.0	2	\$0.0
SOLPT 44 - RIV2339	99	\$1.0	17	\$0.9
Western Interface	30	\$0.8	1813	\$83.0
01MAHNSL - 05TIDD	171	\$0.8	0	\$0.0
02SENECA - 01KRENDL	75	\$0.6	0	\$0.0
BRIS - YORKANA	10	\$0.5	0	\$0.0
HOMER CY - HOMER CT	181	\$0.3	497	\$1.4
MAREN;RT - P VAL; R	64	\$0.2	58	\$0.2
01MITCHL - 15ELRM 5	64	\$0.2	1049	\$5.6
LEWISTWN - JUNI BU2	24	\$0.1	164	\$1.5
3HALIFAX - 3MT LREL	2	\$0.1	72	\$9.6
01MITCHL - 01UNIONJ	0	\$0.0	48	\$0.6
CHERR; B - CHERR;2M	0	\$0.0	25	\$0.7
		\$1,664.2		\$986.1

Indicates congestion reduced by at least \$5 million in simulation made with 2014 topology



Market Simulation Results 2013 Generation and Load Scenario

Constraint	2010 As-Is System Topology		2014 System Topology (without PATH, MAPP, Susquehanna-Roseland, Branchburg-Roseland-Hudson)	
	Frequency (Hours)	Market Congestion (\$millions)	Frequency (Hours)	Market Congestion (\$millions)
AP - South Interface	6386	\$859.1	5888	\$909.3
01DOUBS - 01DOUBS	805	\$482.5	0	\$0.0
50045005 Interface	4054	\$367.3	707	\$45.7
01BLACKO - 01BEDNGT	3880	\$345.8	52	\$6.3
05CLOVRD - 8LEXNGTN	2301	\$155.4	1902	\$102.8
8LEXNGTN - 8DOOMS	602	\$123.1	317	\$68.4
Eastern Interface	541	\$110.4	1988	\$236.6
ALTOONA - BEAR RCK	2712	\$88.3	2699	\$86.8
ATHENIA - SADDLBRK	666	\$80.8	0	\$0.0
MAREN;RT - P VAL; R	782	\$64.9	656	\$49.2
8MT STM (T157_TAP) - 01DOUBS	212	\$48.4	88	\$21.1
EDDYSTN3 - ISLANDR6	126	\$33.6	0	\$0.0
BAY0NDUM - PVSC	2808	\$32.6	0	\$0.0
01PRNTY - 8MT STM	646	\$27.4	0	\$0.0
BRANCHBG - READ-GTN	68	\$25.1	37	\$10.9
01BEDNGT - 01HARMNY	186	\$21.9	0	\$0.0
6BREMO - 6POWHATN	609	\$17.7	13	\$0.2
Central Interface	348	\$16.8	1316	\$71.0
6CLOVER - 8CLOVER	557	\$15.7	1210	\$34.2
E FRA; B - CRETE;BP	1128	\$14.8	1226	\$16.2
FAIRLWN1 - SADDLBRK	3145	\$14.3	0	\$0.0
WATER;3B - W DEK;3T	68	\$11.5	40	\$7.2
BRADFRD2 - PLANBRK1	23	\$11.1	14	\$2.3
CDR GV F - CLIFTN K	4966	\$8.7	6913	\$49.0
15ELRM 5 - 01MITCHL	1427	\$6.7	920	\$7.3
CAYUGA;(LORET;B) - PONTI; B	53	\$5.3	23	\$2.3
GILBERT - G GARDNR	16	\$3.8	0	\$0.0
02SAMMIS - 01WYLIE	153	\$2.4	56	\$0.2
JUNI BU2 - DAUP TR2	87	\$2.1	136	\$3.0
EDDINGTP - EDDINGT6	46	\$1.9	0	\$0.0
SOLPT 44 - RIV2339	126	\$1.9	60	\$4.1
01CABOT - 01CABOT	11	\$1.7	0	\$0.0
SLINE; R - 17WOLFLK	399	\$1.5	453	\$2.0
HOMER CY - HOMER CT	511	\$1.4	735	\$1.9
NRGDOVER - KENT	160	\$1.4	107	\$1.2
KEYSTONE - CONEM-GH	135	\$1.3	0	\$0.0
GRACETON - RAPHAEL	18	\$1.2	0	\$0.0
02SENECA - 01KRENDL	173	\$0.8	0	\$0.0
Western Interface	6	\$0.7	1611	\$92.1
01MAHNSL - 05TIDD	357	\$0.7	23	\$0.1
01MITCHL - 15ELRM 5	32	\$0.0	384	\$1.4
01WYLIE - 01WYLIE	1	\$0.0	274	\$3.7
01MITCHL - 01UNIONJ	0	\$0.0	114	\$2.3
CHERR; B - CHERR;2M	0	\$0.0	87	\$4.5
3HALIFAX - 3MT LREL	0	\$0.0	162	\$17.9
ATHENIA - BERGEN	0	\$0.0	1884	\$30.9
		\$3,012.9		\$1,894.6

Indicates congestion reduced by at least \$5 million in simulation made with 2014 topology



RTEP Upgrades responsible for Congestion Reduction 2010 and 2013 Simulations

Constraints with at least \$5 million Congestion Reduction and RTEP Upgrade(s) responsible for reduction

Constraint	RTEP Upgrade most responsible for Reduction
01BLACKO - 01BEDNGT	TrAIL (6/2011)
50045005 Interface	TrAIL (6/2011)
01DOUBS - 01DOUBS	Replace Doubs #2, #3, and #4 Transformers (6/2011)
8LEXNGTN - 8DOOMS	TrAIL (6/2011)
01PRNTY - 8MT STM	TrAIL (6/2011)
05CLOVRD - 8LEXNGTN	TrAIL (6/2011)
8MT STM - 01DOUBS	TrAIL (6/2011)
02SAMMIS - 01WYLIE	Reconductor Sammis - Wylie Ridge 345 KV circuit (11/2010)
01BEDNGT - 01HARMNY	TrAIL (6/2011)
ATHENIA - SADDLBRK	Athenia - Bergen - new 230 kV Parallel Circuit (6/2010)
MAREN;RT - P VAL; R	
EDDYSTN3 - ISLANDR6	Eddystone - Island Rd line terminal equipment (6/2011)
BAYONDUM - PVSC	Build a new 138 kV circuit from Bayonne to Marion substation (6/2013)
BRANCHBG - READ-GTN	Reconductor Readington- Branchburg 230kV circuit (6/2011)
6BREMO - 6POWHATN	TrAIL (6/2011)
FAIRLWN1 - SADDLBK	Athenia - Bergen - new 230 kV parallel Circuit (6/2010)
BRADFRD2 - PLANBRK1	Reconductor Bradford - Planebrook 230 kV circuit (6/2013)



Market Simulation Results 2013, 2016, and 2019 Load and Generation Scenarios

Constraint	2013 Study Year		2016 Study Year		2019 Study Year	
	Frequency (Hours)	Market Congestion (\$millions)	Frequency (Hours)	Market Congestion (\$millions)	Frequency (Hours)	Market Congestion (\$millions)
AP - South Interface	5888	\$909.3	4327	\$803.6	4300	\$801.7
Eastern Interface	1988	\$236.6	88	\$20.6	115	\$5.3
05CLOVRD - 8LEXNGTN	1902	\$102.8	135	\$4.9	395	\$22.0
Western Interface	1611	\$92.1	0	\$0.0	0	\$0.0
ALTOONA - BEAR RCK	2699	\$86.8	1807	\$74.4	2415	\$138.6
Central Interface	1316	\$71.0	1216	\$43.5	1895	\$95.0
8LEXNGTN - 8DOOMS	317	\$68.4	7	\$0.5	29	\$8.7
MAREN;RT - P VAL; R	656	\$49.2	2567	\$243.2	4083	\$1,031.7
CDR GV F - CLIFTN K	6913	\$49.0	5816	\$161.9	5943	\$30.0
50045005 Interface	707	\$45.7	955	\$75.9	1171	\$154.3
6CLOVER - 8CLOVER	1210	\$34.2	241	\$10.3	621	\$26.2
ATHENIA - BERGEN	1884	\$30.9	1561	\$97.7	1558	\$47.8
T157_TAP - 01DOUBS	88	\$21.1	0	\$0.0	0	\$0.0
3HALIFAX - 3MT LREL	162	\$17.9	234	\$57.9	408	\$96.0
E FRA; B - CRETE;BP	1226	\$16.2	121	\$1.1	445	\$14.9
BRANCHBG - READ-GTN	37	\$10.9	0	\$0.0	0	\$0.0
15ELRM 5 - 01MITCHL	920	\$7.3	761	\$7.6	175	\$2.3
WATER;3B - W DEK;3T	40	\$7.2	129	\$16.9	208	\$33.0
01BLACKO - 01BEDNGT	52	\$6.3	26	\$4.9	17	\$1.5
CHERR; B - CHERR;2M	87	\$4.5	172	\$12.8	261	\$53.1
SOLPT 44 - RIV2339	60	\$4.1	111	\$6.9	205	\$9.0
01WYLIE - 01WYLIE	274	\$3.7	7	\$0.0	0	\$0.0
JUNI BU2 - DAUP TR2	136	\$3.0	0	\$0.0	95	\$1.4
BRADFRD2 - PLANBRK1	14	\$2.3	26	\$6.8	29	\$10.9
LORET;B - PONTI; B	23	\$2.3	12	\$0.7	89	\$12.2
01MITCHL - 01UNIONJ	114	\$2.3	246	\$3.6	211	\$5.3
SLINE; R - 17WOLFLK	453	\$2.0	45	\$0.1	80	\$0.5
HOMER CY - HOMER CT	735	\$1.9	114	\$0.1	129	\$0.3
01MITCHL - 15ELRM 5	384	\$1.4	437	\$2.2	18	\$0.1
NRGDOVER - KENT	107	\$1.2	24	\$0.1	38	\$0.1
GRACETON - BAGLEY13	13	\$0.4	9	\$0.5	35	\$1.2
PRINTZ - RIDLEY	4	\$0.2	14	\$1.1	60	\$22.4
SANDY34T - H.RDGE16	2	\$0.0	22	\$0.5	84	\$17.0
LINWOOD - CHICHST2	0	\$0.0	230	\$15.6	219	\$15.1
TODD - VIENN 69	0	\$0.0	68	\$8.5	112	\$18.8
RL 138N - HARES CR	0	\$0.0	24	\$2.7	51	\$6.8
01DOUBS - 01DOUBS	0	\$0.0	6	\$0.0	22	\$6.5
8LOUDOUN - 6LOUDOUN	0	\$0.0	0	\$0.0	5	\$11.6
8PL VIEW - 6PL VIEW	0	\$0.0	0	\$0.0	46	\$23.0
8NO ANNA - 8MORRSVL	0	\$0.0	0	\$0.0	124	\$38.5
		\$1,894.6		\$1,688.6		\$2,780.4

Indicates congestion costs of at least \$20 million in study year 2013, 2016, or 2019.



Constraints showing Significant Congestion Levels in 2013, 2016, or 2019

Constraints with at least \$20 million of Simulated Future Congestion

Constraint	Observations
AP - South Interface	PATH (6/2015) reduces but does not eliminate congestion
Eastern Interface	Susquehanna-Roseland 500 KV significantly reduces congestion (6/2015)
05CLOVRD - 8LEXNGTN	PATH (6/2015) reduces but does not eliminate congestion
Western Interface	PATH (6/2015) eliminates congestion
ALTOONA - BEAR RCK	Conemaugh-Seward 230 KV line and Conemaugh 500 kV TX will significantly reduce congestion
Central Interface	MAPP (6/2015) reduces but does not eliminate congestion
8LEXNGTN - 8DOOMS	PATH (6/2015) significantly reduces but does not eliminate congestion
MAREN;RT - P VAL; R	Significant Level of congestion in future years directly linked to scaling of Wind resources to meet Reserve Requirement. Will monitor in future Market Efficiency Analysis. Identified as violation in Ten Year Stage 1A ARR analysis.
CDR GV F - CLIFTN K	Congestion higher without Branchburg-Roseland-Hudson upgrade. Alternatives being considered.
50045005 Interface	Reactive issue studied as part of reliability planning.
6CLOVER - 8CLOVER	New Clover 2nd 500/230 kV transformer (6/2015) not modeled and should reduce this congestion.
ATHENIA - BERGEN	Congestion higher without Branchburg-Roseland-Hudson upgrade. Alternatives being considered.
T157_TAP - 01DOUBS	PATH (6/2014) eliminates congestion.
3HALIFAX - 3MT LREL	New Clover 2nd 500/230 kV transformer (6/2015) not modeled and should reduce this congestion.
WATER;3B - W DEK;3T	Significant Level of congestion in future years directly linked to scaling of Wind resources to meet Reserve Requirement. Will monitor in future Market Efficiency Analysis.
CHERR; B - CHERR;2M	Significant Level of congestion in future years directly linked to scaling of Wind resources to meet Reserve Requirement. Will monitor in future Market Efficiency Analysis.
8NO ANNA - 8MORRSVL	Higher Level of congestion in future years. Will monitor in future Market Efficiency Analysis
PRINTZ - RIDLEY	Higher Level of congestion in future years linked to scaling of resources to meet Reserve Requirement. Will monitor in future Market Efficiency Analysis
8PL VIEW - 6PL VIEW	New Brambleton 500/230 kV transformer (6/2014) not modeled and should reduce this congestion.



Stage 1A 10-Year ARR analysis

- Section 7.5 (b) of Schedule 1 of OA indicates:
 - On an annual basis PJM shall conduct a simultaneous feasibility analysis test for stage 1A ARRs which shall access the simultaneous feasibility for each year remaining in terms of the rights. This test shall be based on the ARRs required to meet zonal base load requirements. PJM shall apply a zonal load growth rate for the 10 year term of stage 1A ARRs.
- The 10-year analysis on 2010/11 Stage 1A ARRs resulted in infeasibility on the following facilities. Upgrades will be evaluated for inclusion into the PJM RTEP.
 - 155 Nelson 345 KV 15502 Line (Nelson to Electric Junction 345 KV line)
 - 12204 138 KV 12204 2 Line (Marengo to Pleasant Valley 138 KV line)
 - 151 Wood 138 KV 12205 2 (Woodstock to Marengo 138 KV line)

- 2024 high level Simulation
- Identify any potential acceleration candidates from list on slide 6
- Consider upgrades to relieve congestion-causing constraints from list on slide 8
- Conduct Benefit/Cost analysis of any acceleration candidates or any economic upgrades

- Review Costs and Benefits for 2009 approved Market Efficiency project (Conemaugh-Seward 230 KV and Conemaugh 500/230 kV transformer)
- Conduct Benefit/Cost Analysis for requested projects.
 - LaSalle Transmission Project submitted by Central Transmission, LCC for new single or double 345 kV line from Pontiac Midpoint to Reynolds to Dumont (V4-026).
 - Duquesne Light proposal for additional 345/138 kV autotransformer at Crescent (S0168)
- Evaluate appropriate projects as part of Interregional studies.