

CVLE 4660 – Sustainable Building Design

LED Retrofit Programs – Group 3



College of Engineering
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INTRODUCTION

There are many reasons why a building owner, city or even University would want to take the necessary steps to make the buildings more energy efficient using LED lights. However, two of the most prominent reasons include the reduction of carbon footprint, as well as the economic advantage behind LED retrofits. These two reasons alone go hand in hand; if you can cut the energy use of a building you will in return cut the amount spent on electricity. With The University of Georgia having 465 buildings spanning across 762 acres with countless miles of sidewalks and roads on its main campus in Athens, it is abundantly clear why campus officials would want a LED retrofit program up and running as soon as possible.

During the evaluation of other LED retrofit programs we found that the return on investment (ROI) for interior lighting is an average of 3.3 years while exterior lights have a return of 6 years. To maximize the returns our group focused on three buildings that were chosen based on UGA's office of sustainability priority lists. The three buildings include Miller Plant Science, Davison Life Sciences, and Conner Hall. Take-offs of lighting fixtures were done on each building showing total fixtures in Miller life science to be 2274, 1093 for Conner Hall and 2930 for Davison Life Sciences. With Conner hall having the least amount of fixtures it is recommended to start the retrofit there over the summer while there will be less students. The estimated time for completion is about 273 hours or about 7 weeks at 40 hour work weeks for one installer. It is recommended to have 4 man crews to reduce this to about two weeks. Miller life sciences is recommended to start next with an estimated completion time of 570 total man hours. Finally, Davison Life Sciences is estimated to take a total of 730 man hours.

The cost analysis for each building was found by including the price per unit and labor time to install each fixture along with taxes. An initial investment for Conner Hall, Miller, and Davison are \$116326, \$243237, and \$313010 respectively. The return on investment was calculated using a net present value and came out to a total \$656,351 for all buildings in five years. This investment will start turning a profit after and will be at \$2,083,166 in ten years; \$3,638,565 in fifteen years; and \$4,721,109 in twenty years.

ANALYSIS

It is our recommendation that when the retrofit is being completed that some of the unnecessary lights fixtures stacked close to each other be taken out all together. It is our belief that the FMD can cut out around 25-30% of the total light fixtures in each building. In our analysis of the three buildings we did not take into consideration eliminating any lights as during our walk thought of each building we could not determine a concise way to decide if a fixture should be eliminated. We also recommend that the FMD switch out all Type B fixtures in Davison Life Science Building to 2x2 or 2x4 fixtures. This also will cut down on the different types of fixtures needed as well as bulbs due to the fact that Type B fixtures range from two feet as six feet in size. In our data analytics we have replaced the Type B fixtures with a 2x2 fixture as we feel a 2x2 fixture will provide plenty of light in these areas. The cost analysis for each building was found by including the price per unit and labor time to install each fixture along with taxes and is broken down by each building as well as each fixture in that building.

Conner Hall		
Floor No. 1		
No. of Fixtures	Type	Model
195	A	2x4
51	B	2x2
73	H	
3	J	
2	K	
6	Exit Sign	
Total No Fixtures	330	
Floor No. 2		
No. of Fixtures	Type	Model
256	A	2x4
88	B	2x2
3	K	
3	M	
10	H	
4	Exit Sign	
Total No Fixtures	364	
Floor No. 3		
No. of Fixtures	Type	Model
323	A	2X4
72	B	2X2
4	Exit Sign	
Total No of Fixtures	399	
Total No. Fixtures In the Building		1093

Table 1 - Breakdown of all fixtures by type and by floor for Conner Hall

Fixture	No. of Fixtures
2x4	774
2x2	211
Recessed	94
Exit	14

Table 2 - Breakdown of the Number of fixtures by type of Conner Hall

Miller Plant Science		
Floor No. 1		
No. of Fixtures	Type	Model
404	NA	2x4
128	NA	1x4
13	J	
8	L	
2	F	
13	H	
20	Exit	
Total No. of Fixtures	588	
Floor No. 2		
No. of Fixtures	Type	Model
432	NA	2X4
85	NA	1X4
18	NA	_x9
12	J	
4	L	
20	Exit	
Total No. of Fixtures	571	
Floor No. 3		
No. of Fixtures	Type	Model
420	NA	2X4
114	NA	1X4
8	J	
5	L	
20	Exit	
Total No. of Fixtures	567	
Floor No. 4		
No. of Fixtures	Type	Model
414	NA	2X4
93	NA	1X4
23	J	
12	I	
4	L	
20	Exit	
Total No. of Fixtures	566	
Total No. Fixtures	2274	

Table 3 - Breakdown of all fixtures by type and by floor for Miller Plant Science Building

Fixtures	Total No. of Fixtures
2x4	1670
2x2	420
Recessed Lights	104
Exit Sign	80

Table 4 - Breakdown of the Number of fixtures by type of Miller Plant Science Building

Life Science		
Floor No. 0		
No. of Fixtures	Type	Model
138	A	2x4
83	B	
17	D	
17	Exit Sign	
Total No. of Fixtures	255	
Floor No. 1		
390	A	2x4
63	B	
20	D	
24	Exit Sign	
Total No. of Fixtures	497	
Floor No. 2		
625	A	2X4
41	B	
58	D	
28	Exit Sign	
Total No. of Fixtures	752	
Floor No. 3		
592	A	2X4
41	B	
50	D	
29	Exit Sign	
Total No. of Fixtures	712	
Floor No. 4		
603	A	2X4
39	B	
43	D	
29	Exit Sign	
Total No. of Fixtures	714	
Total No. Fixtures In the Building		2930

Table 5 - Breakdown of all fixtures by type and by floor for Davison Life Science Building

Fixture	No. of Fixtures
2x4	2348
Type B	267
Recessed	188
Exit	127

Table 6 - Breakdown of the Number of fixtures by type of Davison Life Science Building

No. of Fixtures	Time for Installation for 1 Unit (min)	Time to Install All Units (min)	Time in Hours	Cost of Labor (hr)	Cost of Installation Labor
774	15	11610	193.5	\$31	\$6,066
211	15	3165	52.75	\$31	\$1,654
94	15	1410	23.5	\$31	\$737
14	15	210	3.5	\$31	\$110

Table 7 - Installation labor costs based on each type of fixture for Conner Hall

Total Investment 2x4	\$87,302.40
Total Investment 2x2	\$21,423.74
Total Investment Recessed	\$6,772
Total Investment Exit Sign	\$829
Total Investment	\$116,326.43

Table 8 - Total investment for the LED retrofit for Conner Hall

Total No. of Fixtures	Time for Installation for 1 Unit (min)	Time to Install All Units (min)	Time in Hours	Cost of Labor (hr)	Cost of Installation Labor
1670	15	25050	417.5	\$31	\$13,089
420	15	6300	105	\$31	\$3,292
104	15	1560	26	\$31	\$815
80	15	1200	20	\$31	\$627

Table 9 - Installation labor costs based on each type of fixture for Miller Plant Science

Total Investment 2x4	\$188,365.65
Total Investment 2x2	\$42,644.02
Total Investment Recessed	\$7,492
Total Investment Exit Sign	\$4,736
Total Investment	\$243,237.36

Table 10 - Total investment for the LED retrofit of Miller Plant Science

No. of Fixtures	Time for Installation for 1 Unit (min)	Time to Install All Units (min)	Time in Hours	Cost of Labor (hr)	Cost of Installation Labor
2348	15	35220	587	\$31	\$18,402
267	15	4005	66.75	\$31	\$2,093
188	15	2820	47	\$31	\$1,473
127	15	1905	31.75	\$31	\$995

Table 11 - Installation labor costs based on each type of fixture for Davison Life Science

Total Investment 2x4	\$264,839.84
Total Investment Type B	\$27,109.34
Total Investment Recessed	\$13,543
Total Investment Exit Sign	\$7,518
Total Investment	\$313,010.32

Table 12 - Total investment for the LED retrofit of Davison Life Science

Using the information provided by Kevin Kirshe in *Figure 1*, the Director of the Office of Sustainability, we are able to compare the cost difference between installing LED lighting to not replacing the lights and maintaining fluorescent lights. Conner Hall was inspected and the number of fixtures were counted. The total number of fixtures consisted of 1,093 fixtures in need of being replaced. Miller Plant Sciences has 2,274 fixtures in need of replacement, and Life Sciences with 2,930. The cost of each fixture is \$105.00. The federal government and local municipalities offer a number of incentives and government rebates for LED lighting. Usage of many energy-efficient LED lighting options qualifies businesses and commercial property owners for these governmental rebates and incentives therefore a rebate of \$20.00 for each one. The average time it takes for the fixture to be replaced is 5 minutes. The labor cost of a technician is \$32/hr, meaning the total cost of labor to replace a fixture comes out to be \$2.67. The average time to dispose of the previous lamps is 10 minutes, with the same hourly rate for the technician, the cost to dispose of the previous fixture is \$5.33 for each one with an additional \$0.60 for fees due to the recycling company. With all these factors accounted for, the total cost of the complete replacement per fixtures, including the disposal of the fluorescent light and installation of LED lights, comes out to be \$93.60

Based on the figures provided by UGA's Office of Sustainability in *Figure 2*, energy is used in Conner Hall for 19 hours per day, amounting towards an energy use of 7000 hours per year, and an energy cost of \$0.045 per hour. Each fluorescent fixture uses 140 watts to provide the required amount of lumination. The total kilowatts-hour per year was calculated to be 980 kWh/yr. This was found by multiplying the energy use and the required wattage of each fluorescent fixture. This figure was multiplied by the energy cost listed totaling an energy cost of \$44.10 per hour for the current fixture. LED lighting, on the other hand, only requires one 40-watt bulb to provide the same required lumination. With LED lighting, the total kilowatts-hour per year reduces to 280 kWh/yr. Lowering this amount also lowers the energy cost to an optimal \$12.60 per hour, providing a 66% savings in operation and maintenance costs. These savings amount towards an annual reduction of \$34,178 per year for Conner Hall, \$70,308 for Miller Science Plants, and \$92,295 for Life Sciences as shown in *Figure 5 and Figure 8*.

With each fixture costing \$93.60 to replace, replacing all 1,085 fixtures in Conner Hall will have a total investment of \$101,556. After making these initial investments, many sources of savings will produce a promising cash flow for the years to come. As stated earlier, the savings solely on energy costs come out to be \$31.50 each year. Along with that, LED lighting has a much longer lifespan. Therefore every other year, \$20.58 is saved due to the lack of need to replace the fluorescent lamp. The ballast is a device which controls the starting voltage and the operating currents of lighting devices. Since LED lighting does not require as much wattage as the fluorescent lamps, the ballast does not have to be replaced as often, leading to saving \$29.73 on year 7 and year 15. A return of investment analysis, shown in *Figure 3*, was performed incorporating all these factors which shows a return of \$819,978 in twenty years for installing LED lighting in Conner Hall alone. An ROI analysis was performed as well, shown in *Figure 6 and Figure 9*, for the other two buildings, Life Sciences and Miller Science Plants. LED retrofit for Miller Science Plants showed an initial investment of \$208,915 and a twenty-year return of \$1,686,812. For Life Sciences, the initial investment came out to be \$274,248 with a twenty-year return of \$2,214,319. In conclusion, LED retrofit for the three building listed will consist of a total investment of \$672,574, but a profit of \$656,351 in five years; \$2,083,166 in ten years; \$3,638,565 in fifteen years; and \$4,721,109 in twenty years.

Georgia Power Rebate Report		Conner Hall		Miller Plant Science		Life Science	
Type	Rebate Amount	Units Applicable	Rebate Total	Units Applicable	Rebate Total	Units Applicable	
LED Screw-in	\$2	0	0	0	0	0	0
LED Decor	\$4	0	0	0	0	0	0
TLEDs	\$3	0	0	0	0	0	0
LED Retrofit Kit	\$25	985	\$24,625	2090	\$52,250	2615	\$65,375
LED Recessed Fixture	\$10	94	\$940	104	\$1,040	188	\$1,880
LED Troffer Fixture	\$25	0	0	0	0	0	\$0
LED Stairwell Fixture	\$20	21	\$420	39	\$780	26	\$520
LED Exit Signs	\$7	14	\$98	80	\$560	127	\$889
Total Rebate Per Building			\$26,083		\$54,630		\$68,664

Table 13 - Georgia Power Rebate Report for each building

The table above shows the amount the University will receive for installing new LED fixtures. There are many other arenas of the rebate that can be explored for different buildings. However according to Georgia Power “The maximum rebate for combination of measures is \$25,000 per building per year. Rebates are capped at 50 percent of the equipment cost.” This rebate just provides another added advantage of completing the LED Retrofit Program as soon as possible.

Conclusion

Three different groups are working on the same LED Retrofit project therefore to coordinate our efforts to ensure the groups do not work on the same buildings, the Office of Sustainability assigned this group to work on Conner Hall, Miller Plant Sciences, and Life Sciences. UGA standard LED fixture specifications consist of 2’x2’ and 2’x4’ fixtures. Prices for the fixtures, labor, and disposal were given, along with the average running time and energy cost per kWh. The LED Retrofit program for these specific buildings overall has a large initial cost of \$672,573, but it is later shown the return of investment for 15-20 years results in millions of dollars in savings. Not only are the operations and maintenance costs drastically reduced, LED lighting also has positive environmental impacts. Most traditional lights contain toxins such as mercury, which can have harmful effects on the environment. LED lights contain no toxins. LED lighting provides better quality luminance, which results in less light bulbs being used and disposed of. Lastly, LED lasts longer which lowers the costs and amount of necessary resources for manufacturing, packaging, transportation, and carbon emissions.

APPENDIX

	Fluorescent Do Nothing	LED Retrofit	Delta
lamps per fixture	3	1	
fixture W	140	40	100
kWh/yr	980	280	700
energy cost/yr	\$ 44.10	\$ 12.60	\$ 31.50
Fixture cost	n/a	\$ 105.00	
Rebate per fixture (subtracted from first cost)	n/a	\$ 20.00	
Rebate adjusted fixture cost	n/a	\$ 85.00	
Fixture replacement labor, minutes/fixture	n/a	5	
Fixture replacement labor cost	n/a	\$ 2.67	
Old fixture disposal cost (labor + lamp fee)	n/a	\$ 5.93	
Rebate adjusted installed cost	n/a	\$ 93.60	
lamp unit cost	\$ 2.75	\$ 20.00	
lamp cost per fixture	\$ 8.25	\$ 20.00	
re-lamp labor, minutes/fixture	12	5	
re-lamp labor cost per fixture	\$ 6.40	\$ 2.67	
lamp disposal fee per fixture	\$ 0.60	\$ 0.04	
lamp disposal labor, minutes/fixture	10	5	
lamp disposal labor cost per fixture	\$ 5.33	\$ 2.67	
total re-lamp cost	\$ 20.58	\$ 25.38	
lamp lifetime, hrs	15,000	125,000	
lamp lifetime, yrs	2.1	17.9	
ballast cost	\$ 18.00	n/a	
ballast replacement labor, minutes	20	n/a	
ballast replacement labor cost	\$ 10.67	n/a	
ballast disposal labor cost	\$ 1.07	n/a	
total ballast replacement cost	\$ 29.73	n/a	
ballast lifetime, hrs	50,000	n/a	
ballast lifetime, yrs	7.1	n/a	

Figure 1 - Given Prices from the UGA Office of Sustainability

Input	
average runtime, hrs/yr	7,000
# fixtures	1,085
energy cost, \$/kWh	\$ 0.045
discount rate	0.00%
Output	
gross total first cost	\$ 123,256
total rebate	\$ 21,700
net total first cost	\$ 101,556
5-year NPV	\$ 113,997
annual energy savings, kWh	759,500
annual energy cost savings	\$ 34,178

Figure 2 - Conner Hall Energy Input vs Energy Output

Year	Per Fixture						Total	
	Energy savings	LED Costs	Fluor Relamp	Fluor Ballast	Cash flow	NPV	Cash Flow	NPV
0	\$ -	\$ 93.60	\$ -	\$ -	\$ (93.60)	\$ (93.60)	\$ (101,556)	\$ (101,556)
1	\$ 31.50	\$ -	\$ -	\$ -	\$ 31.50	\$ (62.10)	\$ 34,178	\$ (67,379)
2	\$ 31.50	\$ -	\$ -	\$ -	\$ 31.50	\$ (30.60)	\$ 34,178	\$ (33,201)
3	\$ 31.50	\$ -	\$ 20.58	\$ -	\$ 52.08	\$ 21.48	\$ 56,510	\$ 23,309
4	\$ 31.50	\$ -	\$ -	\$ -	\$ 31.50	\$ 52.98	\$ 34,178	\$ 57,487
5	\$ 31.50	\$ -	\$ 20.58	\$ -	\$ 52.08	\$ 105.07	\$ 56,510	\$ 113,997
6	\$ 31.50	\$ -	\$ -	\$ -	\$ 31.50	\$ 136.57	\$ 34,178	\$ 148,175
7	\$ 31.50	\$ -	\$ 20.58	\$ -	\$ 52.08	\$ 188.65	\$ 56,510	\$ 204,685
8	\$ 31.50	\$ -	\$ -	\$ 29.73	\$ 61.23	\$ 249.88	\$ 66,438	\$ 271,123
9	\$ 31.50	\$ -	\$ 20.58	\$ -	\$ 52.08	\$ 301.97	\$ 56,510	\$ 327,634
10	\$ 31.50	\$ -	\$ -	\$ -	\$ 31.50	\$ 333.47	\$ 34,178	\$ 361,811
11	\$ 31.50	\$ -	\$ 20.58	\$ -	\$ 52.08	\$ 385.55	\$ 56,510	\$ 418,322
12	\$ 31.50	\$ -	\$ -	\$ -	\$ 31.50	\$ 417.05	\$ 34,178	\$ 452,499
13	\$ 31.50	\$ -	\$ 20.58	\$ -	\$ 52.08	\$ 469.13	\$ 56,510	\$ 509,010
14	\$ 31.50	\$ -	\$ -	\$ -	\$ 31.50	\$ 500.63	\$ 34,178	\$ 543,187
15	\$ 31.50	\$ -	\$ 20.58	\$ 29.73	\$ 81.82	\$ 582.45	\$ 88,771	\$ 631,958
16	\$ 31.50	\$ -	\$ -	\$ -	\$ 31.50	\$ 613.95	\$ 34,178	\$ 666,136
17	\$ 31.50	\$ -	\$ -	\$ -	\$ 31.50	\$ 645.45	\$ 34,178	\$ 700,313
18	\$ 31.50	\$ 25.38	\$ 20.58	\$ -	\$ 26.71	\$ 672.16	\$ 28,977	\$ 729,290
19	\$ 31.50	\$ -	\$ -	\$ -	\$ 31.50	\$ 703.66	\$ 34,178	\$ 763,468
20	\$ 31.50	\$ -	\$ 20.58	\$ -	\$ 52.08	\$ 755.74	\$ 56,510	\$ 819,978

Figure 3- Conner Hall Return of Investment for LED Lighting Replacement

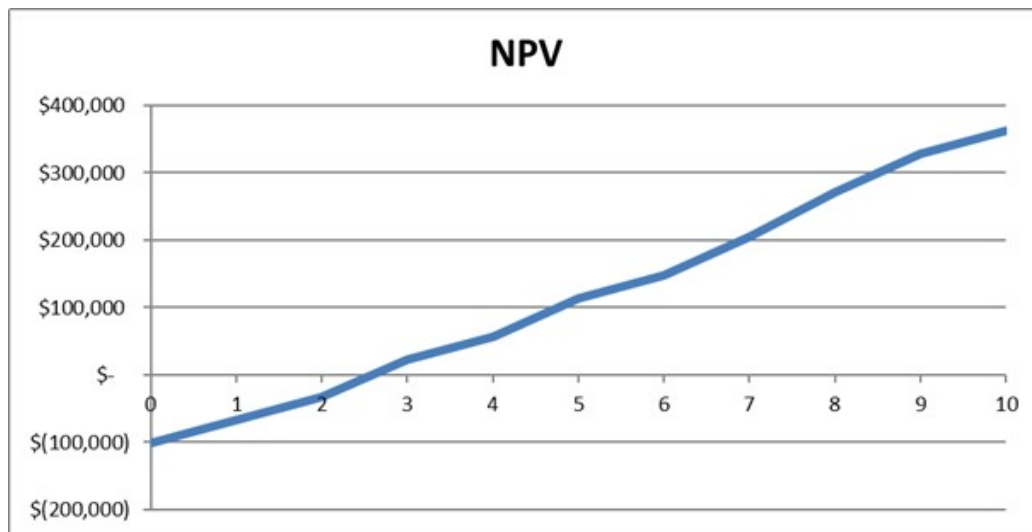


Figure 4 - NPV for Conner Hall

Input	
average runtime, hrs/yr	7,000
# fixtures	2,232
energy cost, \$/kWh	\$ 0.045
discount rate	0.00%
Output	
gross total first cost	\$ 253,555
total rebate	\$ 44,640
net total first cost	\$ 208,915
5-year NPV	\$ 234,509
annual energy savings, kWh	1,562,400
annual energy cost savings	\$ 70,308

Figure 5 - Miller Plant Sciences Energy Input vs Energy Output

Year	Per Fixture						Total	
	Energy savings	LED Costs	Fluor Relamp	Fluor Ballast	Cash flow	NPV	Cash Flow	NPV
0	\$ -	\$ 93.60	\$ -	\$ -	\$ (93.60)	\$ (93.60)	\$ (208,915)	\$ (208,915)
1	\$ 31.50	\$ -	\$ -	\$ -	\$ 31.50	\$ (62.10)	\$ 70,308	\$ (138,607)
2	\$ 31.50	\$ -	\$ -	\$ -	\$ 31.50	\$ (30.60)	\$ 70,308	\$ (68,299)
3	\$ 31.50	\$ -	\$ 20.58	\$ -	\$ 52.08	\$ 21.48	\$ 116,250	\$ 47,951
4	\$ 31.50	\$ -	\$ -	\$ -	\$ 31.50	\$ 52.98	\$ 70,308	\$ 118,259
5	\$ 31.50	\$ -	\$ 20.58	\$ -	\$ 52.08	\$ 105.07	\$ 116,250	\$ 234,509
6	\$ 31.50	\$ -	\$ -	\$ -	\$ 31.50	\$ 136.57	\$ 70,308	\$ 304,817
7	\$ 31.50	\$ -	\$ 20.58	\$ -	\$ 52.08	\$ 188.65	\$ 116,250	\$ 421,067
8	\$ 31.50	\$ -	\$ -	\$ 29.73	\$ 61.23	\$ 249.88	\$ 136,673	\$ 557,740
9	\$ 31.50	\$ -	\$ 20.58	\$ -	\$ 52.08	\$ 301.97	\$ 116,250	\$ 673,990
10	\$ 31.50	\$ -	\$ -	\$ -	\$ 31.50	\$ 333.47	\$ 70,308	\$ 744,298
11	\$ 31.50	\$ -	\$ 20.58	\$ -	\$ 52.08	\$ 385.55	\$ 116,250	\$ 860,548
12	\$ 31.50	\$ -	\$ -	\$ -	\$ 31.50	\$ 417.05	\$ 70,308	\$ 930,856
13	\$ 31.50	\$ -	\$ 20.58	\$ -	\$ 52.08	\$ 469.13	\$ 116,250	\$ 1,047,106
14	\$ 31.50	\$ -	\$ -	\$ -	\$ 31.50	\$ 500.63	\$ 70,308	\$ 1,117,414
15	\$ 31.50	\$ -	\$ 20.58	\$ 29.73	\$ 81.82	\$ 582.45	\$ 182,615	\$ 1,300,028
16	\$ 31.50	\$ -	\$ -	\$ -	\$ 31.50	\$ 613.95	\$ 70,308	\$ 1,370,336
17	\$ 31.50	\$ -	\$ -	\$ -	\$ 31.50	\$ 645.45	\$ 70,308	\$ 1,440,644
18	\$ 31.50	\$ 25.38	\$ 20.58	\$ -	\$ 26.71	\$ 672.16	\$ 59,610	\$ 1,500,254
19	\$ 31.50	\$ -	\$ -	\$ -	\$ 31.50	\$ 703.66	\$ 70,308	\$ 1,570,562
20	\$ 31.50	\$ -	\$ 20.58	\$ -	\$ 52.08	\$ 755.74	\$ 116,250	\$ 1,686,812

Figure 6 - Miller Plant Sciences Return of Investment for LED Lighting Replacement

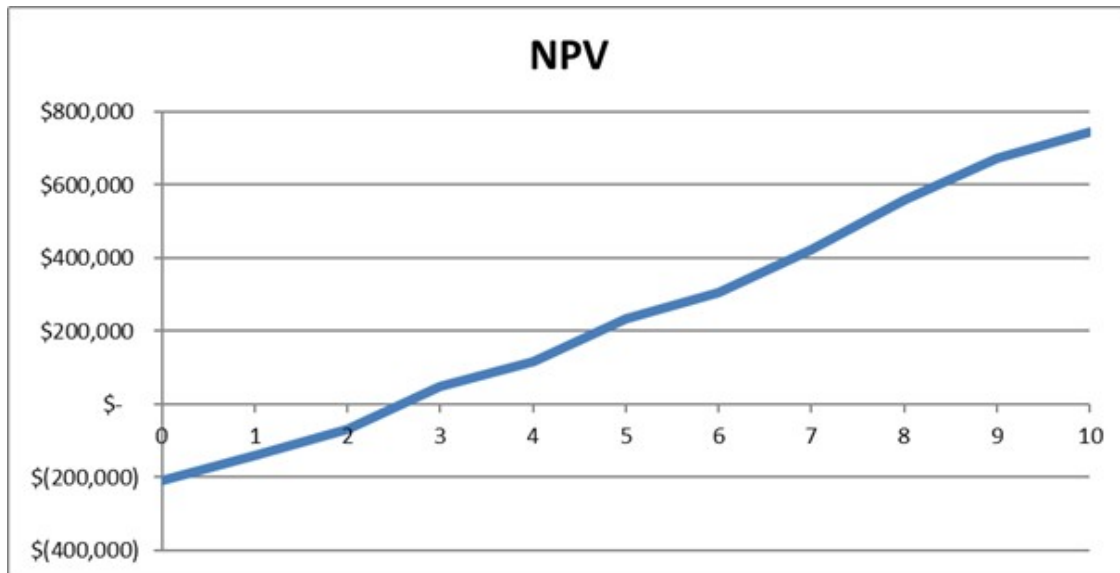


Figure 7 - NPV for Miller Plant Sciences

Input	
average runtime, hrs/yr	7,000
# fixtures	2,930
energy cost, \$/kWh	\$ 0.045
discount rate	0.00%
Output	
gross total first cost	\$ 332,848
total rebate	\$ 58,600
net total first cost	\$ 274,248
5-year NPV	\$ 307,845
annual energy savings, kWh	2,051,000
annual energy cost savings	\$ 92,295

Figure 8 - Life Sciences Energy Input vs Energy Output

Year	Per Fixture						Total	
	Energy savings	LED Costs	Fluor Relamp	Fluor Ballast	Cash flow	NPV	Cash Flow	NPV
0	\$ -	\$ 93.60	\$ -	\$ -	\$ (93.60)	\$ (93.60)	\$ (274,248)	\$ (274,248)
1	\$ 31.50	\$ -	\$ -	\$ -	\$ 31.50	\$ (62.10)	\$ 92,295	\$ (181,953)
2	\$ 31.50	\$ -	\$ -	\$ -	\$ 31.50	\$ (30.60)	\$ 92,295	\$ (89,658)
3	\$ 31.50	\$ -	\$ 20.58	\$ -	\$ 52.08	\$ 21.48	\$ 152,604	\$ 62,946
4	\$ 31.50	\$ -	\$ -	\$ -	\$ 31.50	\$ 52.98	\$ 92,295	\$ 155,241
5	\$ 31.50	\$ -	\$ 20.58	\$ -	\$ 52.08	\$ 105.07	\$ 152,604	\$ 307,845
6	\$ 31.50	\$ -	\$ -	\$ -	\$ 31.50	\$ 136.57	\$ 92,295	\$ 400,140
7	\$ 31.50	\$ -	\$ 20.58	\$ -	\$ 52.08	\$ 188.65	\$ 152,604	\$ 552,745
8	\$ 31.50	\$ -	\$ -	\$ 29.73	\$ 61.23	\$ 249.88	\$ 179,414	\$ 732,158
9	\$ 31.50	\$ -	\$ 20.58	\$ -	\$ 52.08	\$ 301.97	\$ 152,604	\$ 884,762
10	\$ 31.50	\$ -	\$ -	\$ -	\$ 31.50	\$ 333.47	\$ 92,295	\$ 977,057
11	\$ 31.50	\$ -	\$ 20.58	\$ -	\$ 52.08	\$ 385.55	\$ 152,604	\$ 1,129,662
12	\$ 31.50	\$ -	\$ -	\$ -	\$ 31.50	\$ 417.05	\$ 92,295	\$ 1,221,957
13	\$ 31.50	\$ -	\$ 20.58	\$ -	\$ 52.08	\$ 469.13	\$ 152,604	\$ 1,374,561
14	\$ 31.50	\$ -	\$ -	\$ -	\$ 31.50	\$ 500.63	\$ 92,295	\$ 1,466,856
15	\$ 31.50	\$ -	\$ 20.58	\$ 29.73	\$ 81.82	\$ 582.45	\$ 239,723	\$ 1,706,579
16	\$ 31.50	\$ -	\$ -	\$ -	\$ 31.50	\$ 613.95	\$ 92,295	\$ 1,798,874
17	\$ 31.50	\$ -	\$ -	\$ -	\$ 31.50	\$ 645.45	\$ 92,295	\$ 1,891,169
18	\$ 31.50	\$ 25.38	\$ 20.58	\$ -	\$ 26.71	\$ 672.16	\$ 78,252	\$ 1,969,420
19	\$ 31.50	\$ -	\$ -	\$ -	\$ 31.50	\$ 703.66	\$ 92,295	\$ 2,061,715
20	\$ 31.50	\$ -	\$ 20.58	\$ -	\$ 52.08	\$ 755.74	\$ 152,604	\$ 2,214,319

Figure 9 - Life Sciences Return of Investment for LED Lighting Replacement

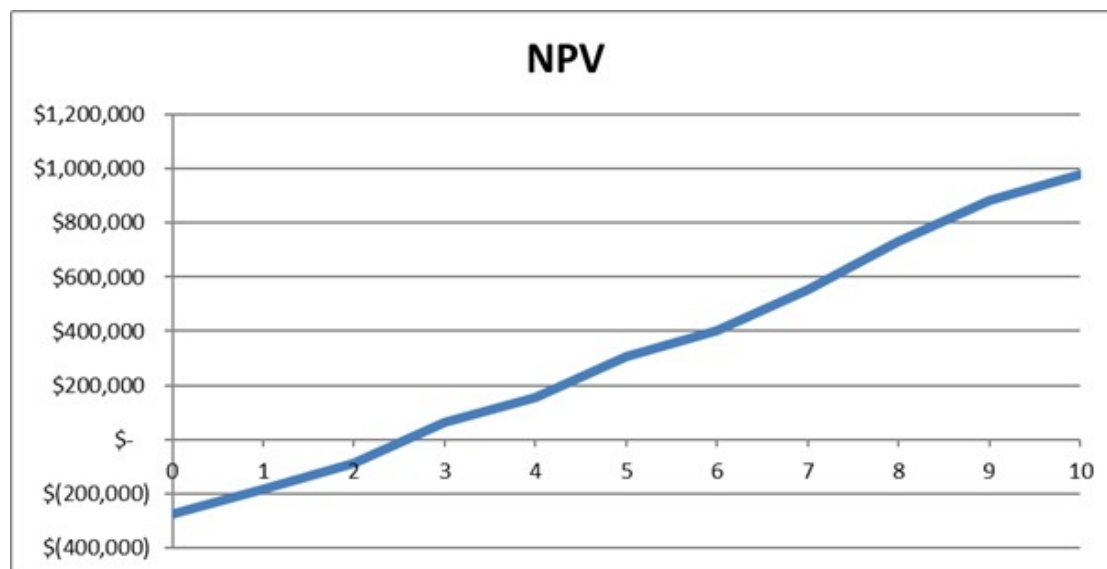


Figure 10 - NPV for Conner Hall