

Lifecycle Summary

Project: 60-17-427 Belmont High School - HVAC
 Prepared By: BALA

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Life Cycle Cost Analysis for HVAC Options

30 year life-cycle cost analysis for three HVAC system options.

Type of Analysis Public Sector Lifecycle Analysis
 Type of Design Alternatives Independent
 Length of Analysis 30 yrs
 Discount Rate 2.25 %

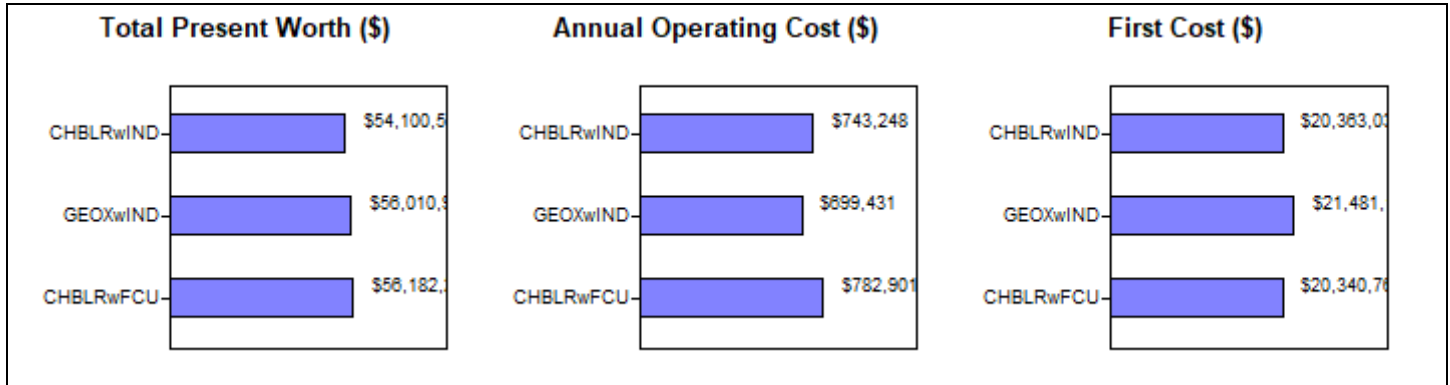


Table 1. Executive Summary

Economic Criteria	Best Design Case for Each Criteria	Value (\$)
Lowest Total Present Worth	Chiller/ Boiler with Induction	\$54,100,534
Lowest Annual Operating Cost	Geo-Exchange with Induction	\$699,431
Lowest First Cost	Chiller/ Boiler with Fan Coil Units	\$20,340,759

Table 2. Design Cases Ranked by Total Present Worth

Design Case Name	Design Case Short Name	Total Present Worth (\$)	Annual Operating Cost (\$/yr)	First Cost (\$)
Chiller/ Boiler with Induction	CHBLRwIND	\$54,100,534	\$743,248	\$20,363,034
Geo-Exchange with Induction	GEOXwIND	\$56,010,898	\$699,431	\$21,481,139
Chiller/ Boiler with Fan Coil Units	CHBLRwFCU	\$56,182,200	\$782,901	\$20,340,759

Design Case Inputs

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Type of Analysis.....Public Sector Lifecycle Analysis
 Length of Analysis.....30 yrs
 Income Taxes Not Considered

General Information :

Design Case Name Geo-Exchange with Induction
 Design Case Short Name ... GEOXwIND
 Description :

Geo-exchange system with central chiller-heaters and induction terminal units.
 \$21,481,139 total system cost.

Investment Costs :

Cost Item	Cost (\$)	Year Incurred	Esc Rate (%/yr)	Salvage Value (\$)	Useful Life (yrs)
Geo-Exchange System Part 1	\$ 9,000,000	0	0.00	\$ 0	30
Geo-Exchange System Part 2	\$ 3,481,139	0	0.00	\$ 0	30
Partial Replacement Cost	\$ 5,000,000	20	3.00	\$ 0	10
Geo-Exchange System Part 3	\$ 9,000,000	0	0.00	\$ 0	30

Loans :

Loan Item	Start Year	Investment In Start Year (\$)	Percent Financed	Term Of Loan (Years)	Interest Rate (%/yr)	Payment Method
Municipal Bond Financing for HVAC	0	\$ 26,481,139	100	30	3.25	Equal Payments
Replacement Cost Financing	20	\$ 26,481,139	100	10	4.50	Equal Payments

Annual Operating Costs :

Cost Item	Cost (\$)	Start Year	Number Of Years	Esc Rate (%/yr)
Annual Energy Cost	\$ 539,431	1	30	3.50
Annual Maintenance Cost	\$ 160,000	1	30	3.00

There are no non-annual operating cost inputs

Design Case Inputs

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Type of Analysis.....Public Sector Lifecycle Analysis
 Length of Analysis.....30 yrs
 Income Taxes Not Considered

General Information :

Design Case Name Chiller/ Boiler with Induction

Design Case Short Name ... CHBLRWIND

Description :

Central chiller with cooling tower, gas-fired hot water boilers and induction terminal units.

\$19,993,034 total system cost.

\$370,000 Additional Costs: cooling tower support and screening plus gas service.

Investment Costs :

Cost Item	Cost (\$)	Year Incurred	Esc Rate (%/yr)	Salvage Value (\$)	Useful Life (yrs)
Chiller Boiler Induction Part 1	\$ 9,370,000	0	0.00	\$ 0	30
Chiller Boiler Induction Part 2	\$ 1,993,034	0	0.00	\$ 0	30
Partial System Replacement Cost	\$ 6,000,000	20	0.00	\$ 0	10
Chiller Boiler Induction Part 3	\$ 9,000,000	0	0.00	\$ 0	30

Loans :

Loan Item	Start Year	Investment In Start Year (\$)	Percent Financed	Term Of Loan (Years)	Interest Rate (%/yr)	Payment Method
Municipal Bond Financing for HVAC	0	\$ 26,363,034	100	30	3.25	Equal Payments
Replacement Cost Financing	20	\$ 26,363,034	100	10	4.50	Equal Payments

Annual Operating Costs :

Cost Item	Cost (\$)	Start Year	Number Of Years	Esc Rate (%/yr)
Annual Energy Costs	\$ 563,248	1	30	3.50
Annual Maintenance Costs	\$ 180,000	1	30	3.00

There are no non-annual operating cost inputs

Design Case Inputs

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Type of Analysis.....Public Sector Lifecycle Analysis
 Length of Analysis.....30 yrs
 Income Taxes Not Considered

General Information :

Design Case Name Chiller/ Boiler with Fan Coil Units
 Design Case Short Name ... CHBLRwFCU
 Description :

Central chiller with cooling tower, gas-fired hot water boilers and fan coil terminal units.
 \$19,970,759 total system cost.
 \$370,000 Additional Costs: cooling tower support and screening plus gas service.

Investment Costs :

Cost Item	Cost (\$)	Year Incurred	Esc Rate (%/yr)	Salvage Value (\$)	Useful Life (yrs)
Chiller Boiler Fan Coil Part 1	\$ 9,370,000	0	0.00	\$ 0	30
Chiller Boiler Fan Coil Part 2	\$ 1,970,759	0	0.00	\$ 0	30
Partial System Replacement Cost	\$ 7,000,000	20	0.00	\$ 0	10
Chiller Boiler Fan Coil Part 3	\$ 9,000,000	0	0.00	\$ 0	30

Loans :

Loan Item	Start Year	Investment In Start Year (\$)	Percent Financed	Term Of Loan (Years)	Interest Rate (%/yr)	Payment Method
Municipal Bond Financing for HVAC	0	\$ 27,340,759	100	30	3.25	Equal Payments
Replacement Cost Financing	20	\$ 27,340,759	100	10	4.50	Equal Payments

Annual Operating Costs :

Cost Item	Cost (\$)	Start Year	Number Of Years	Esc Rate (%/yr)
Annual Energy Costs	\$ 582,901	1	30	3.50
Annual Maintenance Costs	\$ 200,000	1	30	3.00

There are no non-annual operating cost inputs

Cash Flow Details

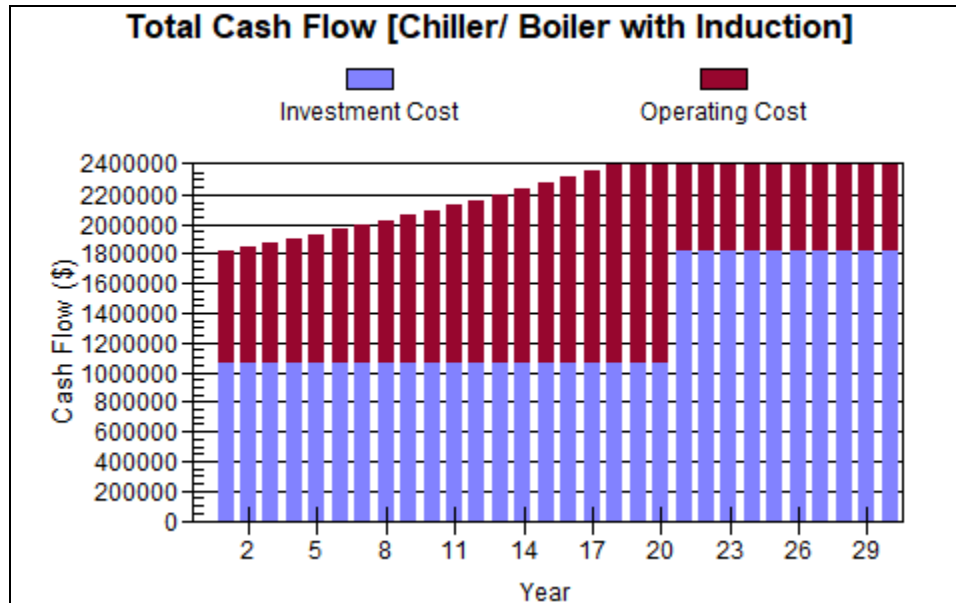
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1A. Component Cash Flows [Chiller/ Boiler with Induction], Actual Value

Year	Date	Cash Investment (\$)	Loan Principal (\$)	Loan Interest (\$)	Total Investment Cost (\$)	Annual Operating Cost (\$)	Non-Annual Operating Cost (\$)	Total Operating Cost (\$)	Total Cash Flow (\$)
0	Initial	0	0	0	0	0	0	0	0
1	1	0	410,961	661,799	1,072,760	768,362	0	768,362	1,841,121
2	2	0	424,317	648,442	1,072,760	794,327	0	794,327	1,867,087
3	3	0	438,108	634,652	1,072,760	821,174	0	821,174	1,893,934
4	4	0	452,346	620,414	1,072,760	848,932	0	848,932	1,921,691
5	5	0	467,047	605,712	1,072,760	877,631	0	877,631	1,950,391
6	6	0	482,226	590,533	1,072,760	907,305	0	907,305	1,980,065

Cash Flow Details

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Year	Date	Cash Investment (\$)	Loan Principal (\$)	Loan Interest (\$)	Total Investment Cost (\$)	Annual Operating Cost (\$)	Non-Annual Operating Cost (\$)	Total Operating Cost (\$)	Total Cash Flow (\$)
7	7	0	497,899	574,861	1,072,760	937,986	0	937,986	2,010,746
8	8	0	514,080	558,679	1,072,760	969,709	0	969,709	2,042,468
9	9	0	530,788	541,972	1,072,760	1,002,508	0	1,002,508	2,075,268
10	10	0	548,039	524,721	1,072,760	1,036,422	0	1,036,422	2,109,181
11	11	0	565,850	506,910	1,072,760	1,071,487	0	1,071,487	2,144,247
12	12	0	584,240	488,520	1,072,760	1,107,743	0	1,107,743	2,180,503
13	13	0	603,228	469,532	1,072,760	1,145,231	0	1,145,231	2,217,991
14	14	0	622,833	449,927	1,072,760	1,183,993	0	1,183,993	2,256,752
15	15	0	643,075	429,685	1,072,760	1,224,071	0	1,224,071	2,296,831
16	16	0	663,975	408,785	1,072,760	1,265,511	0	1,265,511	2,338,271
17	17	0	685,554	387,206	1,072,760	1,308,360	0	1,308,360	2,381,120
18	18	0	707,834	364,925	1,072,760	1,352,665	0	1,352,665	2,425,425
19	19	0	730,839	341,921	1,072,760	1,398,476	0	1,398,476	2,471,236
20	20	0	754,591	318,168	1,072,760	1,445,845	0	1,445,845	2,518,604
21	21	0	1,267,388	563,644	1,831,033	1,494,824	0	1,494,824	3,325,856
22	22	0	1,314,682	516,351	1,831,033	1,545,468	0	1,545,468	3,376,501
23	23	0	1,363,787	467,245	1,831,033	1,597,835	0	1,597,835	3,428,868
24	24	0	1,414,775	416,257	1,831,033	1,651,983	0	1,651,983	3,483,016
25	25	0	1,467,720	363,312	1,831,033	1,707,973	0	1,707,973	3,539,006
26	26	0	1,522,700	308,333	1,831,033	1,765,868	0	1,765,868	3,596,900
27	27	0	1,579,794	251,239	1,831,033	1,825,732	0	1,825,732	3,656,765
28	28	0	1,639,085	191,947	1,831,033	1,887,634	0	1,887,634	3,718,666
29	29	0	1,700,661	130,371	1,831,033	1,951,642	0	1,951,642	3,782,674
30	30	0	1,764,612	66,420	1,831,033	2,017,828	0	2,017,828	3,848,861
Totals		0	26,363,034	13,402,483	39,765,530	38,914,525	0	38,914,525	78,680,045

1B. Present Worth Cash Flows [Chiller/ Boiler with Induction]

Year	Date	Total Investment Cost (\$)	Total Operating Cost (\$)	Total Present Worth (\$)
0	Initial	0	0	0
1	1	1,049,154	751,454	1,800,608
2	2	1,026,067	759,754	1,785,821
3	3	1,003,489	768,149	1,771,637
4	4	981,407	776,639	1,758,046
5	5	959,811	785,228	1,745,039
6	6	938,691	793,914	1,732,605
7	7	918,035	802,700	1,720,735

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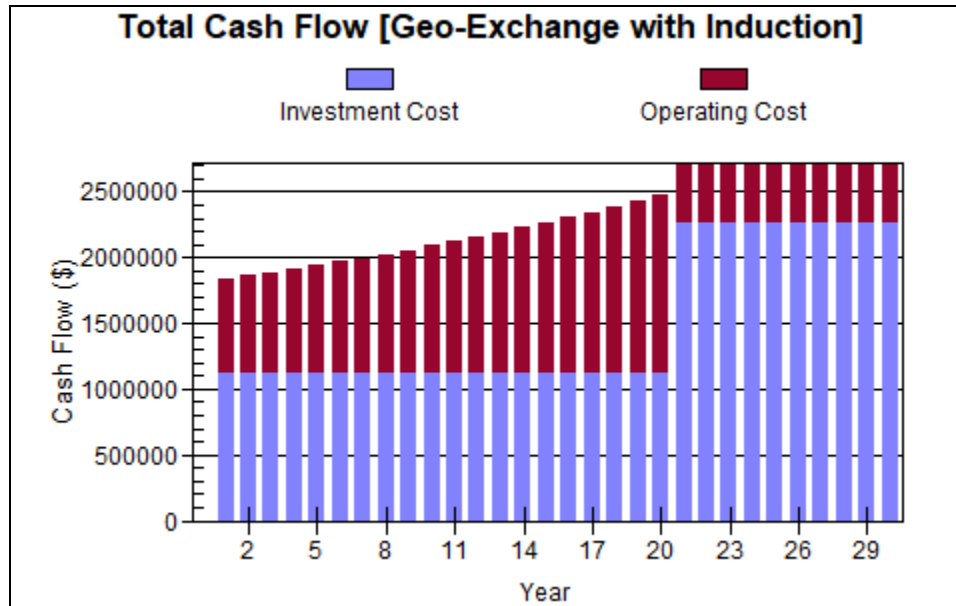
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Year	Date	Total Investment Cost (\$)	Total Operating Cost (\$)	Total Present Worth (\$)
8	8	897,834	811,586	1,709,420
9	9	878,077	820,575	1,698,652
10	10	858,755	829,666	1,688,421
11	11	839,858	838,862	1,678,720
12	12	821,377	848,163	1,669,540
13	13	803,303	857,571	1,660,874
14	14	785,626	867,087	1,652,713
15	15	768,339	876,712	1,645,050
16	16	751,431	886,447	1,637,879
17	17	734,896	896,295	1,631,191
18	18	718,725	906,255	1,624,980
19	19	702,909	916,330	1,619,240
20	20	687,442	926,521	1,613,963
21	21	1,147,536	936,829	2,084,365
22	22	1,122,285	947,255	2,069,540
23	23	1,097,589	957,802	2,055,391
24	24	1,073,437	968,470	2,041,906
25	25	1,049,816	979,260	2,029,076
26	26	1,026,715	990,175	2,016,890
27	27	1,004,122	1,001,215	2,005,337
28	28	982,026	1,012,383	1,994,409
29	29	960,417	1,023,679	1,984,096
30	30	939,283	1,035,106	1,974,389
Totals		27,528,452	26,572,082	54,100,533

Cash Flow Details

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2A. Component Cash Flows [Geo-Exchange with Induction], Actual Value

Year	Date	Cash Investment (\$)	Loan Principal (\$)	Loan Interest (\$)	Total Investment Cost (\$)	Annual Operating Cost (\$)	Non-Annual Operating Cost (\$)	Total Operating Cost (\$)	Total Cash Flow (\$)
0	Initial	0	0	0	0	0	0	0	0
1	1	0	433,526	698,137	1,131,663	723,111	0	723,111	1,854,774
2	2	0	447,616	684,047	1,131,663	747,596	0	747,596	1,879,259
3	3	0	462,163	669,500	1,131,663	772,913	0	772,913	1,904,576
4	4	0	477,184	654,480	1,131,663	799,091	0	799,091	1,930,754
5	5	0	492,692	638,971	1,131,663	826,159	0	826,159	1,957,822
6	6	0	508,705	622,959	1,131,663	854,147	0	854,147	1,985,810
7	7	0	525,238	606,426	1,131,663	883,087	0	883,087	2,014,750
8	8	0	542,308	589,355	1,131,663	913,011	0	913,011	2,044,674
9	9	0	559,933	571,730	1,131,663	943,953	0	943,953	2,075,616
10	10	0	578,131	553,533	1,131,663	975,947	0	975,947	2,107,611
11	11	0	596,920	534,743	1,131,663	1,009,030	0	1,009,030	2,140,694
12	12	0	616,320	515,344	1,131,663	1,043,239	0	1,043,239	2,174,902
13	13	0	636,350	495,313	1,131,663	1,078,612	0	1,078,612	2,210,275
14	14	0	657,032	474,632	1,131,663	1,115,188	0	1,115,188	2,246,852

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Year	Date	Cash Investment (\$)	Loan Principal (\$)	Loan Interest (\$)	Total Investment Cost (\$)	Annual Operating Cost (\$)	Non-Annual Operating Cost (\$)	Total Operating Cost (\$)	Total Cash Flow (\$)
15	15	0	678,385	453,278	1,131,663	1,153,010	0	1,153,010	2,284,673
16	16	0	700,433	431,231	1,131,663	1,192,119	0	1,192,119	2,323,782
17	17	0	723,197	408,467	1,131,663	1,232,559	0	1,232,559	2,364,223
18	18	0	746,700	384,963	1,131,663	1,274,377	0	1,274,377	2,406,040
19	19	0	770,968	360,695	1,131,663	1,317,618	0	1,317,618	2,449,281
20	20	0	796,025	335,639	1,131,663	1,362,332	0	1,362,332	2,493,995
21	21	0	1,556,792	716,143	2,272,934	1,408,568	0	1,408,568	3,681,503
22	22	0	1,616,573	656,361	2,272,934	1,456,380	0	1,456,380	3,729,314
23	23	0	1,678,712	594,223	2,272,934	1,505,820	0	1,505,820	3,778,755
24	24	0	1,743,301	529,633	2,272,934	1,556,945	0	1,556,945	3,829,880
25	25	0	1,810,442	462,493	2,272,934	1,609,812	0	1,609,812	3,882,746
26	26	0	1,880,236	392,699	2,272,934	1,664,480	0	1,664,480	3,937,415
27	27	0	1,952,791	320,143	2,272,934	1,721,012	0	1,721,012	3,993,946
28	28	0	2,028,220	244,715	2,272,934	1,779,470	0	1,779,470	4,052,405
29	29	0	2,106,638	166,296	2,272,934	1,839,922	0	1,839,922	4,112,856
30	30	0	2,188,167	84,767	2,272,934	1,902,434	0	1,902,434	4,175,368
Totals		0	30,511,698	14,850,916	45,362,600	36,661,942	0	36,661,942	82,024,551

2B. Present Worth Cash Flows [Geo-Exchange with Induction]

Year	Date	Total Investment Cost (\$)	Total Operating Cost (\$)	Total Present Worth (\$)
0	Initial	0	0	0
1	1	1,106,761	707,199	1,813,960
2	2	1,082,407	715,056	1,797,463
3	3	1,058,589	723,004	1,781,593
4	4	1,035,295	731,043	1,766,338
5	5	1,012,513	739,174	1,751,687
6	6	990,233	747,399	1,737,632
7	7	968,443	755,719	1,724,161
8	8	947,132	764,134	1,711,266
9	9	926,291	772,646	1,698,937
10	10	905,908	781,256	1,687,164
11	11	885,974	789,965	1,675,938
12	12	866,478	798,774	1,665,252
13	13	847,411	807,685	1,655,096
14	14	828,764	816,699	1,645,462
15	15	810,527	825,816	1,636,343

Cash Flow Details

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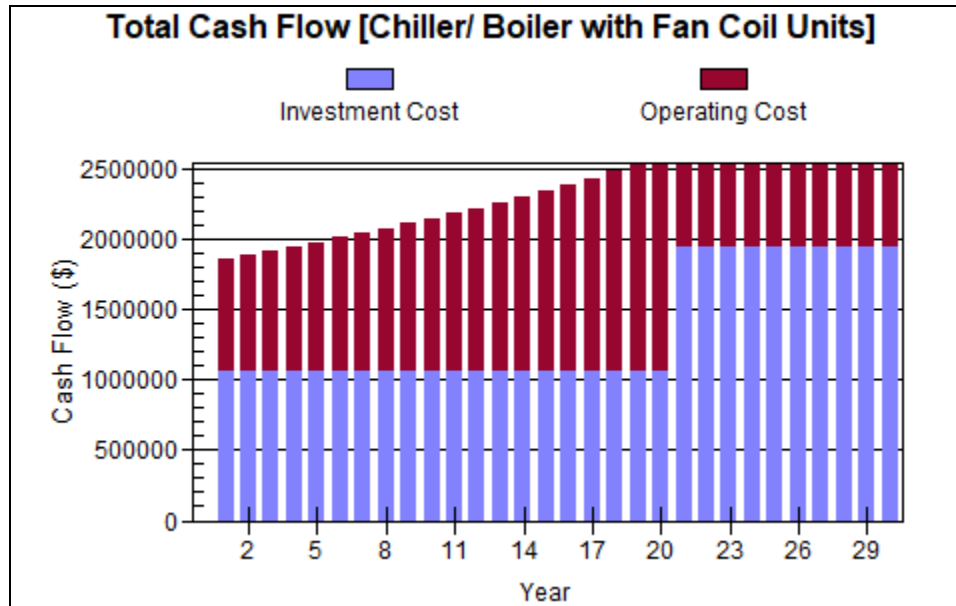
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Year	Date	Total Investment Cost (\$)	Total Operating Cost (\$)	Total Present Worth (\$)
16	16	792,691	835,038	1,627,730
17	17	775,248	844,367	1,619,616
18	18	758,189	853,804	1,611,993
19	19	741,505	863,349	1,604,854
20	20	725,188	873,005	1,598,193
21	21	1,424,483	882,771	2,307,254
22	22	1,393,137	892,651	2,285,788
23	23	1,362,481	902,645	2,265,126
24	24	1,332,500	912,754	2,245,254
25	25	1,303,179	922,980	2,226,159
26	26	1,274,502	933,324	2,207,826
27	27	1,246,457	943,788	2,190,245
28	28	1,219,029	954,372	2,173,401
29	29	1,192,204	965,080	2,157,284
30	30	1,165,970	975,911	2,141,881
Totals		30,979,489	25,031,408	56,010,896

Cash Flow Details

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3A. Component Cash Flows [Chiller/ Boiler with Fan Coil Units], Actual Value

Year	Date	Cash Investment (\$)	Loan Principal (\$)	Loan Interest (\$)	Total Investment Cost (\$)	Annual Operating Cost (\$)	Non-Annual Operating Cost (\$)	Total Operating Cost (\$)	Total Cash Flow (\$)
0	Initial	0	0	0	0	0	0	0	0
1	1	0	410,511	661,075	1,071,586	809,303	0	809,303	1,880,889
2	2	0	423,853	647,733	1,071,586	836,598	0	836,598	1,908,184
3	3	0	437,628	633,958	1,071,586	864,818	0	864,818	1,936,404
4	4	0	451,851	619,735	1,071,586	893,994	0	893,994	1,965,580
5	5	0	466,536	605,050	1,071,586	924,158	0	924,158	1,995,744
6	6	0	481,699	589,887	1,071,586	955,345	0	955,345	2,026,931
7	7	0	497,354	574,232	1,071,586	987,588	0	987,588	2,059,174
8	8	0	513,518	558,068	1,071,586	1,020,923	0	1,020,923	2,092,509
9	9	0	530,207	541,379	1,071,586	1,055,389	0	1,055,389	2,126,975
10	10	0	547,439	524,147	1,071,586	1,091,023	0	1,091,023	2,162,609
11	11	0	565,231	506,355	1,071,586	1,127,865	0	1,127,865	2,199,451
12	12	0	583,601	487,985	1,071,586	1,165,956	0	1,165,956	2,237,542
13	13	0	602,568	469,018	1,071,586	1,205,338	0	1,205,338	2,276,924
14	14	0	622,151	449,435	1,071,586	1,246,057	0	1,246,057	2,317,643

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Year	Date	Cash Investment (\$)	Loan Principal (\$)	Loan Interest (\$)	Total Investment Cost (\$)	Annual Operating Cost (\$)	Non-Annual Operating Cost (\$)	Total Operating Cost (\$)	Total Cash Flow (\$)
15	15	0	642,371	429,215	1,071,586	1,288,156	0	1,288,156	2,359,742
16	16	0	663,248	408,338	1,071,586	1,331,683	0	1,331,683	2,403,270
17	17	0	684,804	386,782	1,071,586	1,376,688	0	1,376,688	2,448,274
18	18	0	707,060	364,526	1,071,586	1,423,219	0	1,423,219	2,494,805
19	19	0	730,039	341,547	1,071,586	1,471,329	0	1,471,329	2,542,915
20	20	0	753,766	317,820	1,071,586	1,521,072	0	1,521,072	2,592,658
21	21	0	1,347,915	608,323	1,956,238	1,572,504	0	1,572,504	3,528,741
22	22	0	1,398,843	557,395	1,956,238	1,625,681	0	1,625,681	3,581,919
23	23	0	1,451,746	504,492	1,956,238	1,680,664	0	1,680,664	3,636,901
24	24	0	1,506,704	449,534	1,956,238	1,737,513	0	1,737,513	3,693,751
25	25	0	1,563,798	392,440	1,956,238	1,796,293	0	1,796,293	3,752,531
26	26	0	1,623,113	333,125	1,956,238	1,857,070	0	1,857,070	3,813,308
27	27	0	1,684,737	271,500	1,956,238	1,919,911	0	1,919,911	3,876,149
28	28	0	1,748,764	207,474	1,956,238	1,984,886	0	1,984,886	3,941,124
29	29	0	1,815,289	140,949	1,956,238	2,052,069	0	2,052,069	4,008,307
30	30	0	1,884,412	71,825	1,956,238	2,121,535	0	2,121,535	4,077,773
Totals		0	27,340,756	13,653,342	40,994,100	40,944,628	0	40,944,628	81,938,727

3B. Present Worth Cash Flows [Chiller/ Boiler with Fan Coil Units]

Year	Date	Total Investment Cost (\$)	Total Operating Cost (\$)	Total Present Worth (\$)
0	Initial	0	0	0
1	1	1,048,006	791,494	1,839,500
2	2	1,024,945	800,185	1,825,129
3	3	1,002,391	808,975	1,811,365
4	4	980,333	817,865	1,798,198
5	5	958,761	826,856	1,785,617
6	6	937,664	835,950	1,773,614
7	7	917,031	845,147	1,762,178
8	8	896,851	854,450	1,751,301
9	9	877,116	863,859	1,740,975
10	10	857,816	873,375	1,731,190
11	11	838,939	883,000	1,721,939
12	12	820,479	892,734	1,713,213
13	13	802,424	902,580	1,705,004
14	14	784,767	912,539	1,697,306
15	15	767,498	922,611	1,690,109

Cash Flow Details

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 Prepared By: BALA

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Year	Date	Total Investment Cost (\$)	Total Operating Cost (\$)	Total Present Worth (\$)
16	16	750,609	932,799	1,683,408
17	17	734,092	943,103	1,677,195
18	18	717,939	953,525	1,671,464
19	19	702,141	964,066	1,666,207
20	20	686,690	974,728	1,661,418
21	21	1,226,004	985,512	2,211,517
22	22	1,199,026	996,420	2,195,446
23	23	1,172,642	1,007,452	2,180,094
24	24	1,146,838	1,018,611	2,165,449
25	25	1,121,602	1,029,898	2,151,500
26	26	1,096,921	1,041,315	2,138,236
27	27	1,072,784	1,052,862	2,125,646
28	28	1,049,177	1,064,542	2,113,719
29	29	1,026,090	1,076,356	2,102,446
30	30	1,003,511	1,088,305	2,091,816
Totals		28,221,087	27,961,114	56,182,199