

# Elementary #24 Design/Budget Considerations



June 27, 2017

Catherine Coleman Bell Elementary

Terry Hoyle, Principal-in-Charge  
Michael Elmore, Senior Project Manager  
Engiell Tomaj, Senior Electrical Engineer

# Design Considerations:

- 1** 100% LED lighting
- 2** Wind turbines
- 3** Solar array
- 4** Storm Shelter

# Project Budget:

Original Bond Budget:	\$20,924,000
Current Opinion of Probable Cost	<u>\$22,836,000</u>
Inflation	\$1,912,000

# Design Considerations:

**1** 100% LED lighting

**\$0**

**2** Wind turbines

**3** Solar array

**4** Storm Shelter





# Design Considerations:


- 1 100% LED lighting \$0
- 2 Wind turbines \$25,000
- 3 Solar array
- 4 Storm Shelter



# Design Considerations:

- |   |                    |          |
|---|--------------------|----------|
| 1 | 100% LED lighting  | \$0      |
| 2 | Wind turbines      | \$25,000 |
| 3 | <b>Solar array</b> |          |
| 4 | Storm Shelter      |          |



An architectural rendering of a modern elementary school building. The building is constructed with red brick and grey stone accents. It features large, multi-paned windows and a central entrance. In the foreground, there is a paved area with a low concrete wall. A large, circular orange graphic on the left side of the image contains the text 'Photovoltaics Renewable Energy Denton Elementary School #24'. The scene is set on a bright day with a blue sky and scattered clouds. Several people, including children and adults, are depicted in various activities on the lawn and in the foreground, suggesting a lively school environment. There are also some trees and shrubs planted around the building.

Photovoltaics  
Renewable  
Energy  
Denton  
Elementary  
School #24



# Solar | Photovoltaic | PV Panels





# Solar | Photovoltaic | PV Panels





# Solar | Photovoltaic | PV Panels







heating



lighting



cooling



equipment



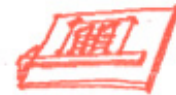
pumps/fans



hot water



GROSS  
BUILDING  
AREA



EUI  
kBTU/SF/YR



renewables



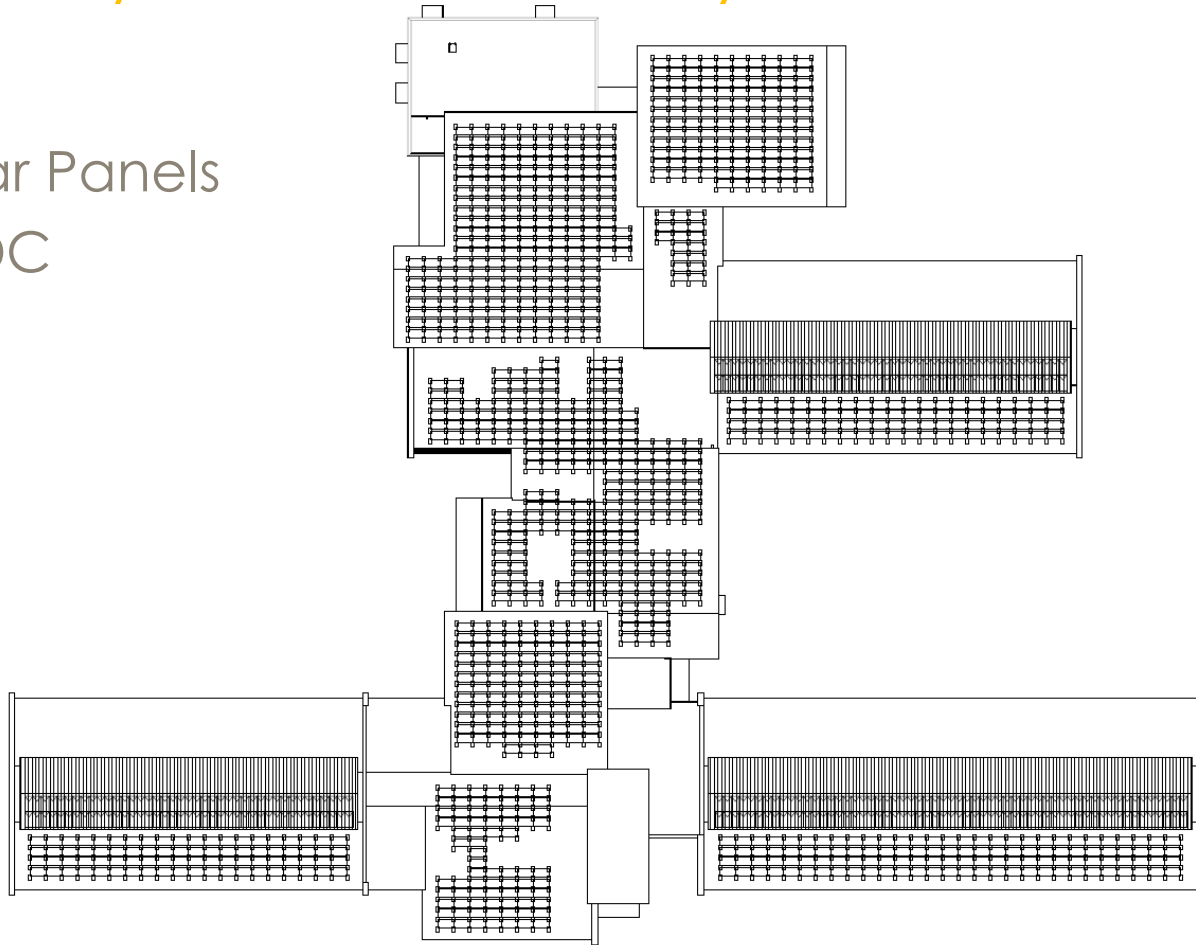
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NET-ZERO  
ENERGY

# TOTAL ENERGY CONSUMPTION OF A BUILDING

# Preliminary Roof Plan PV Layout – DISD ES #24

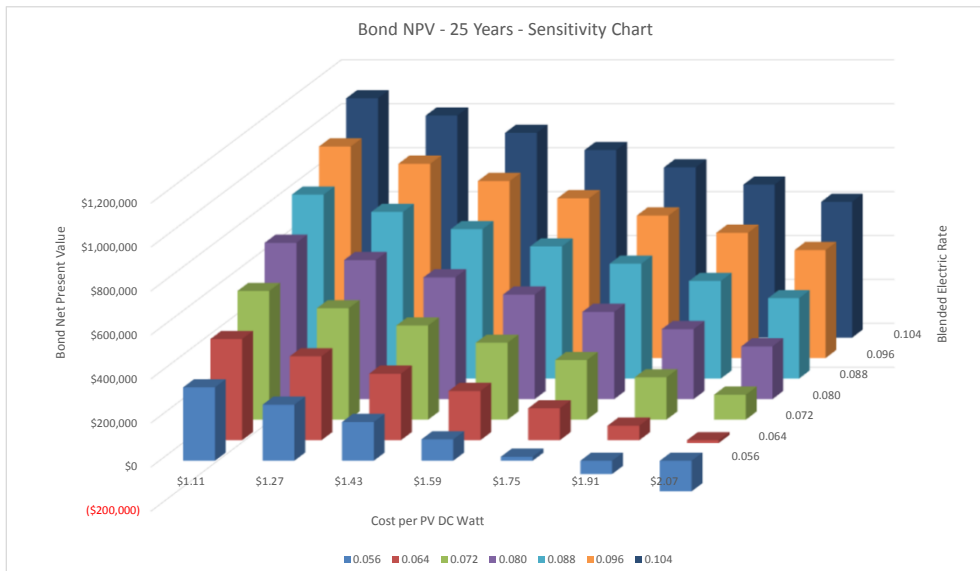
1455 Solar Panels  
494 kW DC



## Economic Analysis - 494 kW Standard Efficiency Solar Photovoltaic System - Zero Net Energy\* Denton ISD - Elementary School #24

System Variables								
KWH Cost	Average Yearly Escalation	Discount (Bond) Rate	Treasury Investment Rate					
\$0.080	2.00%	2.79%	2.12%					
System Size kW DC	Cost (\$/W DC)	System Cost	Utility Incentive	Utility Incentive, % of System Cost	Total Bond Investment			
494	\$1.67	\$826,174	\$0	0%	\$826,174			
Estimated Cash Flow Analysis								
Year #	Year	Grid kWh Rate with Escalation	Annual KWH Produced	Annual Energy Savings	Cumulative Savings	Bond Present Value of Annual Energy Savings	Bond Investment vs. Savings (Simple Payback View)	Bond NPV (Discounted Payback View)
1	2017	\$0.082	716,687	\$58,482	\$58,482	\$56,894	(\$767,692)	(\$769,280)
2	2018	\$0.083	714,895	\$59,502	\$117,984	\$56,316	(\$708,190)	(\$712,964)
3	2019	\$0.085	713,108	\$60,540	\$178,524	\$55,743	(\$647,650)	(\$657,220)
4	2020	\$0.087	711,325	\$61,597	\$240,121	\$55,177	(\$586,053)	(\$602,044)
<b>5</b>	<b>2021</b>	<b>\$0.088</b>	<b>709,547</b>	<b>\$62,672</b>	<b>\$302,793</b>	<b>\$54,616</b>	<b>(\$523,381)</b>	<b>(\$547,428)</b>
6	2022	\$0.090	707,773	\$63,765	\$366,558	\$54,060	(\$459,616)	(\$493,368)
7	2023	\$0.092	706,004	\$64,878	\$431,436	\$53,511	(\$394,737)	(\$439,857)
8	2024	\$0.094	704,239	\$66,010	\$497,447	\$52,967	(\$328,727)	(\$386,890)
9	2025	\$0.096	702,478	\$67,162	\$564,609	\$52,428	(\$261,565)	(\$334,461)
<b>10</b>	<b>2026</b>	<b>\$0.098</b>	<b>700,722</b>	<b>\$68,334</b>	<b>\$632,943</b>	<b>\$51,895</b>	<b>(\$193,231)</b>	<b>(\$282,566)</b>
11	2027	\$0.099	698,970	\$69,527	\$702,469	\$51,368	(\$123,705)	(\$231,198)
12	2028	\$0.101	697,223	\$70,740	\$773,209	\$50,846	(\$52,965)	(\$180,353)
13	2029	\$0.103	695,480	\$71,974	\$845,183	\$50,329	\$19,009	(\$130,024)
14	2030	\$0.106	693,741	\$73,230	\$918,413	\$49,817	\$92,239	(\$80,207)
<b>15</b>	<b>2031</b>	<b>\$0.108</b>	<b>692,007</b>	<b>\$74,508</b>	<b>\$992,921</b>	<b>\$49,311</b>	<b>\$166,747</b>	<b>(\$30,896)</b>
16	2032	\$0.110	690,276	\$75,808	\$1,068,730	\$48,809	\$242,556	\$17,913
17	2033	\$0.112	688,551	\$77,131	\$1,145,861	\$48,313	\$319,687	\$66,226
18	2034	\$0.114	686,829	\$78,477	\$1,224,337	\$47,822	\$398,163	\$114,048
19	2035	\$0.117	685,112	\$79,846	\$1,304,184	\$47,336	\$478,010	\$161,383
<b>20</b>	<b>2036</b>	<b>\$0.119</b>	<b>683,400</b>	<b>\$81,240</b>	<b>\$1,385,423</b>	<b>\$46,854</b>	<b>\$559,249</b>	<b>\$208,238</b>
21	2037	\$0.121	681,691	\$82,657	\$1,468,081	\$46,378	\$641,907	\$254,616
22	2038	\$0.124	679,987	\$84,100	\$1,552,180	\$45,907	\$726,006	\$300,522
23	2039	\$0.126	678,287	\$85,567	\$1,637,748	\$45,440	\$811,574	\$345,962
24	2040	\$0.129	676,591	\$87,060	\$1,724,808	\$44,978	\$898,634	\$390,940
<b>25</b>	<b>2041</b>	<b>\$0.131</b>	<b>674,900</b>	<b>\$88,580</b>	<b>\$1,813,388</b>	<b>\$44,521</b>	<b>\$987,214</b>	<b>\$435,461</b>
26	2042	\$0.134	673,212	\$90,125	\$1,903,513	\$44,068	\$1,077,339	\$479,529
27	2043	\$0.137	671,529	\$91,698	\$1,995,211	\$43,620	\$1,169,037	\$523,149
28	2044	\$0.139	669,851	\$93,298	\$2,088,509	\$43,177	\$1,262,335	\$566,326
29	2045	\$0.142	668,176	\$94,926	\$2,183,435	\$42,738	\$1,357,261	\$609,063
<b>30</b>	<b>2046</b>	<b>\$0.145</b>	<b>666,506</b>	<b>\$96,583</b>	<b>\$2,280,018</b>	<b>\$42,303</b>	<b>\$1,453,844</b>	<b>\$651,367</b>
<b>Payback Period</b>						<b>12.74</b>	<b>15.63</b>	
Assumptions / Clarifications								
1. Assumes a electric utility incentive of (per kW DC)			\$0.00					
2. Assumes a blended utility rate of*			\$0.08					
3. Assumes a nominal discount rate of <sup>2</sup>			2.79%					
4. Assumes a nominal investment rate of <sup>3</sup>			2.12%					
5. Assumes a nominal utility cost escalation rate of			2.00%					
6. Estimated Texas State Recapture rate			0.00% Give Back to the State					
7. Estimated annual kWh production			716,687					
8. Pricing is based on the following system type			Roof Ballasted					
9. Assumes Net Salvage Value			\$0.00					
					<b>IRR - Investment Life - 25 Years</b>	<b>6.63%</b>		
					<b>IRR - 15 years</b>	<b>2.29%</b>		
					<b>Bond NPV - 25 Years</b>	<b>\$435,461</b>		

### Sensitivity Analysis



#### Parameter Variation, Cost Factor, %

	70%	80%	90%	100%	110%	120%	130%
<b>Blended Rate</b>	\$0.056	\$0.064	\$0.072	\$0.080	\$0.088	\$0.096	\$0.104
<b>Bond Simple Payback</b>	17.44	15.52	13.99	12.74	11.69	10.80	10.04
<b>Bond Discounted Payback</b>	23.18	19.96	17.53	15.63	14.10	12.85	11.80
<b>Bond NPV - 25 Years</b>	\$56,971	\$183,134	\$309,298	\$435,461	\$561,625	\$687,788	\$813,952

#### Bond NPV - 25 Years

Blended Rate	Cost/DC Watt						
	\$1.11	\$1.27	\$1.43	\$1.59	\$1.75	\$1.91	\$2.07
0.056	\$332,819	\$254,201	\$175,583	\$96,965	\$18,347	(\$40,271)	(\$138,889)
0.064	\$458,982	\$380,364	\$301,746	\$223,128	\$144,510	\$65,892	(\$12,726)
0.072	\$585,146	\$506,528	\$427,910	\$349,292	\$270,674	\$192,056	\$113,438
0.080	\$711,309	\$632,691	\$554,073	\$475,455	\$396,837	\$318,219	\$239,601
0.088	\$837,473	\$758,855	\$680,237	\$601,619	\$523,001	\$444,383	\$365,765
0.096	\$963,636	\$885,018	\$806,400	\$727,782	\$649,164	\$570,546	\$491,928
0.104	\$1,089,800	\$1,011,182	\$932,564	\$853,946	\$775,328	\$696,710	\$618,092

	Worst Case	Base Case	Best Case
<b>Cost/ DC Watt</b>	\$2.07	\$1.59	\$1.11
<b>Blended Rate</b>	\$0.056	\$0.080	\$0.104
<b>Bond NPV - 25 Years</b>	(\$138,889)	\$475,455	\$1,089,800

**Notes:**

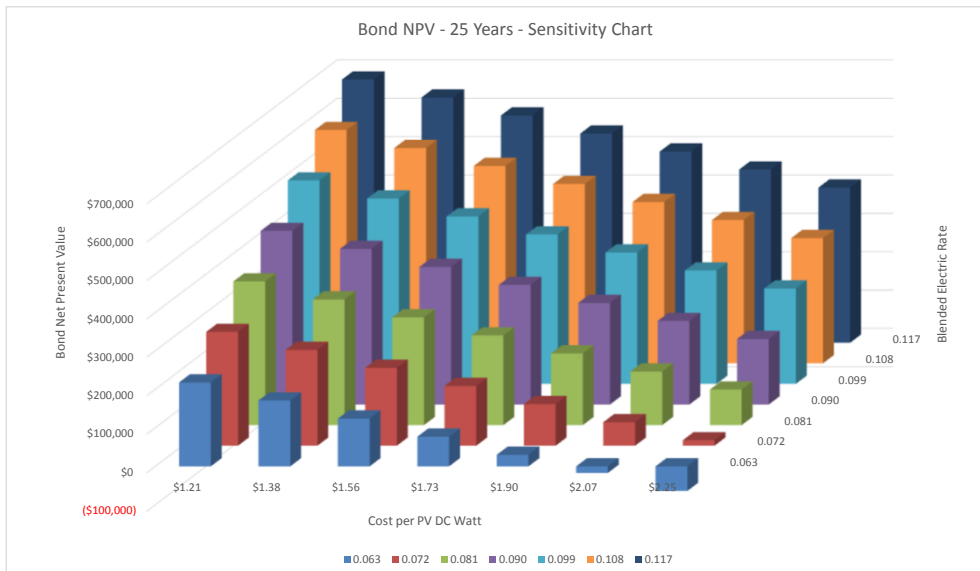
- NPV = (PV of future cash flows) - (Initial Outlay)
- Discount Rate = Cost of Capital = Bond Rate
- The Treasury Bill (T-Bill) Rate at which funds are invested.

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## Economic Analysis - 272 kW Standard Efficiency Solar Photovoltaic System - 50% Energy Offset\* Denton ISD - Elementary School #24

System Variables									
KWH Cost		Average Yearly Escalation	Discount (Bond) Rate	Treasury Investment Rate					
\$0.090		2.00%	2.79%	2.12%					
System Size kW DC	Cost (\$/W DC)	System Cost	Utility Incentive	Utility Incentive, % of System Cost	Total Bond Investment				
272	\$1.80	\$489,492	\$0	0%	\$489,492				
Estimated Cash Flow Analysis									
Year #	Year	Grid kWh Rate with Escalation	Annual KWH Produced	Annual Energy Savings	Cumulative Savings	Bond Present Value of Annual Energy Savings	Bond Investment vs. Savings (Simple Payback View)	Bond NPV (Discounted Payback View)	
1	2017	\$0.092	394,178	\$36,186	\$36,186	\$35,203	(\$453,306)	(\$454,288)	
2	2018	\$0.094	393,192	\$36,817	\$73,002	\$34,845	(\$416,489)	(\$419,443)	
3	2019	\$0.096	392,209	\$37,459	\$110,462	\$34,491	(\$379,030)	(\$384,952)	
4	2020	\$0.097	391,229	\$38,113	\$148,575	\$34,141	(\$340,917)	(\$350,811)	
<b>5</b>	<b>2021</b>	<b>\$0.099</b>	<b>390,251</b>	<b>\$38,778</b>	<b>\$187,353</b>	<b>\$33,793</b>	<b>(\$302,138)</b>	<b>(\$317,017)</b>	
6	2022	\$0.101	389,275	\$39,455	\$226,808	\$33,450	(\$262,684)	(\$283,568)	
7	2023	\$0.103	388,302	\$40,143	\$266,951	\$33,110	(\$222,540)	(\$250,458)	
8	2024	\$0.105	387,331	\$40,844	\$307,795	\$32,773	(\$181,696)	(\$217,684)	
9	2025	\$0.108	386,363	\$41,557	\$349,352	\$32,440	(\$140,140)	(\$185,244)	
<b>10</b>	<b>2026</b>	<b>\$0.110</b>	<b>385,397</b>	<b>\$42,282</b>	<b>\$391,633</b>	<b>\$32,110</b>	<b>(\$97,858)</b>	<b>(\$153,134)</b>	
11	2027	\$0.112	384,434	\$43,020	\$434,653	\$31,784	(\$54,839)	(\$121,350)	
12	2028	\$0.114	383,472	\$43,770	\$478,423	\$31,461	(\$11,068)	(\$89,890)	
13	2029	\$0.116	382,514	\$44,534	\$522,957	\$31,141	\$33,466	(\$58,749)	
14	2030	\$0.119	381,557	\$45,311	\$568,268	\$30,824	\$78,777	(\$27,924)	
<b>15</b>	<b>2031</b>	<b>\$0.121</b>	<b>380,604</b>	<b>\$46,102</b>	<b>\$614,370</b>	<b>\$30,511</b>	<b>\$124,879</b>	<b>\$2,586</b>	
16	2032	\$0.124	379,652	\$46,906	\$661,276	\$30,201	\$171,785	\$32,787	
17	2033	\$0.126	378,703	\$47,725	\$709,001	\$29,894	\$219,510	\$62,681	
18	2034	\$0.129	377,756	\$48,558	\$757,559	\$29,590	\$268,067	\$92,271	
19	2035	\$0.131	376,812	\$49,405	\$806,964	\$29,289	\$317,472	\$121,560	
<b>20</b>	<b>2036</b>	<b>\$0.134</b>	<b>375,870</b>	<b>\$50,267</b>	<b>\$857,231</b>	<b>\$28,991</b>	<b>\$367,739</b>	<b>\$150,551</b>	
21	2037	\$0.136	374,930	\$51,144	\$908,375	\$28,696	\$418,883	\$179,247	
22	2038	\$0.139	373,993	\$52,037	\$960,412	\$28,405	\$470,920	\$207,652	
23	2039	\$0.142	373,058	\$52,945	\$1,013,356	\$28,116	\$523,865	\$235,768	
24	2040	\$0.145	372,125	\$53,869	\$1,067,225	\$27,830	\$577,733	\$263,598	
<b>25</b>	<b>2041</b>	<b>\$0.148</b>	<b>371,195</b>	<b>\$54,809</b>	<b>\$1,122,034</b>	<b>\$27,547</b>	<b>\$632,542</b>	<b>\$291,145</b>	
26	2042	\$0.151	370,267	\$55,765	\$1,177,799	\$27,267	\$688,307	\$318,412	
27	2043	\$0.154	369,341	\$56,738	\$1,234,537	\$26,990	\$745,045	\$345,402	
28	2044	\$0.157	368,418	\$57,728	\$1,292,265	\$26,716	\$802,773	\$372,118	
29	2045	\$0.160	367,497	\$58,736	\$1,351,000	\$26,444	\$861,509	\$398,562	
<b>30</b>	<b>2046</b>	<b>\$0.163</b>	<b>366,578</b>	<b>\$59,760</b>	<b>\$1,410,761</b>	<b>\$26,175</b>	<b>\$921,269</b>	<b>\$424,737</b>	
<b>Payback Period</b>						<b>12.25</b>	<b>14.92</b>		
Assumptions / Clarifications						<b>IRR - Investment Life - 25 Years</b>	<b>7.07%</b>		
1. Assumes a electric utility incentive of (per kW DC)			\$0.00			<b>IRR - 15 years</b>	<b>2.86%</b>		
2. Assumes a blended utility rate of*			\$0.09			<b>Bond NPV - 25 Years</b>	<b>\$291,145</b>		
3. Assumes a nominal discount rate of <sup>2</sup>			2.79%						
4. Assumes a nominal investment rate of <sup>3</sup>			2.12%						
5. Assumes a nominal utility cost escalation rate of			2.00%						
6. Estimated Texas State Recapture rate			0.00% Give Back to the State						
7. Estimated annual kWh production			394,178						
8. Pricing is based on the following system type			Roof Ballasted						
9. Assumes Net Salvage Value			\$0.00						

### Sensitivity Analysis



	70%	80%	90%	100%	110%	120%	130%
<b>Blended Rate</b>	\$0.063	\$0.072	\$0.081	\$0.090	\$0.099	\$0.108	\$0.117
<b>Bond Simple Payback</b>	16.80	14.95	13.46	12.25	11.24	10.38	9.64
<b>Bond Discounted Payback</b>	22.08	19.03	16.72	14.92	13.46	12.27	11.27
<b>Bond NPV - 25 Years</b>	\$56,954	\$135,018	\$213,081	\$291,145	\$369,209	\$447,272	\$525,336

Blended Rate	Cost/DC Watt						
	\$1.21	\$1.38	\$1.56	\$1.73	\$1.90	\$2.07	\$2.25
0.063	\$217,784	\$170,832	\$123,881	\$76,929	\$29,977	(\$16,974)	(\$63,926)
0.072	\$295,848	\$248,896	\$201,944	\$154,993	\$108,041	\$61,089	\$14,138
0.081	\$373,911	\$326,960	\$280,008	\$233,056	\$186,105	\$139,153	\$92,201
0.090	\$451,975	\$405,023	\$358,072	\$311,120	\$264,168	\$217,217	\$170,265
0.099	\$530,039	\$483,087	\$436,135	\$389,184	\$342,232	\$295,280	\$248,329
0.108	\$608,102	\$561,151	\$514,199	\$467,247	\$420,296	\$373,344	\$326,392
0.117	\$686,166	\$639,214	\$592,263	\$545,311	\$498,359	\$451,408	\$404,456

	Worst Case	Base Case	Best Case
<b>Cost/ DC Watt</b>	\$2.25	\$1.73	\$1.21
<b>Blended Rate</b>	\$0.063	\$0.090	\$0.117
<b>Bond NPV - 25 Years</b>	(\$63,926)	\$311,120	\$686,166

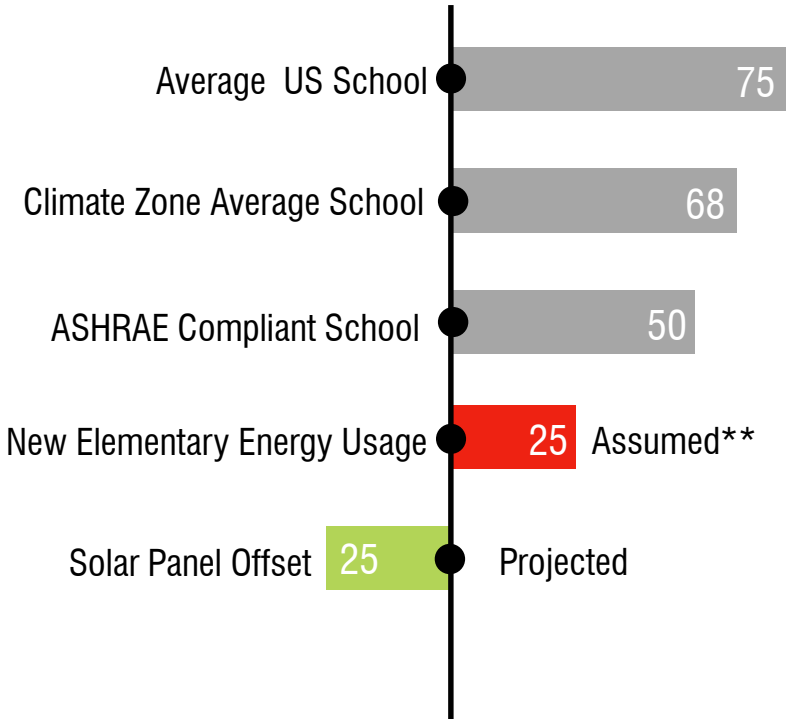
**Notes:**

- NPV = (PV of future cash flows) - (Initial Outlay)
- Discount Rate = Cost of Capital = Bond Rate
- The Treasury Bill (T-Bill) Rate at which funds are invested.

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# The design drives down the building's energy usage and ~100% is offset with solar energy, creating real value for the School District

## Energy Usage (KBTU / SF / Year)



Solar panels, building automation, and LED fixtures contribute to decreased energy usage

Renewable energy generation provides an annual savings of **\$58,482 to the taxpayer\***

This enables reallocation of financial resources **back into the classroom**

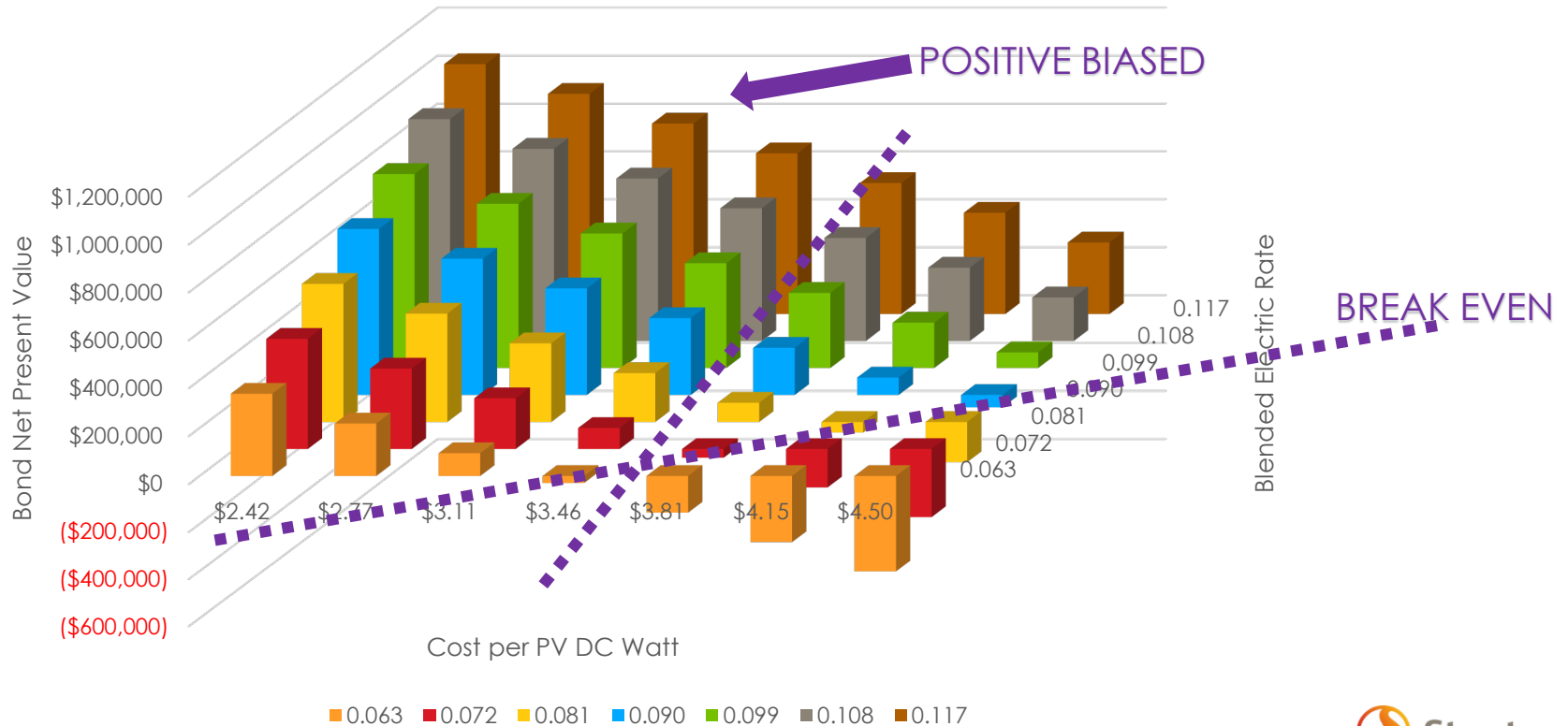
\*Assuming \$0.08 / kWh.

\*\* Based on trends with new projects. Net Zero Projects with Geothermal HVAC Systems can range 17-25 KBTU / SF / Year. Actual energy usage can depend on multiple uncontrollable factors, including occupant behavior, planned vs. actual building usage, etc.



# 25 Year Sensitivity Analysis – Coppell ISD – 23.5% Recapture

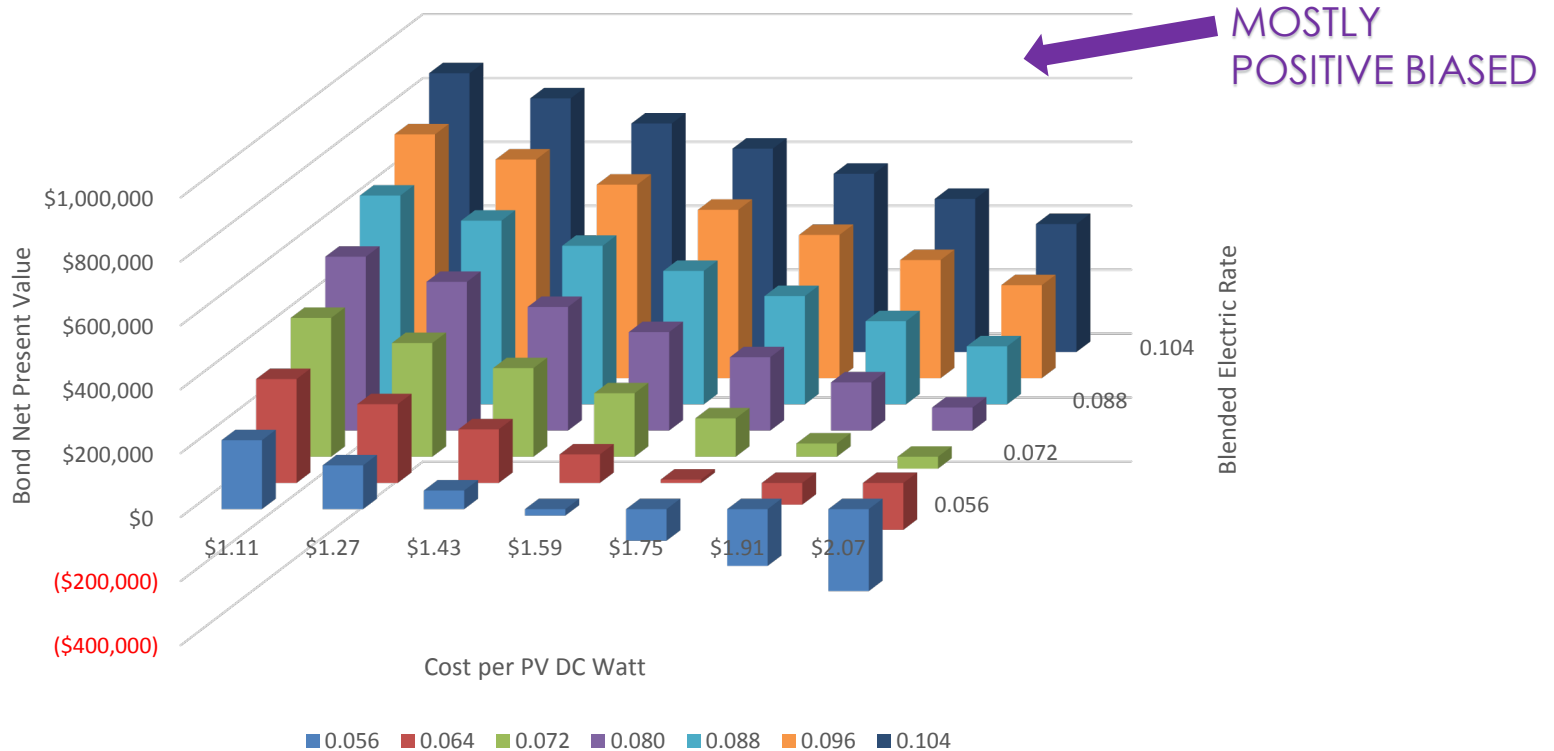
Bond NPV - 25 Years - Sensitivity Chart





# 25 Year Sensitivity Analysis – DISD ES #24

Bond NPV - 25 Years - Sensitivity Chart



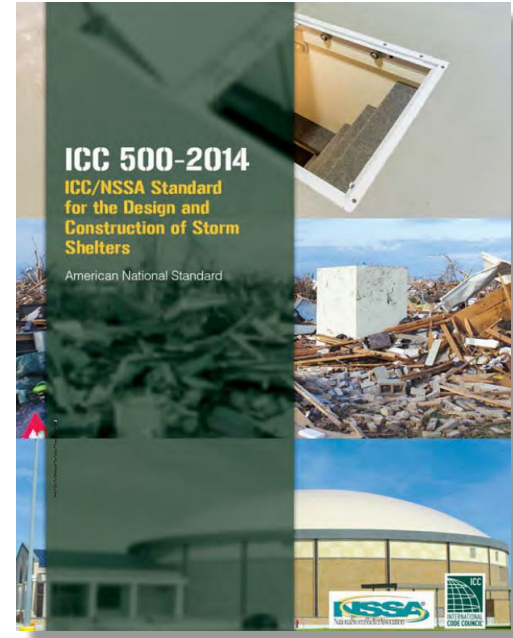
# Design Considerations:

- |   |                    |                  |
|---|--------------------|------------------|
| 1 | 100% LED lighting  | \$0              |
| 2 | Wind turbines      | \$25,000         |
| 3 | <b>Solar array</b> | <b>\$830,000</b> |
| 4 | Storm Shelter      |                  |



# Design Considerations:

<b>1</b>	100% LED lighting	\$0
<b>2</b>	Wind turbines	\$25,000
<b>3</b>	Solar array	\$830,000
<b>4</b>	Storm Shelter	<b>\$930,000</b>



# Design Considerations:

<b>1</b>	100% LED lighting	\$0
<b>2</b>	Wind turbines	\$25,000
<b>3</b>	Solar array	\$830,000
<b>4</b>	Storm Shelter	<u>\$930,000</u>
	<b>Total:</b>	<b>\$1,785,000</b>
	<b>Inflation:</b>	<b><u>\$1,912,000</u></b>
	<b>Total Added Cost:</b>	<b>\$3,697,000</b>

