



Market Efficiency Analysis

Transmission Expansion Advisory Committee

May 9, 2007



Economic Impact of 2006 RTEP Upgrades

Upgrades	Change in Production Cost (\$Millions)		Change in Load Payment (\$Millions)		Change in Generation Revenue (\$Millions)		Change in Congestion Costs (\$Millions)	
	2007	2010	2007	2010	2007	2010	2007	2010
502 Junction Line	-153.2	-140.4	-726.0	-621.2	83.4	168.8	-809.4	-790.1
All Other 2011 RTEP Upgrades	-80.7	-99.9	-314.5	-292.1	-106.4	24.9	-208.1	-316.9
Total 2011 RTEP Impact	-233.9	-240.7	-1,040.5	-913.3	-23.0	193.7	-1,017.5	-1,107.0

Table summarizes the economic impact of all upgrades associated with the 2006 RTEP



2006 RTEP Upgrades Responsible for Reduction in Congestion Costs

UpgradeID	Description	TransmissionOwner	Projected In-Service Date
b0216	Black Oak Install -100/+525 MVAR dynamic reactive device	APS	12/31/2007
b0230	Install fourth Meadowbrook 500/138kV transformer	APS	5/1/2008
b0403	2nd Doods 500/230kV transformer addition	Dominion	6/1/2007
b0169	Build a new 230 kV section from Branchburg – Flagtown and move the Flagtown - Somerville 230 kV circuit to the new section	PSEG	6/1/2009
b0238	Reconductor Doubs - Dickerson and Doubs - Aqueduct 1200MVA	APS	6/1/2009
b0287	Install 600MVAR Dynamic Reactive Device at Whippain 500kV substation	PECO	6/1/2009
b0289	Install 600MVAR Dynamic Reactive Device in the Whippany 230kV vicinity	JCPL	6/1/2010
b0290	Install 400MVAR capacitor in the Branchburg 500kV vicinity	PSEG	6/1/2010
b0284	Build Airydale 500kV substation - install new 400 MVAR capacitor	PENELEC	6/1/2009
b0369	Install 100 MVAR Dynamic Reactive Device at Airydale 500kV substation	PENELEC	5/1/2010
b0370	Install 500 MVAR Dynamic Reactive Device at Airydale 500kV substation	PENELEC	5/1/2011
b0162	Upgrade the Edison – Meadow Rd 138kV “Q” circuit	PSEG	6/1/2009
b0163	Upgrade the Edison – Meadow Rd 138kV “R” circuit	PSEG	6/1/2009

2006 upgrades listed above are responsible for \$208M and \$317M decrease in congestion costs in 2007 and 2010 simulations



Market Efficiency Analysis of 502 Junction-Meadowbrook-Loudoun 500 kV Line

Sensitivity	Year								
	2007	2010	2013	2016			2021		
				G1	G2	G3	G1	G2	G3
Base Assumptions	X	X	X	X	X	X	X	X	X
High Fuel	X	X	X	X	X	X	X	X	X
Low Fuel	X	X	X	X	X	X	X	X	X
High Load	X	X	X	X	X	X	X	X	X
Low Load	X	X	X	X	X	X	X	X	X
High Emissions	X	X	X	X	X	X	X	X	X
Low Emission	X	X	X	X	X	X	X	X	X
Others ?? (Carbon)	X	X	X	X	X	X	X	X	X

Future generation scenarios describe location and type of generation added to maintain 15% Reserve Requirement in 2016 & 2021

G1 – generation added in proportion to location and type of existing generation

G2 – generation added in proportion to location and type of queued generation

G3 – 50% of required generation added to eastern and southwestern MAAC in proportion to existing generation in these regions and 50% of required generation added in proportion to location and type of queued generation

Future Generation Scenarios (Location % of Added Generation MW)

REGION	G1	G2	G3
AECO/DPL/JCPL/PECO/PSEG	19.9%	18.3%	45.9%
AEP/APS/COM/DAY/DUQ	48.1%	34.0%	17.1%
BGE/PEP	7.2%	12.0%	19.1%
DOM	11.8%	11.2%	5.6%
ME/PN/PPL	13.0%	24.5%	12.3%

Future generation scenarios describe location and type of generation added to maintain 15% Reserve Requirement in 2016 & 2021

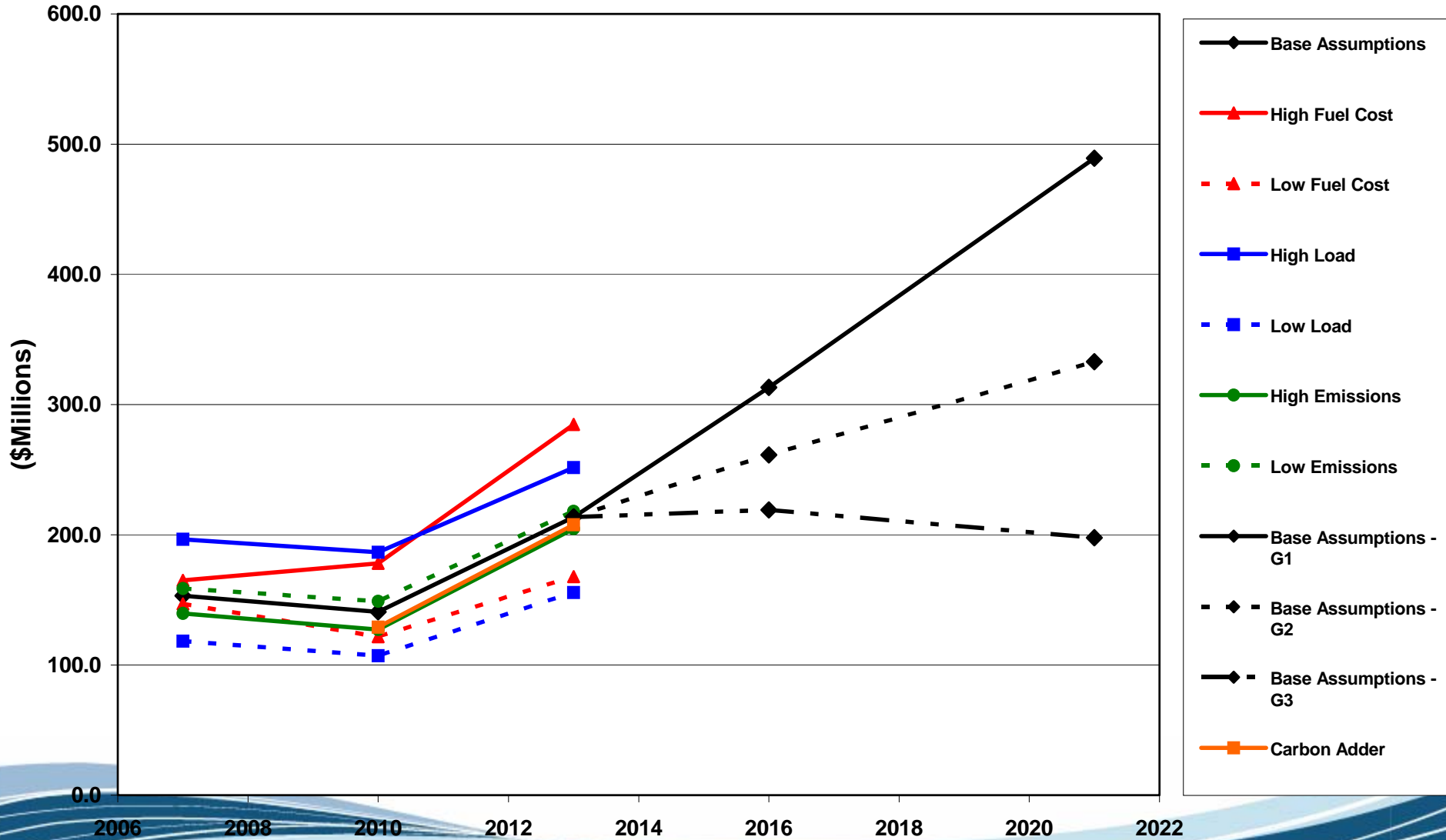
G1 – generation added in proportion to location and type of existing generation

G2 – generation added in proportion to location and type of queued generation

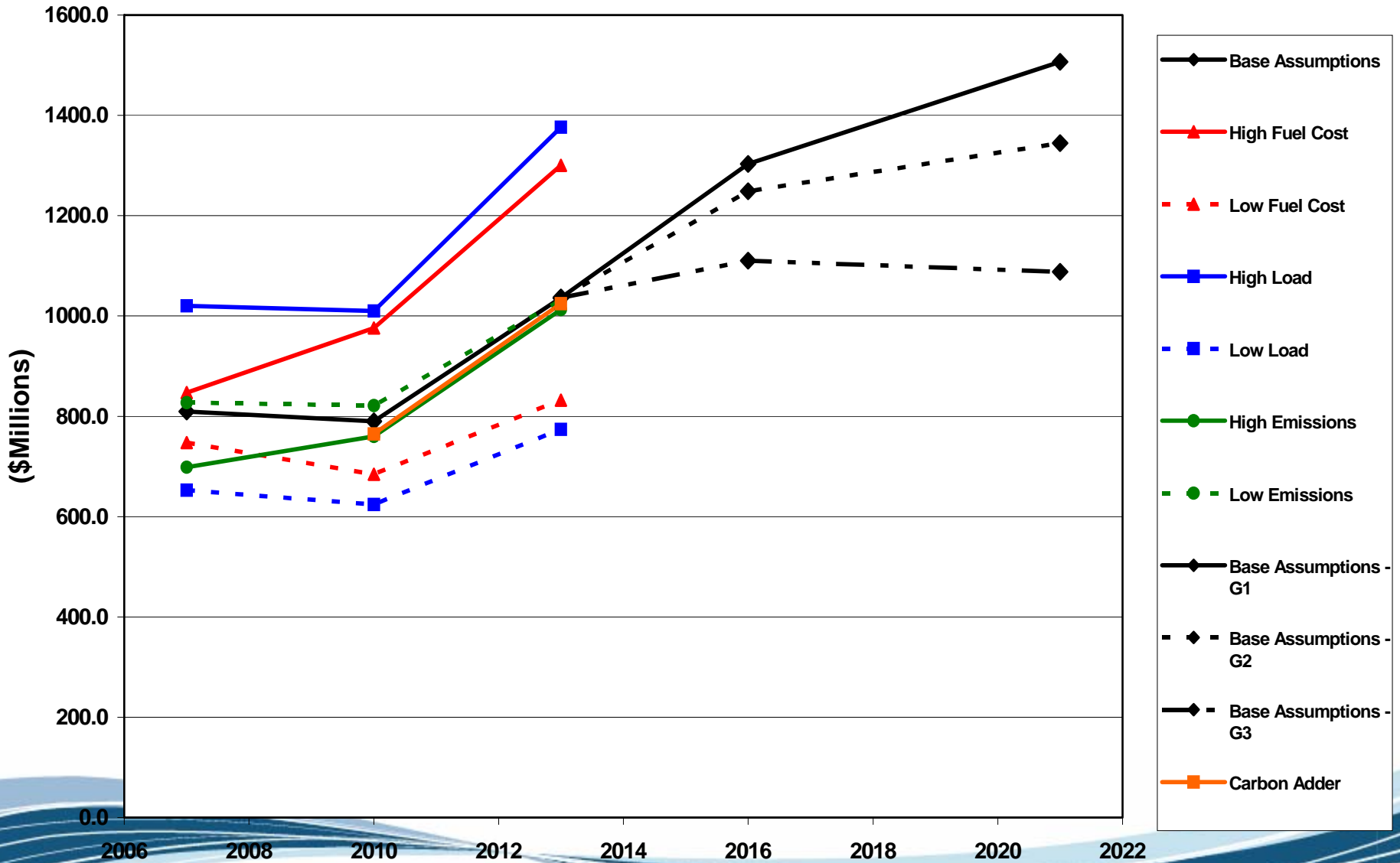
G3 – 50% of required generation added to eastern and southwestern MAAC in proportion to existing generation in these regions and 50% of required generation added in proportion to location and type of queued generation

Approximately 6,400MW and 19,500MW added to 2016 and 2021 cases, respectively, to maintain 15% RR

System Production Cost Savings associated with 502 Junction-Meadowbrook-Loudoun 500 kV Line

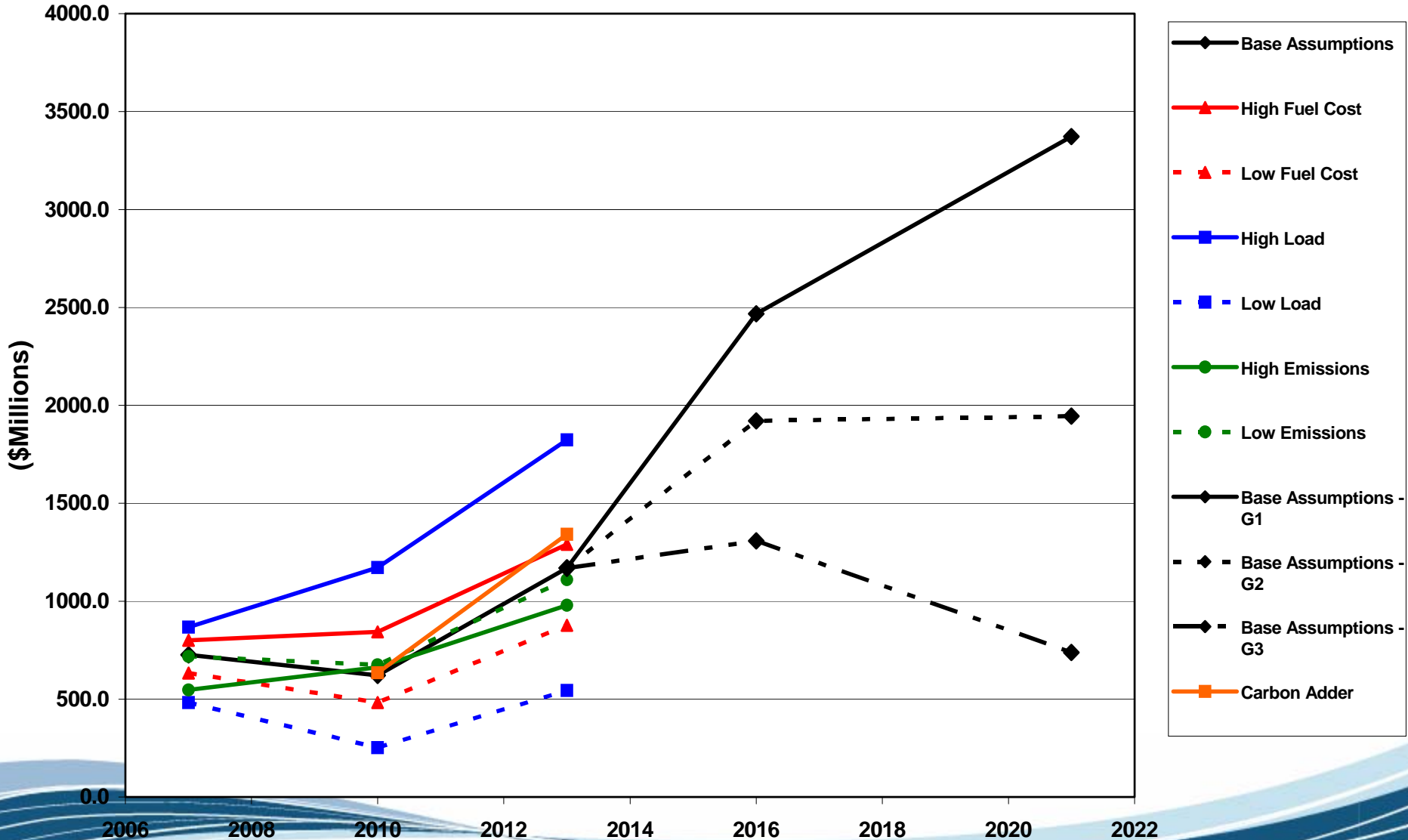


System Congestion Cost Savings associated with 502 Junction-Meadowbrook-Loudoun 500 kV Line

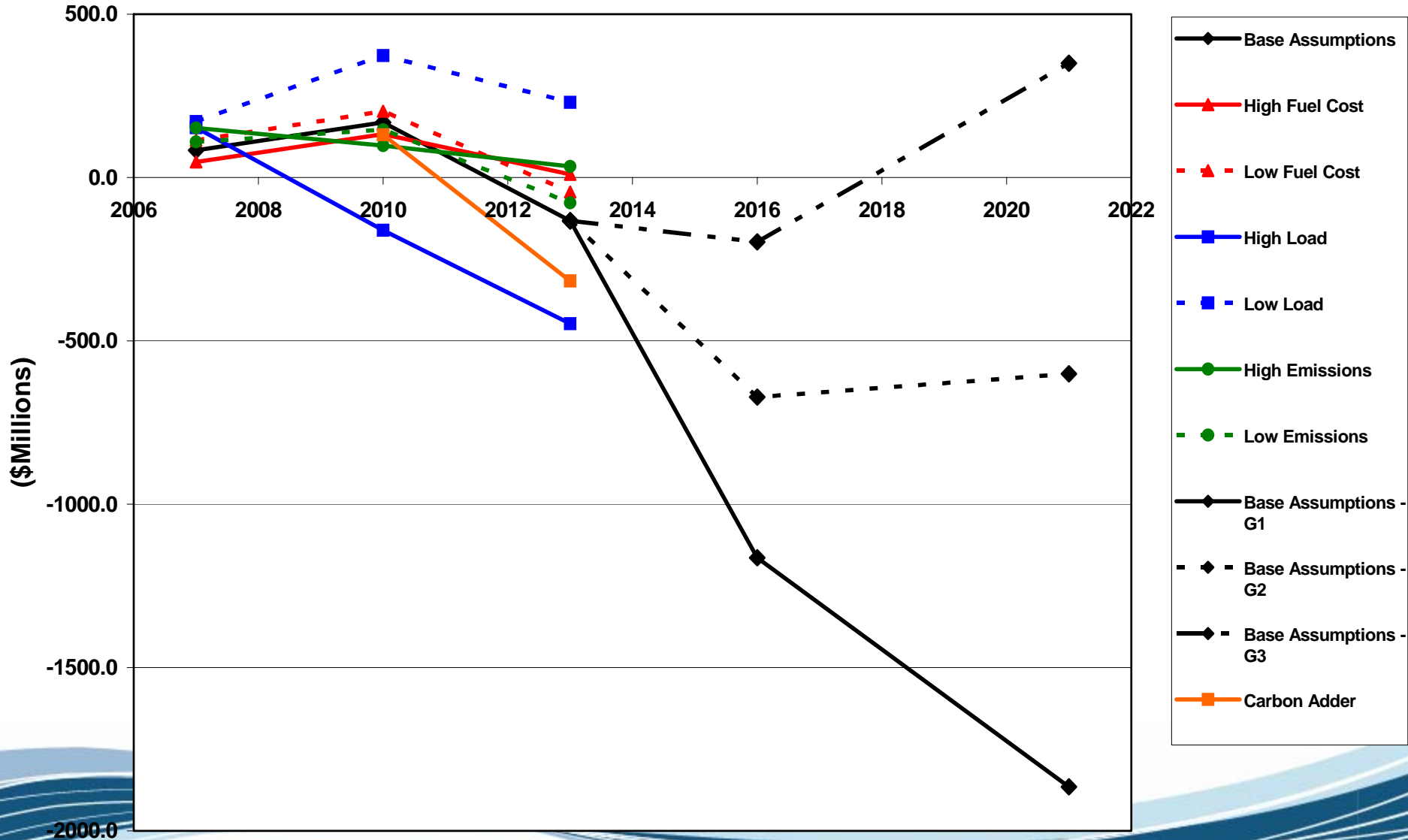


System Load Payment Savings

associated with 502 Junction-Meadowbrook-Loudoun 500 kV Line

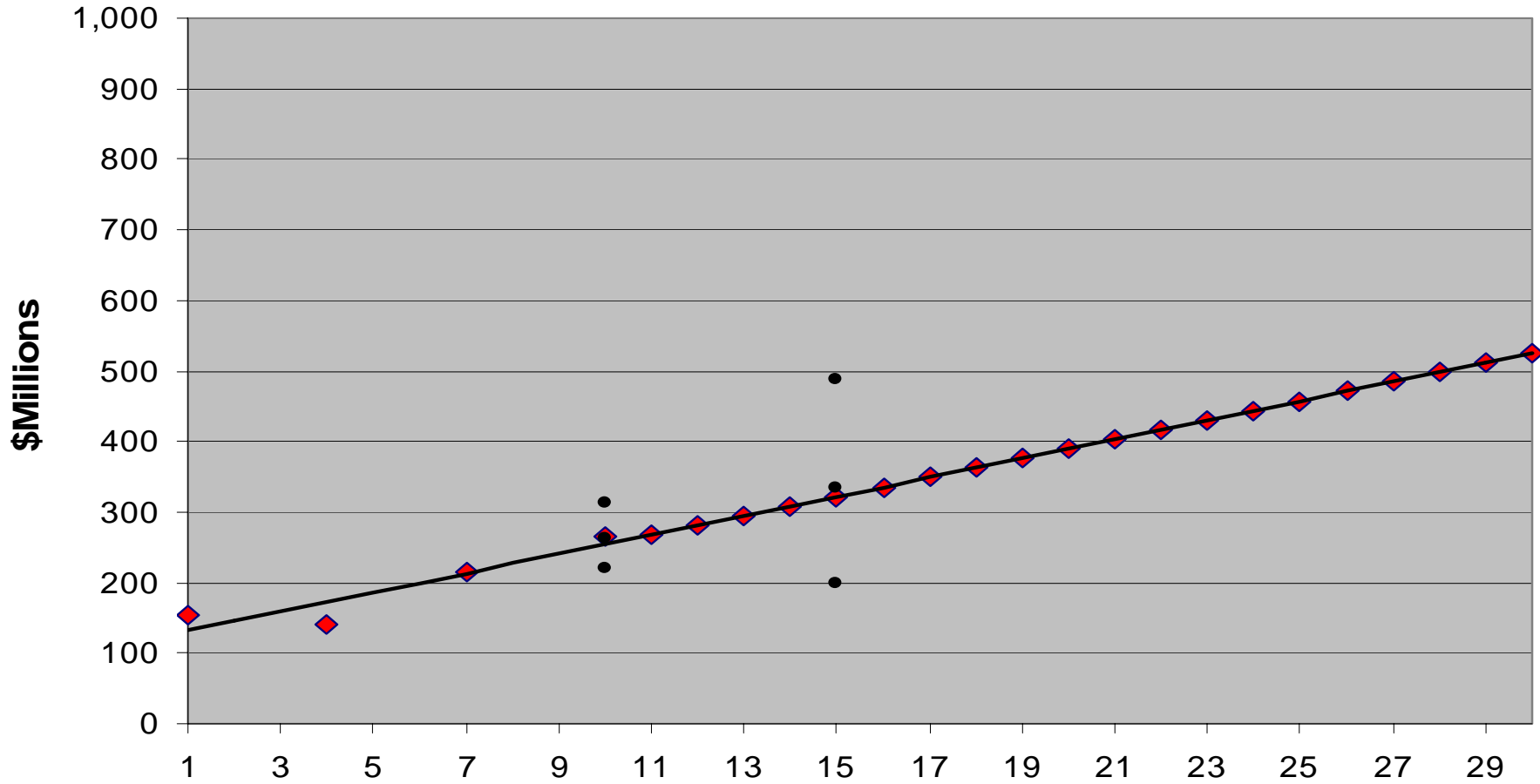


Change in System Generation Revenue associated with 502 Junction-Meadowbrook-Loudoun 500 kV Line

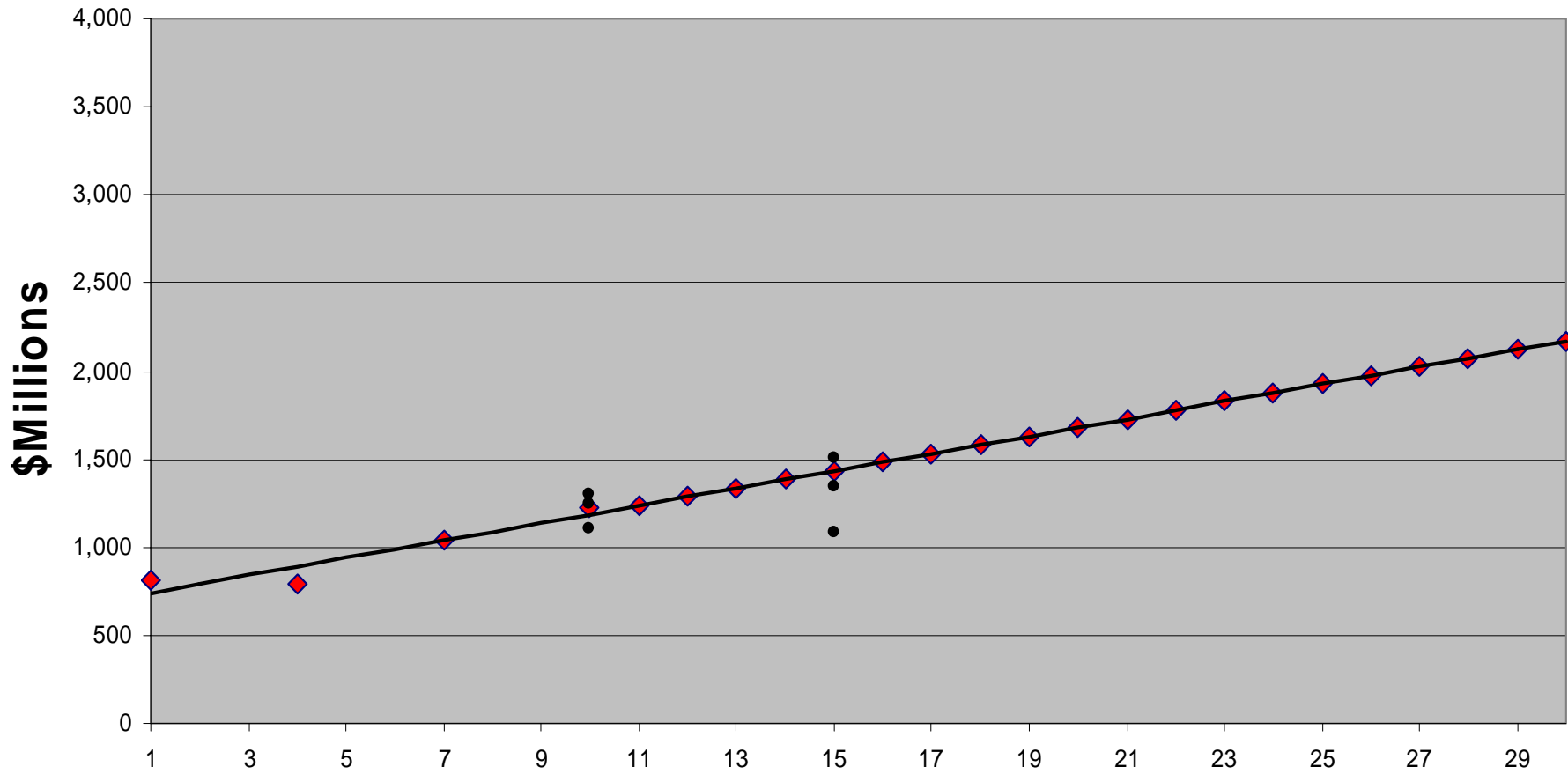


- Annual values of upgrade impact on system production cost, system congestion costs, system load payment, system generator revenues are projected using the following approach
 - Annual impacts for years within the 10-year time frame are projected using linear interpolation between values from simulated years 2007, 2010, 2013 and 2016
 - Annual impacts for years beyond 10-year time frame are projected using linear best-fit extrapolation of values from simulated years 2007, 2010, 2013 and 2016
 - 2016 value used in extrapolation is average value obtained from 3 future generation scenario simulations
 - Values from simulated year 2021 used to validate extrapolation

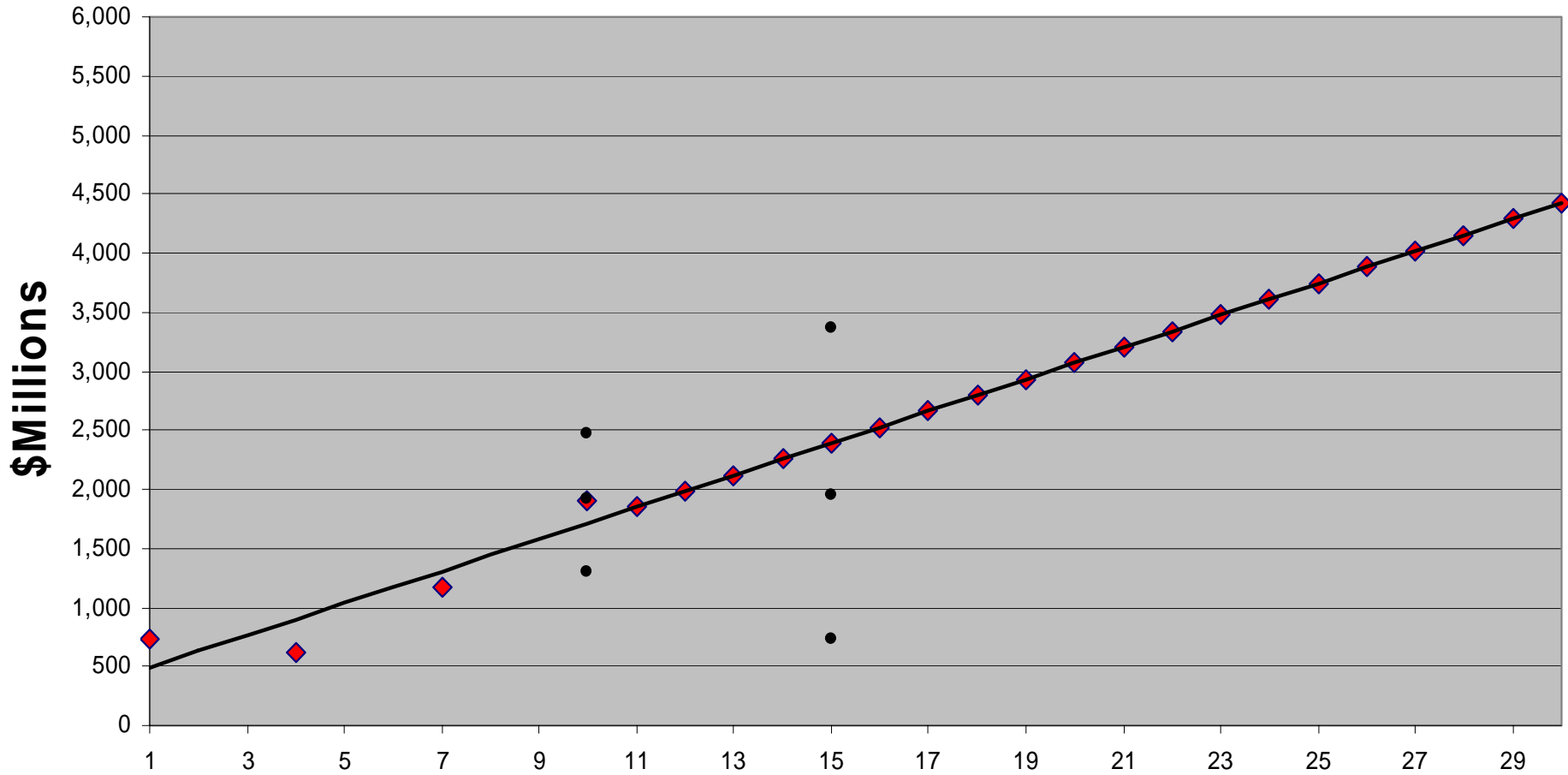
Projection of Annual Production Cost Savings (Base Input Assumptions)



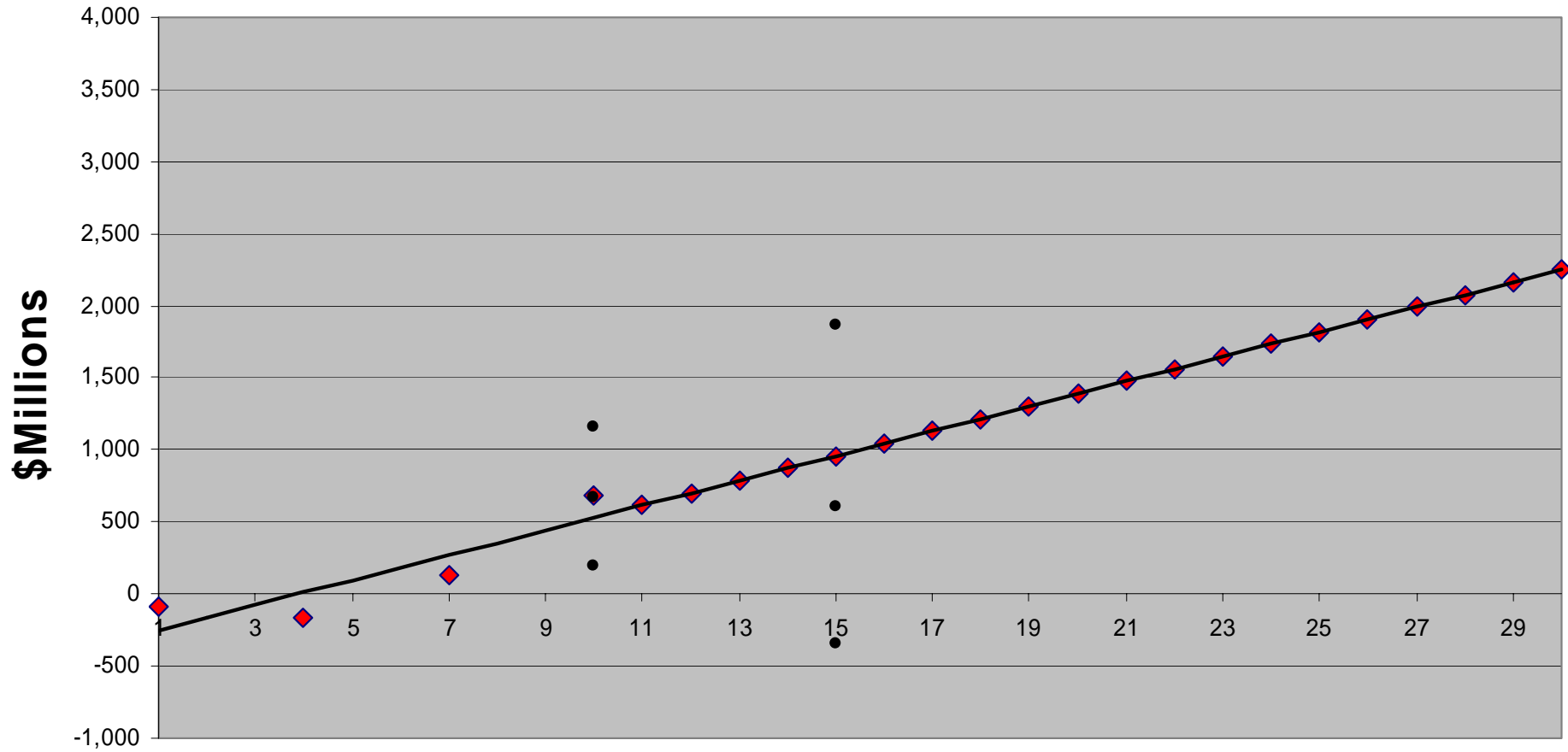
Projection of Annual Congestion Costs Savings (Base Input Assumptions)



Projection of Annual Load Payment Savings (Base Input Assumptions)



Projection of Annual Reduction in Generator Revenue (Base Input Assumptions)





Projected Annual Energy Market Benefits (Base Input Assumptions)

Year	Annual Production Cost Benefit (\$M)	Annual Congestion Cost Benefits (\$M)	Annual Load Payment Benefits (\$M)	Annual Generation Revenue Benefits (\$M)	Estimated Annual Project Cost (\$ M)
2007	153	809	726	-83	200
2008	149	803	691	-112	200
2009	145	797	656	-140	200
2010	141	790	621	-169	200
2011	165	872	804	-69	200
2012	189	954	986	32	200
2013	214	1,036	1,168	132	200
2014	231	1,098	1,412	314	200
2015	248	1,159	1,655	496	200
2016	265	1,221	1,898	678	200
2017	268	1,235	1,849	613	200
2018	281	1,285	1,984	699	200
2019	295	1,334	2,120	786	200
2020	308	1,383	2,255	872	200
2021	322	1,433	2,391	958	200
2022	335	1,482	2,526	1,044	200
2023	349	1,531	2,662	1,130	200
2024	363	1,581	2,797	1,216	200
2025	376	1,630	2,933	1,303	200
2026	390	1,679	3,068	1,389	200
2027	403	1,729	3,204	1,475	200
2028	417	1,778	3,339	1,561	200
2029	430	1,827	3,475	1,647	200
2030	444	1,877	3,610	1,733	200
2031	458	1,926	3,746	1,819	200
2032	471	1,975	3,881	1,906	200
2033	485	2,025	4,017	1,992	200
2034	498	2,074	4,152	2,078	200
2035	512	2,124	4,288	2,164	200
2036	525	2,173	4,423	2,250	200

- NPV of annual benefits for 10, 20 and 30 years compared to NPV of upgrade revenue requirement for 10, 20 and 30 years
- Discount rate sensitivity at 8%, 10% and 12%
- Annual upgrade cost assumed to be \$200M (\$1B project cost at 20% annual carrying charge)



Benefit NPV vs Cost NPV (Energy Market Benefits Only)

PRODUCTION COST METRIC

	8% Discount Rate	10% Discount Rate	12% Discount Rate
30-year NPV Benefit	2,866.9	2,269.5	1,842.3
30-year NPV Cost	<u>(2,251.6)</u>	<u>(1,885.4)</u>	<u>(1,611.0)</u>
30-year Net Benefit	615.4	384.1	231.3
20-year NPV Benefit	2,210.7	1,855.0	1,577.6
20-year NPV Cost	<u>(1,963.6)</u>	<u>(1,702.7)</u>	<u>(1,493.9)</u>
20-year Net Benefit	247.1	152.3	83.7
10-year NPV Benefit	1,215.6	1,101.2	1,002.2
10-year NPV Cost	<u>(1,342.0)</u>	<u>(1,228.9)</u>	<u>(1,130.0)</u>
10-year Net Benefit	(126.4)	(127.7)	(127.8)

CONGESTION COST METRIC

	8% Discount Rate	10% Discount Rate	12% Discount Rate
30-year NPV Benefit	13,386.2	10,732.9	8,818.9
30-year NPV Cost	<u>(2,251.6)</u>	<u>(1,885.4)</u>	<u>(1,611.0)</u>
30-year Net Benefit	11,134.6	8,847.5	7,207.8
20-year NPV Benefit	10,622.3	8,986.0	7,702.7
20-year NPV Cost	<u>(1,963.6)</u>	<u>(1,702.7)</u>	<u>(1,493.9)</u>
20-year Net Benefit	8,658.7	7,283.3	6,208.8
10-year NPV Benefit	6,188.8	5,623.8	5,133.3
10-year NPV Cost	<u>(1,342.0)</u>	<u>(1,228.9)</u>	<u>(1,130.0)</u>
10-year Net Benefit	4,846.8	4,394.9	4,003.3

LOAD PAYMENT METRIC

	8% Discount Rate	10% Discount Rate	12% Discount Rate
30-year NPV Benefit	19,306.0	14,858.8	11,731.3
30-year NPV Cost	<u>(2,251.6)</u>	<u>(1,885.4)</u>	<u>(1,611.0)</u>
30-year Net Benefit	17,054.5	12,973.4	10,120.3
20-year NPV Benefit	13,938.8	11,471.6	9,570.3
20-year NPV Cost	<u>(1,963.6)</u>	<u>(1,702.7)</u>	<u>(1,493.9)</u>
20-year Net Benefit	11,975.1	9,768.9	8,076.4
10-year NPV Benefit	6,562.5	5,896.2	5,323.5
10-year NPV Cost	<u>(1,342.0)</u>	<u>(1,228.9)</u>	<u>(1,130.0)</u>
10-year Net Benefit	5,220.5	4,667.3	4,193.4

GENERATION REVENUE METRIC

	8% Discount Rate	10% Discount Rate	12% Discount Rate
30-year NPV Benefit	5,919.8	4,125.8	2,912.4
30-year NPV Cost	<u>(2,251.6)</u>	<u>(1,885.4)</u>	<u>(1,611.0)</u>
30-year Net Benefit	3,668.2	2,240.4	1,301.4
20-year NPV Benefit	3,316.4	2,485.6	1,867.7
20-year NPV Cost	<u>(1,963.6)</u>	<u>(1,702.7)</u>	<u>(1,493.9)</u>
20-year Net Benefit	1,352.8	782.9	373.8
10-year NPV Benefit	373.6	272.4	190.1
10-year NPV Cost	<u>(1,342.0)</u>	<u>(1,228.9)</u>	<u>(1,130.0)</u>
10-year Net Benefit	(968.4)	(956.5)	(939.9)

- Preliminary analysis shows 502 Junction-Meadowbrook-Loudoun 500 kV line increases SWMAAC LDA import limit by 200 MW
- 2007/08 RPM simulation made with SWMAAC import limit increased by 200 MW to determine change in annual metrics shown below

	Change in Capacity Cost (\$M)	Change in CTR Value (\$M)	Change in Load Payment (\$M)	Change in Generator Revenue (\$M)
RTO	0.0	0.0	0.0	0.0
Eastern MAAC	0.0	0.0	0.0	0.0
Southwestern MAAC	0.0	-53.3	-159.3	-106.0
Total	0.0	-53.3	-159.3	-106.0

- Benefits from 2007/08 RPM Simulation assumed constant over 30-year period
- NPV of these benefits calculated for 10, 20 and 30 years using discount rates of 8%, 10% and 12%
- NPV of RPM benefits added to NPV of like energy market benefit
 - NPV RPM Capacity Procurement Cost + NPV Energy Production Cost
 - NPV RPM CTR Value + NPV Energy Market Congestion Cost
 - NPV RPM Load Payment + NPV Energy Market Load Payment
 - NPV RPM Generation Revenue + NPV Energy Market Generation Revenue



Benefit NPV vs Cost NPV (Energy Market Benefits + RPM Benefits)

PRODUCTION COST METRIC

	8% Discount Rate	10% Discount Rate	12% Discount Rate
30-year NPV Benefit	2,866.9	2,269.5	1,842.3
30-year NPV Cost	<u>(2,251.6)</u>	<u>(1,885.4)</u>	<u>(1,611.0)</u>
30-year Net Benefit	615.4	384.1	231.3
20-year NPV Benefit	2,210.7	1,855.0	1,577.6
20-year NPV Cost	<u>(1,963.6)</u>	<u>(1,702.7)</u>	<u>(1,493.9)</u>
20-year Net Benefit	247.1	152.3	83.7
10-year NPV Benefit	1,215.6	1,101.2	1,002.2
10-year NPV Cost	<u>(1,342.0)</u>	<u>(1,228.9)</u>	<u>(1,130.0)</u>
10-year Net Benefit	(126.4)	(127.7)	(127.8)

CONGESTION COST METRIC

	8% Discount Rate	10% Discount Rate	12% Discount Rate
30-year NPV Benefit	13,986.2	11,235.4	9,248.2
30-year NPV Cost	<u>(2,251.6)</u>	<u>(1,885.4)</u>	<u>(1,611.0)</u>
30-year Net Benefit	11,734.7	9,350.0	7,637.2
20-year NPV Benefit	11,145.6	9,439.8	8,100.8
20-year NPV Cost	<u>(1,963.6)</u>	<u>(1,702.7)</u>	<u>(1,493.9)</u>
20-year Net Benefit	9,182.0	7,737.1	6,606.9
10-year NPV Benefit	6,546.5	5,951.3	5,434.5
10-year NPV Cost	<u>(1,342.0)</u>	<u>(1,228.9)</u>	<u>(1,130.0)</u>
10-year Net Benefit	5,204.5	4,722.4	4,304.5

LOAD PAYMENT METRIC

	8% Discount Rate	10% Discount Rate	12% Discount Rate
30-year NPV Benefit	21,099.4	16,360.5	13,014.5
30-year NPV Cost	<u>(2,251.6)</u>	<u>(1,885.4)</u>	<u>(1,611.0)</u>
30-year Net Benefit	18,847.8	14,475.1	11,403.4
20-year NPV Benefit	15,502.8	12,827.8	10,760.2
20-year NPV Cost	<u>(1,963.6)</u>	<u>(1,702.7)</u>	<u>(1,493.9)</u>
20-year Net Benefit	13,539.2	11,125.1	9,266.3
10-year NPV Benefit	7,631.4	6,875.0	6,223.5
10-year NPV Cost	<u>(1,342.0)</u>	<u>(1,228.9)</u>	<u>(1,130.0)</u>
10-year Net Benefit	6,289.4	5,646.1	5,093.5

GENERATION REVENUE METRIC

	8% Discount Rate	10% Discount Rate	12% Discount Rate
30-year NPV Benefit	7,113.1	5,125.1	3,766.2
30-year NPV Cost	<u>(2,251.6)</u>	<u>(1,885.4)</u>	<u>(1,611.0)</u>
30-year Net Benefit	4,861.5	3,239.7	2,155.2
20-year NPV Benefit	4,357.1	3,388.0	2,659.4
20-year NPV Cost	<u>(1,963.6)</u>	<u>(1,702.7)</u>	<u>(1,493.9)</u>
20-year Net Benefit	2,393.5	1,685.3	1,165.5
10-year NPV Benefit	1,084.9	923.7	789.0
10-year NPV Cost	<u>(1,342.0)</u>	<u>(1,228.9)</u>	<u>(1,130.0)</u>
10-year Net Benefit	(257.1)	(305.2)	(341.0)



Future Congestion

Estimated congestion costs for most significant constraints from year 2013 simulations

CONSTRAINT	YEAR 2013 SIMULATION 2011 RTEP System		YEAR 2013 SIMULATION 2011 RTEP SYSTEM + AMOS-KEMPTOWN 765	
	# OF HOURS	CONGESTION COSTS (\$M)	# OF HOURS	CONGESTION COSTS (\$M)
AP - SOUTH INTERFACE	658	224.8	6	0.9
PJM-EASTERN INTERFACE	947	87.5	1304	158.0
CABOT 500 XFMR	57	12.6	117	43.7
PRUNTYTOWN-MT STORM 500	17	4.7	2	0.1
CLOVERDALE-LEXINGTON 500	2005	215.2	1453	129.5
KAMMER 765 XFMR	2957	215.1	519	24.9
MUSKNG-OHIOCT 345	117	10.1	79	2.2
PJM-CENTRAL INTERFACE	1220	62.1	2729	154.5
PJM-WESTERN INTERFACE	906	87.7	37	6.1
		919.7		519.9