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Xcel Energy Information Request No. 1
Docket No.: E999/M-14-65
Response To: Minnesota Public Utilities Commission
Requestor: Susan Mackenzie
Date Received: August 5, 2019

Question:

In the August 2, 2019 petition, in Docket E-999/M-14-65, the Company indicates that the preliminary calculation of the avoided distribution cost component, under the current VOS Methodology, will result in an increase. The petition indicates that this cost component will increase from \$0.000 (2019) to \$0.1373 (2020) per kWh.

Please provide the full backup data and calculations under the VOS Methodology that support the preliminary calculation of this cost component. In addition, please provide a qualitative (non-quantitative) description of the significant factors that explain the increase in the cost component from \$0.000 in 2019 to \$0.1373 in 2020.

Response:

Please see attachment A to this response for the distribution capacity cost per unit growth calculation of \$6,340. Also see Attachment B where the cost per unit growth of \$6,340 is inserted in Table 5 and then is referenced by Table 15 for the distribution capacity component calculation. The final results of the calculation (i.e., the \$0.1373) can be found in the tab labeled “ES-1” on the distribution capacity component line of the VOS summary.

The result of the calculation in the current methodology is much higher than past calculations because the denominator of the equation “peak demand growth” is relatively small. When growth is used in the denominator of an equation there is a potential for unstable results since growth can be small and as growth gets smaller and smaller the result of the equation grows exponentially toward infinity. Historical growth can also be negative, which causes the distribution capacity cost calculation to result in negative value as was the case in the 2016 and 2017 VOS rates and again last year in the 2019 VOS Rate. Our proposal to calculate avoided capacity costs using potentially avoidable capacity and the dollars related to those capacity projects ties the avoidable capacity to the avoidable dollars, for a more stable result.

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Date: August 15, 2019

VOS Distribution Capacity Cost per kW

A. Estimate the percentage of distribution cost that is deferrable per the VOS methodology:

	MN Electric Distribution Costs <i>Nominal</i>	Percent Capacity Related	Capacity Related Project Costs <i>Nominal</i>	2020 Inflation Adjustment Inflation Rate 2.23%	Capacity Related Project Cost <i>Adjusted for Inflation</i>
	(a)	(a / b)	(b)	(c)	(c * b) = (d)
1 2018	\$175,490,525	4.5%	\$7,812,185	104.5%	\$8,164,493
2 2017	\$155,018,178	6.6%	\$10,270,204	106.8%	\$10,972,716
3 2016	\$165,929,956	9.6%	\$15,936,132	109.2%	\$17,405,895
4 2015	\$134,867,264	12.1%	\$16,309,114	111.7%	\$18,210,513
5 2014	\$129,899,465	16.3%	\$21,147,768	114.1%	\$24,139,858
6 2013	\$142,118,822	20.3%	\$28,825,462	116.7%	\$33,637,585
7 2012	\$109,286,058	20.8%	\$22,683,879	119.3%	\$27,061,023
8 2011	\$100,102,075	7.5%	\$7,502,291	122.0%	\$9,149,538
9 2010	\$98,267,667	11.0%	\$10,823,959	124.7%	\$13,494,902
10 2009	\$82,821,606	10.6%	\$8,749,417	127.5%	\$11,151,700
2009-18 Total					\$173,388,223

B. Identify Peak Demand historical 10-yr growth rate

	Peak Data MN	KW Growth 2018 vs. 2009	Average Annual Growth Rate
1 2018	6,419,811	27,347	
2 2017	6,493,385		
3 2016	6,700,468		
4 2015	6,579,852		
5 2014	6,801,376		
6 2013	7,124,354		
7 2012	6,947,755		
8 2011	6,951,472		
9 2010	6,727,832		
10 2009	6,392,464		

C. Calculate Cost per kW Growth 2009-18

Distribution Cost	\$173,388,223 (g)	From A
10yrs of KW Growth	27,347 (h)	From B
Cost per kW	\$6,340 (i) = (g) / (h)	
Cost per kW (Inserted into Table 15)	\$6,340 (j) = (i) unless (i) < 0, then 0	

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Note: Table 1, 2 and 16 were not included as they are not required for the VOS calculation. Table 7 (Losses to be considered) are included in Fig. ES-1

Figure ES-1. VOS Calculation Table: economic value, load match, loss savings and distributed PV va

CURRENT POSITION	Economic Value	Load Match	Distributed Loss Savings	Distributed PV Value
<i>25 Year Levelized Values</i>	(\$/kWh)	(%)	(%)	(\$/kWh)
Avoided Fuel Cost	\$0.0274		9.8%	\$0.0301
Avoided Plant O&M - Fixed	\$0.0027	48.6%	10.8%	\$0.0014
Avoided Plant O&M - Variable	\$0.0012		9.8%	\$0.0014
Avoided Generation Capacity Cost	\$0.0367	48.6%	10.8%	\$0.0197
Avoided Reserve Capacity Cost	\$0.0029	48.6%	10.8%	\$0.0016
Avoided Transmission Capacity Cos	\$0.0325	48.6%	10.8%	\$0.0175
Avoided Distribution Capacity Cost	\$0.2237	54.6%	12.4%	\$0.1373
Avoided Environmental Cost	\$0.0359		9.8%	\$0.0394
Avoided Voltage Control Cost				
<u>Solar Integration Cost</u>				
TOTAL				\$0.2484

Figure ES-2. 1st-Year VOS Rate calculation

Year	Discount Factor	Escalation Factor	VOS Levelized	Disc.	VOS Inflation Adj. (\$/kWh)	Disc
2020	1.000	1.000	\$0.248	\$0.248	\$0.2027	0.203
2021	0.940	1.022	\$0.248	\$0.234	\$0.2073	0.195
2022	0.884	1.045	\$0.248	\$0.220	\$0.2119	0.187
2023	0.831	1.068	\$0.248	\$0.206	\$0.2166	0.180
2024	0.781	1.092	\$0.248	\$0.194	\$0.2214	0.173
2025	0.735	1.117	\$0.248	\$0.182	\$0.2264	0.166
2026	0.691	1.141	\$0.248	\$0.172	\$0.2314	0.160
2027	0.649	1.167	\$0.248	\$0.161	\$0.2366	0.154
2028	0.611	1.193	\$0.248	\$0.152	\$0.2418	0.148
2029	0.574	1.220	\$0.248	\$0.143	\$0.2472	0.142
2030	0.540	1.247	\$0.248	\$0.134	\$0.2528	0.136
2031	0.508	1.275	\$0.248	\$0.126	\$0.2584	0.131
2032	0.477	1.303	\$0.248	\$0.119	\$0.2642	0.126
2033	0.449	1.332	\$0.248	\$0.111	\$0.2700	0.121
2034	0.422	1.362	\$0.248	\$0.105	\$0.2761	0.116
2035	0.397	1.392	\$0.248	\$0.099	\$0.2822	0.112
2036	0.397	1.423	\$0.248	\$0.099	\$0.2885	0.114
2037	0.351	1.455	\$0.248	\$0.087	\$0.2950	0.103
2038	0.330	1.487	\$0.248	\$0.082	\$0.3015	0.099
2039	0.310	1.521	\$0.248	\$0.077	\$0.3083	0.096
2040	0.291	1.554	\$0.248	\$0.072	\$0.3151	0.092
2041	0.274	1.589	\$0.248	\$0.068	\$0.3222	0.088
2042	0.258	1.625	\$0.248	\$0.064	\$0.3293	0.085
2043	0.242	1.661	\$0.248	\$0.060	\$0.3367	0.082
2044	0.228	1.698	\$0.248	\$0.057	\$0.3442	0.078
				\$3.271		\$3.288

Table 3. Fixed Assumptions to be used for the VOS calculations

Fuel Prices			Environmental Externalities		
Guaranteed NG Fuel Prices			Environmental Discount Rate	5.30%	per year
2020	\$2.671	\$/mmBtu	Environmental Costs	separate table	
2021	\$2.639	\$/mmBtu	Economic Assumptions		
2022	\$2.645	\$/mmBtu	General Escalation Rate	2.23%	per year
2023	\$2.720	\$/mmBtu	Treasury Yields		
2024	\$2.823	\$/mmBtu	1 Year	2.17%	
2025	\$2.935	\$/mmBtu	2 Year	2.05%	
2026	\$3.047	\$/mmBtu	3 Year	2.01%	
2027	\$3.159	\$/mmBtu	5 Year	2.04%	
2028	\$3.271	\$/mmBtu	7 Year	2.14%	
2029	\$3.380	\$/mmBtu	10 Year	2.25%	
2030	\$3.490	\$/mmBtu	20 Year	2.49%	
2031	\$3.596	\$/mmBtu	30 Year	2.68%	
Fuel Price Escalation	2.23%				
PV Assumptions					
PV Degradation Rate	0.50%				
PV Life	25				

Table 4. Environmental costs by year.

Year	Analysis Year	CO2 Cost \$/mmBtu	PM 2.5 Cost \$/mmBtu	CO Cost \$/mmBtu	NOx Cost \$/mmBtu	Pb Cost \$/mmBtu	SO2 Cost \$/mmBtu	Total Cost \$/mmBtu
2020	0	\$2.807	\$0.021	\$0.000	\$0.286	\$0.000	\$0.004	\$3.117
2021	1	\$2.924	\$0.021	\$0.000	\$0.292	\$0.000	\$0.004	\$3.241
2022	2	\$3.045	\$0.021	\$0.000	\$0.299	\$0.000	\$0.004	\$3.369
2023	3	\$3.170	\$0.022	\$0.000	\$0.305	\$0.000	\$0.004	\$3.502
2024	4	\$3.299	\$0.022	\$0.000	\$0.312	\$0.000	\$0.004	\$3.638
2025	5	\$3.433	\$0.023	\$0.000	\$0.319	\$0.000	\$0.004	\$3.779
2026	6	\$3.570	\$0.023	\$0.000	\$0.326	\$0.000	\$0.004	\$3.924
2027	7	\$3.712	\$0.024	\$0.000	\$0.334	\$0.000	\$0.004	\$4.074
2028	8	\$3.859	\$0.025	\$0.000	\$0.341	\$0.000	\$0.004	\$4.229
2029	9	\$4.010	\$0.025	\$0.000	\$0.349	\$0.000	\$0.004	\$4.388
2030	10	\$4.166	\$0.026	\$0.000	\$0.356	\$0.000	\$0.004	\$4.553
2031	11	\$4.344	\$0.026	\$0.000	\$0.364	\$0.000	\$0.004	\$4.740
2032	12	\$4.528	\$0.027	\$0.000	\$0.373	\$0.000	\$0.005	\$4.932
2033	13	\$4.718	\$0.027	\$0.000	\$0.381	\$0.000	\$0.005	\$5.131
2034	14	\$4.915	\$0.028	\$0.000	\$0.389	\$0.000	\$0.005	\$5.337
2035	15	\$5.117	\$0.029	\$0.000	\$0.398	\$0.000	\$0.005	\$5.549
2036	16	\$5.326	\$0.029	\$0.000	\$0.407	\$0.000	\$0.005	\$5.768
2037	17	\$5.542	\$0.030	\$0.000	\$0.416	\$0.000	\$0.005	\$5.993
2038	18	\$5.765	\$0.031	\$0.000	\$0.425	\$0.000	\$0.005	\$6.227
2039	19	\$5.996	\$0.031	\$0.000	\$0.435	\$0.000	\$0.005	\$6.467
2040	20	\$6.233	\$0.032	\$0.000	\$0.444	\$0.000	\$0.005	\$6.715
2041	21	\$6.457	\$0.033	\$0.000	\$0.454	\$0.000	\$0.006	\$6.950
2042	22	\$6.688	\$0.033	\$0.000	\$0.464	\$0.000	\$0.006	\$7.192
2043	23	\$6.926	\$0.034	\$0.000	\$0.475	\$0.000	\$0.006	\$7.441
2044	24	\$7.171	\$0.035	\$0.000	\$0.485	\$0.000	\$0.006	\$7.698

Table 5. VOS Data table -- required format showing assumptions used in the VOS calculation.

	Input Data	Units		Input Data	Units
Economic Factors			Power Generation - Continued		
Start Year for VOS applicability	2020	Year	Other		
Discount Rate (After-tax WACC)	6.36%	Percentage	Solar weighted Heat Rate	7,742	BTU per kWh
Load Match Analysis			Fuel Price Overhead	\$0.004	\$ per MMBtu
ELCC (no loss)	48.6%	% of rating	Generation life	40	years
PLR (no loss)	54.6%	% of rating	Heat Rate degradation	0.10%	per year
Loss Savings - Energy	9.8%	% of PV output	O&M cost (first year) - Fixed	\$3.42	per kW-yr
Loss Savings - PLR	12.4%	% of PV output	O&M cost (first year) - Variable	\$0.0010	\$ per kWh
Loss Savings - ELCC	10.8%	% of PV output	O&M cost escalation rate	2.00%	per year
PV Energy			Reserve planning margin	7.9%	
Simulated - First year annual energy	1,452	kWh per kW-AC	Years until new Generation is needed	0	
year annual energy		kWh per kW-AC	Distribution		
Actual- First year annual energy	1,563		Capacity-related distribution capital costs -System	\$6,340	\$ per kW
Transmission			Capacity-related distribution capital costs - Mpls	N/A	\$ per kW
Capacity-related transmission capital cost	\$50.33	\$ per kW	Capacity-related distribution capital costs - Mtk	N/A	\$ per kW
Power Generation			Capacity-related distribution capital costs -Edina	N/A	\$ per kW
Peaking CT, simple cycle			Capacity-related distribution capital costs - SE	N/A	\$ per kW
Installed Cost	\$476	\$/kW	Capacity-related distribution capital costs -MG	N/A	\$ per kW
Heat Rate	9,738	BTU/kWh	Capacity-related distribution capital costs - Newport	N/A	\$ per kW
Intermediate CCGT			Capacity-related distribution capital costs - St. Paul	N/A	\$ per kW
Installed Cost	\$1,022	\$/kW	Capacity-related distribution capital costs - NW	N/A	\$ per kW
Heat Rate	6,547	BTU/kWh	Capacity-related distribution capital costs - WBL	N/A	\$ per kW
			Distribution capital cost escalation	2.00%	per year
			Peak Load (Weather Normalized)	6,420	MW
			Peak Load Growth	0.43%	per year

Table 6. Azimuth and Tilt Angles

	Array KW	% of Total	Azimuth	Tilt	
1	3,209	4.9%	52	25	
2	2,974	4.5%	140	21	
3	2,906	4.4%	167	19	
4	18,979	28.9%	180	12	
5	3,939	6.0%	180	21	
6	7,997	12.2%	180	26	
7	6,676	10.2%	180	30	
8	3,296	5.0%	180	35	
9	947	1.4%	180	42	
10	5,453	8.3%	180	48	
11	2,769	4.2%	184	19	
12	964	1.5%	197	26	
13	2,816	4.3%	212	18	
14	1,207	1.8%	237	24	
15	1,577	2.4%	271	22	
TOTAL	65,709	100%	176.4	23.2	Weighted Average

Table 8. Economic Value of Avoided Fuel Costs.

Year				Prices		p.u. PV Production (kWh)	Costs		Discount Factor (risk free)	Disc. Costs	
	Guaranteed NG Price	Burner Tip NG Price	Heat Rate	Utility	VOS		Utility	VOS		Utility	VOS
	\$/mmBtu	\$/mmBtu	mmBtu/kWh	\$/kWh	\$/kWh		(\$)	(\$)		(\$)	(\$)
2020	\$2.67	\$2.67	7,742	\$0.021	\$0.0274	1,563	\$32	\$43	1.000	\$32	\$43
2021	\$2.64	\$2.64	7,750	\$0.020	\$0.0274	1,555	\$32	\$43	0.979	\$31	\$42
2022	\$2.64	\$2.65	7,757	\$0.021	\$0.0274	1,547	\$32	\$42	0.960	\$31	\$41
2023	\$2.72	\$2.72	7,765	\$0.021	\$0.0274	1,540	\$33	\$42	0.942	\$31	\$40
2024	\$2.82	\$2.83	7,773	\$0.022	\$0.0274	1,532	\$34	\$42	0.923	\$31	\$39
2025	\$2.93	\$2.94	7,781	\$0.023	\$0.0274	1,524	\$35	\$42	0.904	\$32	\$38
2026	\$3.05	\$3.05	7,789	\$0.024	\$0.0274	1,517	\$36	\$42	0.883	\$32	\$37
2027	\$3.16	\$3.16	7,796	\$0.025	\$0.0274	1,509	\$37	\$41	0.863	\$32	\$36
2028	\$3.27	\$3.28	7,804	\$0.026	\$0.0274	1,502	\$38	\$41	0.842	\$32	\$35
2029	\$3.38	\$3.38	7,812	\$0.026	\$0.0274	1,494	\$40	\$41	0.822	\$32	\$34
2030	\$3.49	\$3.49	7,820	\$0.027	\$0.0274	1,487	\$41	\$41	0.801	\$33	\$33
2031	\$3.60	\$3.60	7,828	\$0.028	\$0.0274	1,479	\$42	\$41	0.781	\$33	\$32
2032	\$3.68	\$3.68	7,835	\$0.029	\$0.0274	1,472	\$42	\$40	0.762	\$32	\$31
2033	\$3.76	\$3.76	7,843	\$0.030	\$0.0274	1,464	\$43	\$40	0.742	\$32	\$30
2034	\$3.84	\$3.85	7,851	\$0.030	\$0.0274	1,457	\$44	\$40	0.723	\$32	\$29
2035	\$3.93	\$3.93	7,859	\$0.031	\$0.0274	1,450	\$45	\$40	0.704	\$32	\$28
2036	\$4.01	\$4.02	7,867	\$0.032	\$0.0274	1,443	\$46	\$40	0.685	\$31	\$27
2037	\$4.10	\$4.11	7,875	\$0.032	\$0.0274	1,435	\$46	\$39	0.666	\$31	\$26
2038	\$4.20	\$4.20	7,883	\$0.033	\$0.0274	1,428	\$47	\$39	0.648	\$31	\$25
2039	\$4.29	\$4.30	7,890	\$0.034	\$0.0274	1,421	\$48	\$39	0.629	\$30	\$25
2040	\$4.39	\$4.39	7,898	\$0.035	\$0.0274	1,414	\$49	\$39	0.611	\$30	\$24
2041	\$4.48	\$4.49	7,906	\$0.035	\$0.0274	1,407	\$50	\$39	0.594	\$30	\$23
2042	\$4.58	\$4.59	7,914	\$0.036	\$0.0274	1,400	\$51	\$38	0.577	\$29	\$22
2043	\$4.69	\$4.69	7,922	\$0.037	\$0.0274	1,393	\$52	\$38	0.561	\$29	\$21
2044	\$4.79	\$4.80	7,930	\$0.038	\$0.0274	1,386	\$53	\$38	0.544	\$29	\$21

Validation: Present Value	\$779	\$779
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Table 9. Economic value of avoided plant O&M - fixed

Year	O&M Fixed	Utility Capacity	PV Capacity	Prices		p.u. PV Production	Costs		Discount Factor	Disc. Costs	
				Utility	VOS		Utility	VOS		Utility	VOS
				\$/kWh	\$/kWh		(\$)	(\$)		(\$)	(\$)
2020	\$3.42	1.00	1.00	\$0.0022	\$0.0027	1,563	\$3.42	\$4.14	1.000	\$3.42	\$4.14
2021	\$3.49	0.999	0.995	\$0.0022	\$0.0027	1,555	\$3.48	\$4.12	0.940	\$3.27	\$3.88
2022	\$3.56	0.998	0.990	\$0.0023	\$0.0027	1,547	\$3.53	\$4.10	0.884	\$3.12	\$3.63
2023	\$3.63	0.997	0.985	\$0.0024	\$0.0027	1,540	\$3.59	\$4.08	0.831	\$2.98	\$3.39
2024	\$3.71	0.996	0.980	\$0.0024	\$0.0027	1,532	\$3.65	\$4.06	0.781	\$2.85	\$3.17
2025	\$3.78	0.995	0.975	\$0.0025	\$0.0027	1,524	\$3.71	\$4.04	0.735	\$2.72	\$2.97
2026	\$3.86	0.994	0.970	\$0.0025	\$0.0027	1,517	\$3.76	\$4.02	0.691	\$2.60	\$2.78
2027	\$3.93	0.993	0.966	\$0.0026	\$0.0027	1,509	\$3.82	\$4.00	0.649	\$2.48	\$2.60
2028	\$4.01	0.992	0.961	\$0.0027	\$0.0027	1,502	\$3.89	\$3.98	0.611	\$2.37	\$2.43
2029	\$4.09	0.991	0.956	\$0.0027	\$0.0027	1,494	\$3.95	\$3.96	0.574	\$2.27	\$2.27
2030	\$4.17	0.990	0.951	\$0.0028	\$0.0027	1,487	\$4.01	\$3.94	0.540	\$2.16	\$2.13
2031	\$4.26	0.989	0.946	\$0.0028	\$0.0027	1,479	\$4.07	\$3.92	0.508	\$2.07	\$1.99
2032	\$4.34	0.988	0.942	\$0.0029	\$0.0027	1,472	\$4.14	\$3.90	0.477	\$1.97	\$1.86
2033	\$4.43	0.987	0.937	\$0.0030	\$0.0027	1,464	\$4.20	\$3.88	0.449	\$1.89	\$1.74
2034	\$4.52	0.986	0.932	\$0.0031	\$0.0027	1,457	\$4.27	\$3.86	0.422	\$1.80	\$1.63
2035	\$4.52	0.985	0.928	\$0.0031	\$0.0027	1,450	\$4.25	\$3.84	0.397	\$1.69	\$1.52
2036	\$4.70	0.984	0.923	\$0.0032	\$0.0027	1,443	\$4.41	\$3.82	0.397	\$1.75	\$1.52
2037	\$4.79	0.983	0.918	\$0.0033	\$0.0027	1,435	\$4.48	\$3.80	0.351	\$1.57	\$1.33
2038	\$4.89	0.982	0.914	\$0.0034	\$0.0027	1,428	\$4.55	\$3.78	0.330	\$1.50	\$1.25
2039	\$4.99	0.981	0.909	\$0.0034	\$0.0027	1,421	\$4.62	\$3.77	0.310	\$1.43	\$1.17
2040	\$5.09	0.980	0.905	\$0.0035	\$0.0027	1,414	\$4.70	\$3.75	0.291	\$1.37	\$1.09
2041	\$5.19	0.979	0.900	\$0.0036	\$0.0027	1,407	\$4.77	\$3.73	0.274	\$1.31	\$1.02
2042	\$5.29	0.978	0.896	\$0.0037	\$0.0027	1,400	\$4.85	\$3.71	0.258	\$1.25	\$0.96
2043	\$5.40	0.977	0.891	\$0.0038	\$0.0027	1,393	\$4.92	\$3.69	0.242	\$1.19	\$0.89
2044	\$5.51	0.976	0.887	\$0.0039	\$0.0027	1,386	\$5.00	\$3.67	0.228	\$1.14	\$0.84

\$0.0027

Validation: Present Value	\$52	\$52
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Table 10. Economic value of avoided plant O&M - variable

Year	Prices		p.u. PV Production (kWh)	Costs		Discount Factor (risk free)	Disc. Costs	
	Utility	VOS		Utility	VOS		Utility	VOS
	\$/kWh	\$/kWh		(\$)	(\$)		(\$)	(\$)
2020	\$0.0010	\$0.0012	1,563	\$2	\$2	1.000	\$2	\$2
2021	\$0.0011	\$0.0012	1,555	\$2	\$2	0.940	\$2	\$2
2022	\$0.0011	\$0.0012	1,547	\$2	\$2	0.884	\$1	\$2
2023	\$0.0011	\$0.0012	1,540	\$2	\$2	0.831	\$1	\$2
2024	\$0.0011	\$0.0012	1,532	\$2	\$2	0.781	\$1	\$1
2025	\$0.0011	\$0.0012	1,524	\$2	\$2	0.735	\$1	\$1
2026	\$0.0012	\$0.0012	1,517	\$2	\$2	0.691	\$1	\$1
2027	\$0.0012	\$0.0012	1,509	\$2	\$2	0.649	\$1	\$1
2028	\$0.0012	\$0.0012	1,502	\$2	\$2	0.611	\$1	\$1
2029	\$0.0012	\$0.0012	1,494	\$2	\$2	0.574	\$1	\$1
2030	\$0.0013	\$0.0012	1,487	\$2	\$2	0.540	\$1	\$1
2031	\$0.0013	\$0.0012	1,479	\$2	\$2	0.508	\$1	\$1
2032	\$0.0013	\$0.0012	1,472	\$2	\$2	0.477	\$1	\$1
2033	\$0.0013	\$0.0012	1,464	\$2	\$2	0.449	\$1	\$1
2034	\$0.0014	\$0.0012	1,457	\$2	\$2	0.422	\$1	\$1
2035	\$0.0014	\$0.0012	1,450	\$2	\$2	0.397	\$1	\$1
2036	\$0.0014	\$0.0012	1,443	\$2	\$2	0.373	\$1	\$1
2037	\$0.0014	\$0.0012	1,435	\$2	\$2	0.351	\$1	\$1
2038	\$0.0015	\$0.0012	1,428	\$2	\$2	0.330	\$1	\$1
2039	\$0.0015	\$0.0012	1,421	\$2	\$2	0.310	\$1	\$1
2040	\$0.0015	\$0.0012	1,414	\$2	\$2	0.291	\$1	\$1
2041	\$0.0016	\$0.0012	1,407	\$2	\$2	0.274	\$1	\$0
2042	\$0.0016	\$0.0012	1,400	\$2	\$2	0.258	\$1	\$0
2043	\$0.0016	\$0.0012	1,393	\$2	\$2	0.242	\$1	\$0
2044	\$0.0017	\$0.0012	1,386	\$2	\$2	0.228	\$1	\$0
Validation: Present Value							\$24	\$24

Table 11. Economic value of avoided generation capacity cost.

Year	Capacity Cost	Utility Capacity	PV Capacity	Prices		PV Production	Costs		Discount Factor	Disc. Costs	
				Utility	VOS		Utility	VOS		Utility	VOS
	\$/kW-yr	pu.	kW	\$/kWh	\$/kWh	(kWh)	(\$)	(\$)		(\$)	(\$)
2020	\$57	1.00	1.00	\$0.036	\$0.0367	1,563	\$57	\$57	1.000	\$57	\$57
2021	\$57	0.999	0.995	\$0.036	\$0.0367	1,555	\$57	\$57	0.940	\$53	\$54
2022	\$57	0.998	0.990	\$0.036	\$0.0367	1,547	\$56	\$57	0.884	\$50	\$50
2023	\$57	0.997	0.985	\$0.036	\$0.0367	1,540	\$56	\$56	0.831	\$47	\$47
2024	\$57	0.996	0.980	\$0.036	\$0.0367	1,532	\$56	\$56	0.781	\$44	\$44
2025	\$57	0.995	0.975	\$0.037	\$0.0367	1,524	\$56	\$56	0.735	\$41	\$41
2026	\$57	0.994	0.970	\$0.037	\$0.0367	1,517	\$55	\$56	0.691	\$38	\$38
2027	\$57	0.993	0.966	\$0.037	\$0.0367	1,509	\$55	\$55	0.649	\$36	\$36
2028	\$57	0.992	0.961	\$0.037	\$0.0367	1,502	\$55	\$55	0.611	\$34	\$34
2029	\$57	0.991	0.956	\$0.037	\$0.0367	1,494	\$55	\$55	0.574	\$31	\$31
2030	\$57	0.990	0.951	\$0.037	\$0.0367	1,487	\$55	\$55	0.540	\$29	\$29
2031	\$57	0.989	0.946	\$0.037	\$0.0367	1,479	\$54	\$54	0.508	\$28	\$28
2032	\$57	0.988	0.942	\$0.037	\$0.0367	1,472	\$54	\$54	0.477	\$26	\$26
2033	\$57	0.987	0.937	\$0.037	\$0.0367	1,464	\$54	\$54	0.449	\$24	\$24
2034	\$57	0.986	0.932	\$0.037	\$0.0367	1,457	\$54	\$53	0.422	\$23	\$23
2035	\$57	0.985	0.928	\$0.037	\$0.0367	1,450	\$53	\$53	0.397	\$21	\$21
2036	\$57	0.984	0.923	\$0.037	\$0.0367	1,443	\$53	\$53	0.373	\$20	\$20
2037	\$57	0.983	0.918	\$0.037	\$0.0367	1,435	\$53	\$53	0.351	\$19	\$18
2038	\$57	0.982	0.914	\$0.037	\$0.0367	1,428	\$53	\$52	0.330	\$17	\$17
2039	\$57	0.981	0.909	\$0.037	\$0.0367	1,421	\$53	\$52	0.310	\$16	\$16
2040	\$57	0.980	0.905	\$0.037	\$0.0367	1,414	\$52	\$52	0.291	\$15	\$15
2041	\$57	0.979	0.900	\$0.037	\$0.0367	1,407	\$52	\$52	0.274	\$14	\$14
2042	\$57	0.978	0.896	\$0.037	\$0.0367	1,400	\$52	\$51	0.258	\$13	\$13
2043	\$57	0.977	0.891	\$0.037	\$0.0367	1,393	\$52	\$51	0.242	\$13	\$12
2044	\$57	0.976	0.887	\$0.037	\$0.0367	1,386	\$52	\$51	0.228	\$12	\$12

\$0.0367

Validation: Present Value

\$721

\$721

Table 12. Economic value of avoided reserve capacity cost.

Year	Capacity Cost	Reserve Margin	Utility Capacity	PV Capacity	Prices		PV Production	Costs		Discount Factor	Disc. Costs	
					Utility	VOS		Utility	VOS		Utility	VOS
	\$/kW-yr	%	pu.	kW	\$/kWh	\$/kWh	(kWh)	(\$)	(\$)		(\$)	(\$)
2020	\$57	7.9%	1.00	1.00	\$0.003	\$0.0029	1,563	\$4	\$5	1.000	\$4	\$5
2021	\$57	7.9%	0.999	0.995	\$0.003	\$0.0029	1,555	\$4	\$5	0.940	\$4	\$4
2022	\$57	7.9%	0.998	0.990	\$0.003	\$0.0029	1,547	\$4	\$4	0.884	\$4	\$4
2023	\$57	7.9%	0.997	0.985	\$0.003	\$0.0029	1,540	\$4	\$4	0.831	\$4	\$4
2024	\$57	7.9%	0.996	0.980	\$0.003	\$0.0029	1,532	\$4	\$4	0.781	\$3	\$3
2025	\$57	7.9%	0.995	0.975	\$0.003	\$0.0029	1,524	\$4	\$4	0.735	\$3	\$3
2026	\$57	7.9%	0.994	0.970	\$0.003	\$0.0029	1,517	\$4	\$4	0.691	\$3	\$3
2027	\$57	7.9%	0.993	0.966	\$0.003	\$0.0029	1,509	\$4	\$4	0.649	\$3	\$3
2028	\$57	7.9%	0.992	0.961	\$0.003	\$0.0029	1,502	\$4	\$4	0.611	\$3	\$3
2029	\$57	7.9%	0.991	0.956	\$0.003	\$0.0029	1,494	\$4	\$4	0.574	\$2	\$2
2030	\$57	7.9%	0.990	0.951	\$0.003	\$0.0029	1,487	\$4	\$4	0.540	\$2	\$2
2031	\$57	7.9%	0.989	0.946	\$0.003	\$0.0029	1,479	\$4	\$4	0.508	\$2	\$2
2032	\$57	7.9%	0.988	0.942	\$0.003	\$0.0029	1,472	\$4	\$4	0.477	\$2	\$2
2033	\$57	7.9%	0.987	0.937	\$0.003	\$0.0029	1,464	\$4	\$4	0.449	\$2	\$2
2034	\$57	7.9%	0.986	0.932	\$0.003	\$0.0029	1,457	\$4	\$4	0.422	\$2	\$2
2035	\$57	7.9%	0.985	0.928	\$0.003	\$0.0029	1,450	\$4	\$4	0.397	\$2	\$2
2036	\$57	7.9%	0.984	0.923	\$0.003	\$0.0029	1,443	\$4	\$4	0.373	\$2	\$2
2037	\$57	7.9%	0.983	0.918	\$0.003	\$0.0029	1,435	\$4	\$4	0.351	\$1	\$1
2038	\$57	7.9%	0.982	0.914	\$0.003	\$0.0029	1,428	\$4	\$4	0.330	\$1	\$1
2039	\$57	7.9%	0.981	0.909	\$0.003	\$0.0029	1,421	\$4	\$4	0.310	\$1	\$1
2040	\$57	7.9%	0.980	0.905	\$0.003	\$0.0029	1,414	\$4	\$4	0.291	\$1	\$1
2041	\$57	7.9%	0.979	0.900	\$0.003	\$0.0029	1,407	\$4	\$4	0.274	\$1	\$1
2042	\$57	7.9%	0.978	0.896	\$0.003	\$0.0029	1,400	\$4	\$4	0.258	\$1	\$1
2043	\$57	7.9%	0.977	0.891	\$0.003	\$0.0029	1,393	\$4	\$4	0.242	\$1	\$1
2044	\$57	7.9%	0.976	0.887	\$0.003	\$0.0029	1,386	\$4	\$4	0.228	\$1	\$1

\$0.0029

Validation: Present Value	\$57	\$57
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Table 13. Economic value of avoided transmission capacity cost.

Year				Prices		PV Production (kWh)	Costs		Discount Factor	Disc. Costs	
	Capacity Cost	Utility Capacity	PV Capacity	Utility	VOS		Utility	VOS		Utility	VOS
	\$/kW-yr	pu.	kW	\$/kWh	\$/kWh		(\$)	(\$)		(\$)	(\$)
2020	\$50	1.00	1.00	\$0.032	\$0.0325	1,563	\$50	\$51	1.000	\$50	\$51
2021	\$50	0.999	0.995	\$0.032	\$0.0325	1,555	\$50	\$51	0.940	\$47	\$47
2022	\$50	0.998	0.990	\$0.032	\$0.0325	1,547	\$50	\$50	0.884	\$44	\$44
2023	\$50	0.997	0.985	\$0.032	\$0.0325	1,540	\$50	\$50	0.831	\$41	\$42
2024	\$50	0.996	0.980	\$0.032	\$0.0325	1,532	\$50	\$50	0.781	\$39	\$39
2025	\$50	0.995	0.975	\$0.032	\$0.0325	1,524	\$49	\$50	0.735	\$36	\$36
2026	\$50	0.994	0.970	\$0.032	\$0.0325	1,517	\$49	\$49	0.691	\$34	\$34
2027	\$50	0.993	0.966	\$0.032	\$0.0325	1,509	\$49	\$49	0.649	\$32	\$32
2028	\$50	0.992	0.961	\$0.032	\$0.0325	1,502	\$49	\$49	0.611	\$30	\$30
2029	\$50	0.991	0.956	\$0.032	\$0.0325	1,494	\$49	\$49	0.574	\$28	\$28
2030	\$50	0.990	0.951	\$0.033	\$0.0325	1,487	\$48	\$48	0.540	\$26	\$26
2031	\$50	0.989	0.946	\$0.033	\$0.0325	1,479	\$48	\$48	0.508	\$24	\$24
2032	\$50	0.988	0.942	\$0.033	\$0.0325	1,472	\$48	\$48	0.477	\$23	\$23
2033	\$50	0.987	0.937	\$0.033	\$0.0325	1,464	\$48	\$48	0.449	\$21	\$21
2034	\$50	0.986	0.932	\$0.033	\$0.0325	1,457	\$48	\$47	0.422	\$20	\$20
2035	\$50	0.985	0.928	\$0.033	\$0.0325	1,450	\$47	\$47	0.397	\$19	\$19
2036	\$50	0.984	0.923	\$0.033	\$0.0325	1,443	\$47	\$47	0.373	\$18	\$17
2037	\$50	0.983	0.918	\$0.033	\$0.0325	1,435	\$47	\$47	0.351	\$16	\$16
2038	\$50	0.982	0.914	\$0.033	\$0.0325	1,428	\$47	\$46	0.330	\$15	\$15
2039	\$50	0.981	0.909	\$0.033	\$0.0325	1,421	\$47	\$46	0.310	\$14	\$14
2040	\$50	0.980	0.905	\$0.033	\$0.0325	1,414	\$46	\$46	0.291	\$14	\$13
2041	\$50	0.979	0.900	\$0.033	\$0.0325	1,407	\$46	\$46	0.274	\$13	\$13
2042	\$50	0.978	0.896	\$0.033	\$0.0325	1,400	\$46	\$45	0.258	\$12	\$12
2043	\$50	0.977	0.891	\$0.033	\$0.0325	1,393	\$46	\$45	0.242	\$11	\$11
2044	\$50	0.976	0.887	\$0.033	\$0.0325	1,386	\$46	\$45	0.228	\$10	\$10
					\$0.0325						
Validation: Present Value										\$639	\$639

Table 14. Determination of deferrable distribution costs.

Year	Distribution Project Costs	% Capacity Related	Capacity Related		
	\$	%	\$		
2018	175,490,525	4.5%	7,812,185		
2017	155,018,178	6.6%	10,270,204		
2016	165,929,956	9.6%	15,936,132		
2015	134,867,264	12.1%	16,309,114		
2014	129,899,465	16.3%	21,147,768		
2013	142,118,822	20.3%	28,825,462		
2012	109,286,058	20.8%	22,683,879		
2011	100,102,075	7.5%	7,502,291		
2010	98,267,667	11.0%	10,823,959		
2009	82,821,606	10.6%	8,749,417		
TOTAL 10-YEAR PERIOD	1,293,801,616		150,060,411		

Table 15. Economic value of avoided distribution capacity cost.

Year	Conventional Distribution Planning					Deferred Distribution Planning			
	Distribution Cost	New Dist. Capacity	Capital Cost	Disc Capital Cost	Amortized	Def. Dist. Capacity	Def. Capital Cost	Disc Capital Cost	Amortized
	\$/kW-yr	(MW)	(\$M)	(\$M)	\$/yr	(MW)	(\$M)	(\$M)	\$/yr
2020	\$6,340	50	\$317	\$317	\$424				\$406
2021	\$6,467	50	\$325	\$305	\$424	50	\$323.3	\$304.0	\$406
2022	\$6,596	50	\$333	\$294	\$424	50	\$331.2	\$292.8	\$406
2023	\$6,728	51	\$341	\$283	\$424	50	\$339.3	\$282.0	\$406
2024	\$6,863	51	\$349	\$273	\$424	51	\$347.6	\$271.6	\$406
2025	\$7,000	51	\$358	\$263	\$424	51	\$356.0	\$261.6	\$406
2026	\$7,140	51	\$366	\$253	\$424	51	\$364.7	\$251.9	\$406
2027	\$7,283	52	\$375	\$244	\$424	51	\$373.6	\$242.6	\$406
2028	\$7,428	52	\$384	\$235	\$424	52	\$382.7	\$233.7	\$406
2029	\$7,577	52	\$394	\$226	\$424	52	\$392.0	\$225.1	\$406
2030	\$7,728	52	\$403	\$218	\$424	52	\$401.6	\$216.8	\$406
2031	\$7,883	52	\$413	\$210	\$424	52	\$411.3	\$208.8	\$406
2032	\$8,041	53	\$423	\$202	\$424	52	\$421.4	\$201.1	\$406
2033	\$8,201	53	\$433	\$194	\$424	53	\$431.6	\$193.6	\$406
2034	\$8,365	53	\$444	\$187	\$424	53	\$442.1	\$186.5	\$406
2035	\$8,533	53	\$455	\$180	\$424	53	\$452.9	\$179.6	\$406
2036	\$8,703	54	\$466	\$174	\$424	53	\$464.0	\$173.0	\$406
2037	\$8,878	54	\$477	\$167	\$424	54	\$475.3	\$166.6	\$406
2038	\$9,055	54	\$489	\$161	\$424	54	\$486.8	\$160.5	\$406
2039	\$9,236	54	\$501	\$155	\$424	54	\$498.7	\$154.5	\$406
2040	\$9,421	54	\$513	\$149	\$424	54	\$510.8	\$148.8	\$406
2041	\$9,609	55	\$526	\$144	\$424	54	\$523.3	\$143.3	\$406
2042	\$9,802	55	\$538	\$139	\$424	55	\$536.0	\$138.1	\$406
2043	\$9,998	55	\$551	\$134	\$424	55	\$549.1	\$133.0	\$406
2044	\$10,197	55	\$565	\$129	\$424	55	\$562.5	\$128.1	\$406
2039	\$10,401					55	\$576.2	\$123.3	
				\$5,235				\$5,021	

Continued - Table 15. Economic value of avoided distribution capacity cost. EXAMPLE

Prices		PV Production	Costs		Discount Factor	Disc. Costs	
Utility \$/kWh	VOS \$/kWh		Utility (\$)	VOS (\$)		Utility (\$)	VOS (\$)
\$0.22223	\$0.2237	1,563	\$347	\$350	1.000	\$347	\$350
\$0.22239	\$0.2237	1,555	\$346	\$348	0.940	\$325	\$327
\$0.22256	\$0.2237	1,547	\$344	\$346	0.884	\$304	\$306
\$0.22272	\$0.2237	1,540	\$343	\$344	0.831	\$285	\$286
\$0.22289	\$0.2237	1,532	\$341	\$343	0.781	\$267	\$268
\$0.22305	\$0.2237	1,524	\$340	\$341	0.735	\$250	\$250
\$0.22322	\$0.2237	1,517	\$339	\$339	0.691	\$234	\$234
\$0.22339	\$0.2237	1,509	\$337	\$338	0.649	\$219	\$219
\$0.22355	\$0.2237	1,502	\$336	\$336	0.611	\$205	\$205
\$0.22372	\$0.2237	1,494	\$334	\$334	0.574	\$192	\$192
\$0.22388	\$0.2237	1,487	\$333	\$333	0.540	\$180	\$179
\$0.22405	\$0.2237	1,479	\$331	\$331	0.508	\$168	\$168
\$0.22422	\$0.2237	1,472	\$330	\$329	0.477	\$157	\$157
\$0.22438	\$0.2237	1,464	\$329	\$328	0.449	\$147	\$147
\$0.22455	\$0.2237	1,457	\$327	\$326	0.422	\$138	\$137
\$0.22472	\$0.2237	1,450	\$326	\$324	0.397	\$129	\$129
\$0.22489	\$0.2237	1,443	\$324	\$323	0.373	\$121	\$120
\$0.22505	\$0.2237	1,435	\$323	\$321	0.351	\$113	\$113
\$0.22522	\$0.2237	1,428	\$322	\$319	0.330	\$106	\$105
\$0.22539	\$0.2237	1,421	\$320	\$318	0.310	\$99	\$98
\$0.22556	\$0.2237	1,414	\$319	\$316	0.291	\$93	\$92
\$0.22572	\$0.2237	1,407	\$318	\$315	0.274	\$87	\$86
\$0.22589	\$0.2237	1,400	\$316	\$313	0.258	\$81	\$81
\$0.22606	\$0.2237	1,393	\$315	\$312	0.242	\$76	\$75
\$0.22623	\$0.2237	1,386	\$314	\$310	0.228	\$71	\$71
					-		
	\$0.2237		Validation: Present Value			\$4,397	\$4,397

Table 17. Economic value of avoided environmental costs

Environmental Discount Rate 5.30%

Year	Env. Cost \$/mmBtu	Solar Weighted Heat Rate mmBtu/MWh	Prices		p.u. PV Production (kWh)	Costs		Discount Factor (risk free)	Disc. Costs	
			Utility \$/kWh	VOS \$/kWh		Utility (\$)	VOS (\$)		Utility (\$)	VOS (\$)
2020	\$3.12	7,742	\$0.024	\$0.0359	1,563	\$38	\$56	1.000	\$38	\$56
2021	\$3.24	7,750	\$0.025	\$0.0359	1,555	\$39	\$56	0.950	\$37	\$53
2022	\$3.37	7,757	\$0.026	\$0.0359	1,547	\$40	\$56	0.902	\$36	\$50
2023	\$3.50	7,765	\$0.027	\$0.0359	1,540	\$42	\$55	0.857	\$36	\$47
2024	\$3.64	7,773	\$0.028	\$0.0359	1,532	\$43	\$55	0.813	\$35	\$45
2025	\$3.78	7,781	\$0.029	\$0.0359	1,524	\$45	\$55	0.773	\$35	\$42
2026	\$3.92	7,789	\$0.031	\$0.0359	1,517	\$46	\$54	0.734	\$34	\$40
2027	\$4.07	7,796	\$0.032	\$0.0359	1,509	\$48	\$54	0.697	\$33	\$38
2028	\$4.23	7,804	\$0.033	\$0.0359	1,502	\$50	\$54	0.662	\$33	\$36
2029	\$4.39	7,812	\$0.034	\$0.0359	1,494	\$51	\$54	0.628	\$32	\$34
2030	\$4.55	7,820	\$0.036	\$0.0359	1,487	\$53	\$53	0.597	\$32	\$32
2031	\$4.74	7,828	\$0.037	\$0.0359	1,479	\$55	\$53	0.567	\$31	\$30
2032	\$4.93	7,835	\$0.039	\$0.0359	1,472	\$57	\$53	0.538	\$31	\$28
2033	\$5.13	7,843	\$0.040	\$0.0359	1,464	\$59	\$53	0.511	\$30	\$27
2034	\$5.34	7,851	\$0.042	\$0.0359	1,457	\$61	\$52	0.485	\$30	\$25
2035	\$5.55	7,859	\$0.044	\$0.0359	1,450	\$63	\$52	0.461	\$29	\$24
2036	\$5.77	7,867	\$0.045	\$0.0359	1,443	\$65	\$52	0.438	\$29	\$23
2037	\$5.99	7,875	\$0.047	\$0.0359	1,435	\$68	\$51	0.416	\$28	\$21
2038	\$6.23	7,883	\$0.049	\$0.0359	1,428	\$70	\$51	0.395	\$28	\$20
2039	\$6.47	7,890	\$0.051	\$0.0359	1,421	\$73	\$51	0.375	\$27	\$19
2040	\$6.72	7,898	\$0.053	\$0.0359	1,414	\$75	\$51	0.356	\$27	\$18
2041	\$6.95	7,906	\$0.055	\$0.0359	1,407	\$77	\$50	0.338	\$26	\$17
2042	\$7.19	7,914	\$0.057	\$0.0359	1,400	\$80	\$50	0.321	\$26	\$16
2043	\$7.44	7,922	\$0.059	\$0.0359	1,393	\$82	\$50	0.305	\$25	\$15
2044	\$7.70	7,930	\$0.061	\$0.0359	1,386	\$85	\$50	0.290	\$25	\$14

Validation: Present Value	\$771	\$771
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Table 18. Calculation of inflation-adjusted VOS

Year	Discount Factor	PV Production	Escallation Factor	VOS Levelized	Disc.	VOS Inflation Adj. (\$/kWh)	Disc
2020	1.000	1563	1.000	\$0.248	\$388	\$0.2027	316.867
2021	0.940	1555	1.022	\$0.248	\$363	\$0.2073	303.040
2022	0.884	1547	1.045	\$0.248	\$340	\$0.2119	289.817
2023	0.831	1540	1.068	\$0.248	\$318	\$0.2166	277.170
2024	0.781	1532	1.092	\$0.248	\$297	\$0.2214	265.075
2025	0.735	1524	1.117	\$0.248	\$278	\$0.2264	253.509
2026	0.691	1517	1.141	\$0.248	\$260	\$0.2314	242.446
2027	0.649	1509	1.167	\$0.248	\$243	\$0.2366	231.867
2028	0.611	1502	1.193	\$0.248	\$228	\$0.2418	221.749
2029	0.574	1494	1.220	\$0.248	\$213	\$0.2472	212.073
2030	0.540	1487	1.247	\$0.248	\$199	\$0.2528	202.819
2031	0.508	1479	1.275	\$0.248	\$186	\$0.2584	193.969
2032	0.477	1472	1.303	\$0.248	\$174	\$0.2642	185.504
2033	0.449	1464	1.332	\$0.248	\$163	\$0.2700	177.410
2034	0.422	1457	1.362	\$0.248	\$153	\$0.2761	169.668
2035	0.397	1450	1.392	\$0.248	\$143	\$0.2822	162.265
2036	0.397	1443	1.423	\$0.248	\$142	\$0.2885	165.054
2037	0.351	1435	1.455	\$0.248	\$125	\$0.2950	148.412
2038	0.330	1428	1.487	\$0.248	\$117	\$0.3015	141.936
2039	0.310	1421	1.521	\$0.248	\$109	\$0.3083	135.743
2040	0.291	1414	1.554	\$0.248	\$102	\$0.3151	129.819
2041	0.274	1407	1.589	\$0.248	\$96	\$0.3222	124.154
2042	0.258	1400	1.625	\$0.248	\$90	\$0.3293	118.737
2043	0.242	1393	1.661	\$0.248	\$84	\$0.3367	113.556
2044	0.228	1386	1.698	\$0.248	\$78	\$0.3442	108.600
					\$4,891		\$4,891