



Transmission Expansion Advisory Committee Meeting

2009 Market Efficiency Analysis Results Update

November 18, 2009

- Review congestion analysis results to identify future economic constraints with a focus on underlying system constraints (< 500 kV)
 - Develop upgrades designed to relieve identified economic constraints
- Overview of market efficiency cost/benefit test procedure
- Review cost/benefit test results for identified economic upgrades
- Recommendations

Congestion by Constraints for Study Years 2012, 2015, and 2018

		2012 Study Year		2015 Study Year		2018 Study Year	
		2013 System Topology (see Note 1)		2013 System Topology (see Note 2)		2013 System Topology (see Note 2)	
Constraint	From/Area	Frequency (Hours)	Market Congestion (\$Millions)	Frequency (Hours)	Market Congestion (\$Millions)	Frequency (Hours)	Market Congestion (\$Millions)
AP-South Interface	-	2817	238.2	1285	74.6	3081	366.5
Western Interface	-	1388	113.5	0	0	0	0
Central Interface	-	1266	37.1	1566	23.6	2585	84.6
8CLOVER - 6CLOVER	VIEP - VIEP	1414	37.1	767	16.9	1696	65.7
05CLOVRD - 8LEXNGTN	AEP - VIEP	901	22.3	201	1.7	1001	32.1
ALTOONA - BEAR RCK	PENNELEC - PENNELEC	688	25.6	799	28.9	2195	106.4
15ELRM 5 - 01MITCHL	APS - DQE	98	0.4	23	0.1	15	0.1
BLA-BED Interface	-	114	18.7	13	2.9	20	5.9
01PRNTY - 8MT STM	APS - VIEP	101	2.6	0	0	0	0
CONOWG01 - COLOR PE	PECO - DPLC	63	1.2	6	0	4	0
01CHARLR - 01MITCHL	APS - APS	145	0.9	0	0	91	0.7
8LEXNGTN - 8DOOMS	VIEP - VIEP	18	0.9	0	0	16	2
HOMER CY - WATRC345	PENNELEC - NYISO	383	1.5	218	0.8	632	3.9
SHAWVL 1 - SHAW1MID	PENNELEC - PENNELEC	151	0.9	162	1	362	2.2
01MITCHL - 01UNIONJ	APS - APS	0	0	0	0	0	0
GRACETON - BAGLEY13	BG&E - BG&E	7	0.9	9	0	16	0.3
NRGDOVER - KENT	DPLC - DPLC	162	0.4	39	0.1	25	0.1
6BREMO - 6POWHATN	VIEP - VIEP	10	0.4	0	0	57	1.3
GRACETON - PCHBTMP	PECO - BG&E	11	0.1	99	0.2	248	1.4
CROYDON - BRLGTN11	PECO - PSEG	151	0	102	0	301	0
HOMER CT - SHELOCTA	PENNELEC - PENNELEC	1241	7.3	156	0.4	302	0.9
WANEETA3 - RICHMOND	PECO - PECO	2	0	0	0	3	0
05KAMMER - 05WBELLA	AEP - AEP	33	0.3	3	0	15	0.1
SHAWVL 2 - SHAW2MID	PENNELEC - PENNELEC	94	0.2	156	0.5	270	0.5
ERIE SE - ERIE E	PENNELEC - PENNELEC	1897	4.1	409	0.5	418	1.7
ATHENIA - BERGEN	PSEG - PSEG	625	0.2	0	0	0	0
Eastern Interface	-	3	0.2	48	5.7	61	3.2
WLOOP; B - STARWLOO	COED - COED	0	0	0	0	0	0
BRUNNER - YORKANA	METED - PPL	3	0.1	0	0	3	0
BURT2334 - SANDY34T	BG&E - PEPCO	0	0	0	0	0	0
LINWOOD - CHICHST2	PECO - PECO	0	0	127	4.1	65	1.3
PRINTZ - RIDLEY	PECO - PECO	0	0	16	2.7	12	0.7
IRONWOOD - S.LEBTAP	METED - METED	0	0	683	2.2	1022	11.2
LUMBRN - COOKSTOW	JCPL - PSEG	0	0	0	0	0	0
COXSCRNR - LUMBRN	PSEG - PSEG	0	0	0	0	0	0
WESTFALL - TYRONE N	PENNELEC - PENNELEC	0	0	42	0.4	84	1.4
BRIGH014 - BURT2314	PEPCO - PEPCO	0	0	8	1.2	1	0.1
PONTI; B - WILTO;B	COED - COED	0	0	10	0.1	212	14.3
50045005 Interface	-	0	0	18	3.6	6	0.6
FORDML90 - EMILIE7	PECO - PECO	0	0	0	0	736	1.8
KENDA;BU - LOCKP; B	COED - COED	0	0	0	0	59	1.8
BYRON; R - CHERR; R	COED - COED	0	0	7	0.3	46	1.6
O24 - DRES; R	COED - COED	0	0	0	0	20	1
CONASTON - MT CAR22	BG&E - BG&E	0	0	0	0	16	0.1
GOODI;2R - LOCKP; R	COED - COED	0	0	0	0	4	0.2
QUAD3-11 - H471 ;	COED - COED	7	0	13	0	17	0.2
GESG TAP - GORE JCT	PENNELEC - PENNELEC	0	0	41	0.1	98	0.3
CHERR; R - SILVE; R	COED - COED	0	0	0	0	1	0
GOODI;4B - LOCKP; B	COED - COED	0	0	0	0	1	0
JUNIATA - DAUPH-H2	PPL - PPL	0	0	1	0	6	0.3
			515.1		172.6		716.5

Indicates Congestion Costs of at least \$5 million in study year 2012, 2015, or 2018.

Note 1: Includes TRAIL and Susquehanna-Roseland 500 KV. Does not includes PATH, MAPP, Branchburg-Roseland 500 KV, and Roseland-Hudson 500 KV upgrades

Note 2: Includes TRAIL, PATH, Susquehanna-Roseland 500 KV, MAPP, Branchburg-Roseland 500 KV, and Roseland-Hudson 500 KV upgrades.



Constraints showing Significant Congestion Levels in 2012 , 2015, and 2018 Simulations

Constraints with at least \$5 million of Simulated Future Congestion

Constraint	Observations
AP-South Interface	PATH (6/2014) significantly reduces but does not eliminate congestion
BLA-BED Interface	PATH (6/2014) significantly reduces but does not eliminate congestion
Western Interface	PATH (6/2014) eliminates congestion
Eastern Interface	Congestion reduces in future study periods
Central Interface	MAPP (6/2014) significantly reduces but does not eliminate congestion
05CLOVRD - 8LEXNGTN	PATH (6/2014) significantly reduces but does not eliminate congestion
8CLOVER - 6CLOVER	PATH (6/2014) significantly reduces but does not eliminate congestion
ALTOONA - BEAR RCK	Significant levels of congestion observed on Penelec's underlying system - consistent throughout study period
IRONWOOD - S.LEBTAP	Significant congestion appears in 2018 simulation. Will closely monitor in future Market Efficiency Analysis.
PONTI; B - WILTO:B	Significant congestion appears in 2018 simulation. Will closely monitor in future Market Efficiency Analysis.
HOMER CT - SHELOCTA	Congestion reduces in future study periods



Summary of Congestion Analysis Results

- Backbone projects significantly reduce congestion levels
- Congestion levels increase over time due to continued high economic west-to-east transfer levels
 - Larger increases in gas/oil prices relative to increases in coal prices (see slide 4 of 5/20/09 TEAC presentation)
 - Significant amount of future generation is base load and renewable generation located in western part of PJM (see slide 9 of 5/20/09 TEAC presentation)
- Two economic constraints of the underlying system exhibit significant levels of congestion sustained throughout study period
 - Altoona-Bear Rock 230 kV (and other Penelec underlying constraints)
 - Clover 500/230 kV transformer (Dominion zone)



Summary of Congestion Analysis Results (cont.)

- Altoona-Bear Rock 230 kV (& Penelec underlying constraints)
 - historical real-time congestion
 - Aggravated by west-to-east transfers
 - Especially sensitive to addition of wind generation in Penelec
- Clover 500/230 kV transformer (Dominion zone)
 - historical real-time congestion
 - Aggravated by west-to-east transfers
 - sensitive to interchange to the south of PJM

- Altoona-Bear Rock 230 kV (& Penelec underlying constraints)
 - Upgrade: Conemaugh 500/230 KV transformer and new line from Conemaugh-Seward 230kV
 - Expected in-service date is 2014
 - Expected Cost = \$21 million
- Clover 500/230 kV transformer (Dominion zone)
 - Upgrade: Add second CLOVER 500/230 KV transformer
 - Expected in-service date is 2012
 - Expected Cost = \$13.2 million



Overview of Market Efficiency Cost/Benefit Test Procedure

Benefit Metric

Annual Benefit = $(.7)(\Delta \text{ System Production Cost}) + (.3)(\Delta \text{ Load Energy Payment})$

- Δ System Production Cost is change in system generation variable cost (fuel costs, variable O&M costs and emissions costs) associated with total PJM energy production
- Δ Load Energy Payment is change in net load energy payment (change in gross load payment minus change in transmission right credit)
 - For projects that have costs allocated regionally (500 kV and up), the load energy payment for all PJM zones is considered
 - For projects that have costs allocated using a flow-based methodology (below 500 kV), the load energy payment for only those PJM zones that show a decrease in load energy payment is considered.



Overview of Market Efficiency Cost/Benefit Test Procedure (cont.)

Cost/Benefit Analysis

- Present value of annual project benefit for first 15 years of project life compared to present value of annual project cost for first 15 years of project life
- Project is considered economic and included in RTEP if B/C ratio exceeds 1.25:1



Overview of Market Efficiency Cost/Benefit Test Procedure (cont.)

Simulation/Model Details

- ▶ Annual market simulations made with and without upgrade for future years 1, 4, 7 and 10 (current year (cy), cy+3, cy+6 and cy+9)
- ▶ Annual benefits within the 10-year time frame for years which were not simulated interpolated using these simulation results
- ▶ Annual benefits for years beyond the 10-year simulation time frame based on an extrapolation of the market simulation results for years 1, 4, 7 and 10
- ▶ A higher-level annual market simulation made for future year 15 (cy+14) to validate the extrapolation results and extrapolation of annual benefits for years beyond the 10-year simulation time frame may be adjusted accordingly

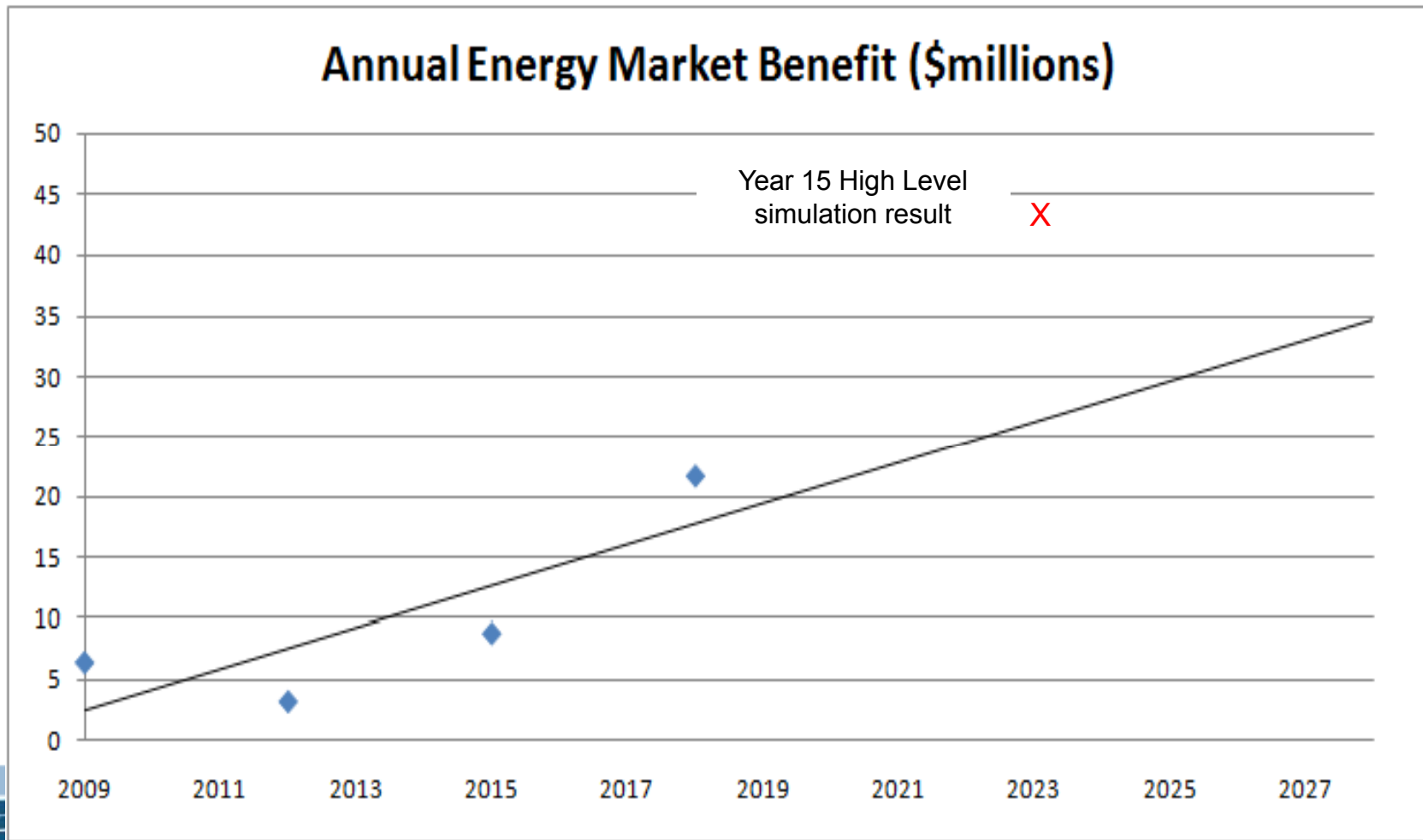


Cost/Benefit Analysis

- Cost/Benefit Analysis ALTOONA-BEAR RCK
 - Upgrade: Conemaugh 500/230 KV transformer and new line from Conemaugh-Seward 230 KV
 - Expected in-service date is 2014
 - Expected Cost = \$21 million

Year	Production Cost Benefit (\$ millions)	Load Energy Payment Benefit (\$ millions)	Energy Market Benefit (\$ millions)
2009	3.5	13.49	6.5
2010	1.7	14.03	5.4
2011	0.0	14.58	4.4
2012	-1.8	15.13	3.3
2013	-1.3	20.17	5.1
2014	-0.8	25.2	7.0
2015	-0.3	30.2	8.9
2016	1.9	39.4	13.1
2017	4.0	48.6	17.4
2018	6.2	57.8	21.7
2019	3.7	56.2	19.4
2020	4.0	61.2	21.1
2021	4.3	66.1	22.8
2022	4.6	71.1	24.6
2023	4.9	76.0	26.3
2024	5.3	80.9	28.0
2025	5.6	85.9	29.7
2026	5.9	90.8	31.4
2027	6.2	95.7	33.1
2028	6.5	100.7	34.8
Cumulative Present Value (2014 thru 2028)	30.7	510.2	174.6

Cost/Benefit Analysis ALTOONA-BEAR RCK



Cost/Benefit Analysis ALTOONA-BEAR RCK

- Upgrade: Conemaugh 500/230 KV transformer and new line from Conemaugh-Seward 230 KV
- Summary
 - Cumulative Present Value of annual benefit equals \$174.6 million (70% NPV of Production Cost Benefit (\$30.7 million) + 30% NPV of Load Benefit (\$510.2 million))
 - Cumulative Present Value of project annual revenue requirement equals \$36.2 million
 - Based on project cost equals \$21 million, discount rate of 7.73%, annual carrying charge of 19.8%, and 2014 in-service date.
 - Benefit/Cost Ratio equals 4.8
 - **4.8 > 1.25**



Cost/Benefit Analysis

- Cost/Benefit Analysis ALTOONA-BEAR RCK
 - Present value of 15 year project load benefit by zone for zones with decrease in Load Energy Payment

	Cumulative Present Value of Load Benefit Metric by Zone (\$ millions)	% of Benefit
ACEC	19.1	3.7%
AEP	0.0	0.0%
APS	31.9	6.3%
BG&E	85.8	16.8%
COED	0.0	0.0%
DP&L	0.0	0.0%
DPLC	0.0	0.0%
DQE	1.6	0.3%
JCPL	64.1	12.6%
METED	35.2	6.9%
PECO	58.8	11.5%
PENNELEC	0.0	0.0%
PEPCO	2.8	0.5%
PPL	78.7	15.4%
PSEG	104.7	20.5%
RECO	3.7	0.7%
VIEP	0.0	0.0%
Neptune	8.7	1.7%
GE VFT	15.1	3.0%
Total	510.2	100%

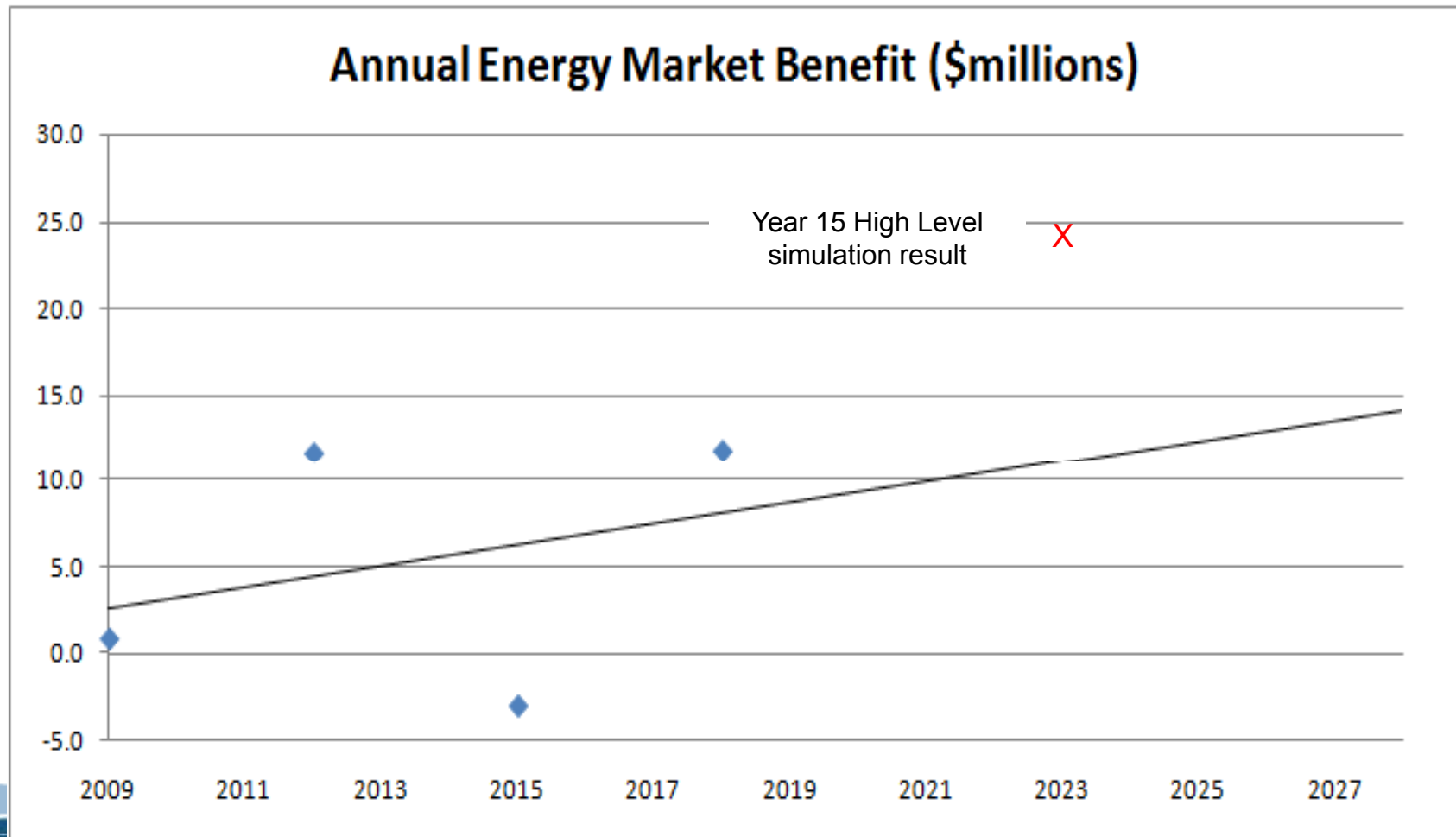


Cost/Benefit Analysis

- Cost/Benefit Analysis 8CLOVER- 6CLOVER
 - Upgrade: Add second CLOVER 500/230 KV transformer
 - Expected in-service date is 2012
 - Expected Cost = \$13.2 million

Year	Production Cost Benefit (\$ millions)	Load Energy Payment Benefit (\$ millions)	Energy Market Benefit (\$ millions)
2009	1.5	-0.8	0.8
2010	1.1	12.2	4.4
2011	0.7	25.3	8.1
2012	0.3	38.3	11.7
2013	-2.7	28.9	6.8
2014	-5.7	19.5	1.8
2015	-8.7	10.0	-3.1
2016	-8.4	25.8	1.9
2017	-8.0	41.6	6.9
2018	-7.7	57.4	11.8
2019	-10.4	53.0	8.6
2020	-11.6	57.8	9.2
2021	-12.8	62.7	9.8
2022	-14.0	67.6	10.5
2023	-15.3	72.5	11.1
2024	-16.5	77.4	11.7
2025	-17.7	82.2	12.3
2026	-18.9	87.1	12.9
Cumulative Present Value (2012 thru 2026)	-77.4	396.9	64.9

Cost/Benefit Analysis 8CLOVER- 6CLOVER



Cost/Benefit Analysis 8CLOVER- 6CLOVER

- Upgrade: Add second CLOVER 500/230 KV transformer.

– Summary

- Cumulative Present Value of annual benefit equals \$64.9 million (70% NPV of Production Cost Benefit (-\$77.4 million) + 30% NPV of Load Benefit (\$396.9 million))
- Cumulative Present Value of project annual revenue requirement equals \$22.7 million
 - Based on project cost equals \$13.2 million, discount rate of 7.73%, annual carrying charge of 19.8%, and 2012 in-service date.
- Benefit/Cost Ratio equals 2.85
- $2.85 > 1.25$



Cost/Benefit Analysis

- Cost/Benefit Analysis 8CLOVER- 6CLOVER
 - Present value of 15 year project load benefit by zone for zones with decrease in Load Energy Payment

	Cumulative Present Value of Load Benefit Metric by Zone (\$ millions)	% of Benefit
ACEC	0.0	0.0%
AEP	0.0	0.0%
APS	0.0	0.0%
BG&E	59.2	14.9%
COED	0.0	0.0%
DP&L	0.0	0.0%
DPLC	1.9	0.5%
DQE	0.0	0.0%
JCPL	0.0	0.0%
METED	2.4	0.6%
PECO	0.0	0.0%
PENNELEC	0.0	0.0%
PEPCO	83.8	21.1%
PPL	0.0	0.0%
PSEG	0.0	0.0%
RECO	0.0	0.0%
VI EP	249.6	62.9%
Neptune	0.0	0.0%
GE VFT	0.0	0.0%
Total	396.9	100%

- Recommend Conemaugh 500/230 kV transformer and Conemaugh-Seward 230 kV line for inclusion in RTEP as economic project
- Defer recommendation of 2nd Clover 500/230 kV transformer as RTEP upgrade
 - Validate congestion analysis results with results from PJM/Duke/TVA Study
 - Constraint relieved by upgrade is sensitive to PJM interchange to the south
 - PJM/Duke/TVA study will have a more complete/robust model of PJM-South interchange