Cost Analysis of Geothermal Heat Pumps

INTRODUCTION

In this section of the report, we can see what, if any cost savings occur based on the proposed mechanical system design which implements geothermal heat pumps, of the ground-coupled closed loop type, to satisfy the HVAC needs of Sibley Memorial Hospital's – Grand Oaks Assisted Living Facility Addition. The initial cost of the current design and the one I propose implementing are documented within this report. Based on the monthly energy savings that the Mechanical Feasibility Report suggested; annual energy savings of the current system vs. the one I propose are analyzed, from which a payback period can be established to offset the high initial cost of the Geothermal Heat Pump Design. The high electricity rates that are set to affect the Baltimore/Washington area this summer of 2006; discussed in detail in the Mechanical Feasibility report, are also taken into account when establishing a payback period. The rate structure is scaled to assume the inflated cost that would be associated with a 35%-72% rate increase in utility bills. Obliviously, a 72% rate increase would not be passed by lawmakers, but for demonstrative purposes and to further sell my proposed Geothermal Heat Pump design, I choose to establish payback periods based on these rate increases. Also included is the net present value of the annual energy savings offered by a 25 year projected life of the geothermal heat pump system. The different net present value of the energy savings are shown with the current electrical rates, the 35% rate increase, and the 72% rate increase. Also included is the Rate of Return on the initial investment of this Geothermal Heat Pump System over a 25 year projected life, given present electric rates, a 35% rate increase, and a 72% rate increase.

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EQUIPMENT COST COMPARISON OF CURRENT SYSTEM VS. PROPOSED

Current System

Designation	Equipment	Quanity	Size	Division	section number	Discription	Length	TOTAL
CH-1	Air-Cooled helical Rotary Screw Chiller		140 TON	15620| Package Water Chillers	600|1200	140 ton cooling, Water cooled, dual compressors, direct drive		78500
CONV-1	Steam Converter		220 GPM	15710|Heat Exchangers	900|3100	220 GPM		10200
CONV-2	Steam Converter		220 GPM	15710|Heat Exchangers	900|3100	220 GPM		10200
CR-1	Duplex Steam Condensate Reciever Pumpset	2	1-1/2 HP	15180|Heating and Cooling Piping	300|1000	Duplex, 2 pumps, float switch, alternator assembly, 15 Gal. C.I. reciever		14100
FCU	4-Pipe Fan Coil Units	63	1-ton	15760|Terminal Heating & Cooling Units	300|0120	Fan Coil, Cabinet mounted, filters, controls		52920
FCU	4-Pipe Fan Coil Units	26	2-ton	15760|Terminal Heating & Cooling Units	300|0150	Fan Coil, Cabinet mounted, filters, controls		173550
P-HW1	Htg Hot Water Pump		7-1/2 HP	15400|Plumbing Pumps	240|0480	Pump System, with diapragm tank, control, press. switch	-	6675
P-HW2	Htg Hot Water Pump		7-1/2 HP	15400|Plumbing Pumps	240|0480	Pump System, with diapragm tank, control, press. switch	-	6675
ET-HW	Htg Hot Water Expansion Tank		60 Gallons	15120|Piping Specialties	320|2080	60 gallon capacity		750
BF-HW	Htg Hot Water System Bypass Water Filter							0
SF-HW	Htg Hot Water System Shot Feeder							0
ET-CW	Cold Water Expansion Tank		24 Gallons	15120|Piping Specialties	320|2020	24 gallon capacity		470
BF-CW	Cold Water System Bypass Water Filter							0
SF-CW	Cold Water System Shot Feeder							0
Piping Return	Htg Hot Water Return Piping - Assume 2" throughout		2"	15107|Metal Piping and Fittings	620|0610	Metal Piping & Fittings	653	11982.55
Piping Supply	Htg Hot Water Supply Piping - Assume 2" throughout		2"	15107|Metal Piping and Fittings	620|0610	Metal Piping & Fittings	653	11982.55
						Total System Cost		**$380,000.00**

Proposed System

Designation	Equipment	Quanity	Size	Division	section number	Discription	Length	TOTAL
HP	Heat Pumps	64	1 ton	15740|Heat Pumps	800|2100	Water source to air		99200
HP	Heat Pumps	12	2 ton	15740|Heat Pumps	800|2140	Water source to air		21000
HP	Heat Pumps	14	5 ton	15740|Heat Pumps	800|2220	Water source to air		40250
HP-ERU	Heat Pumps	2	20 ton	15740|Heat Pumps		water-to-water		9360
Drilling Cost	All equimpent rentals embedded in cost, as well as		200 ton				160	140800
	grouting, piping, and backfill material							
						Subtotal		**310610**
Overall Installation Cost(based on professional estimate)			60000 sqft					
						Total System Cost		**$600,000.00**

A few things to make note of when looking at the cost comparison of the two systems: The total cost associated with any piece of equipment is from R.S. Means. The cold water pumps are not considered in the Current System total cost because I am assuming that the cost of those pumps are similar to the cost of the variable rate, and side straight pump in the Proposed System. Also, the Proposed System is a two pipe system, thereby I account for the heating hot water piping in the cost associated with the Current System cost. The total cost of the Proposed Geothermal System is based off a ($20,000/2000 sqft) figure given to me by Mr. Dave Feyock, a consultant

for Somerset Rural Electric, who specializes in the design and construction of geothermal heat pump systems. So based on the approximate building square footage, I was able to estimate a total installation cost of the proposed geothermal system. The next section address the initial costs associated with the two systems and an annual electric bill that each system might see.

INITIAL COST COMPARISON VS. ANNUAL ELECTRIC BILL

Current System	Initial Cost	Energy Use(Summer) kw	Energy Use(Winter) kw	Summer Bill	Winter Bill	Annual Electric Bill
Air Cooled, Rotary Screw Chiller, Fan Coil Units	$380,000.00	199.9547961	36.848	$66,113.61	$22,975.56	$89,089.18
Proposed System	Initial Cost	Energy Use(Summer) kw	Energy Use(Winter) kw	Summer Bill	Winter Bill	Annual Electric Bill
Heat Pumps with Geothermal Loop	$600,000.00	65.1	65.1	$26,059.63	$34,292.29	$60,351.92
Cost/Usage Difference	**$220,000.00**	**-134.85**	**28.25**	**-$40,053.98**	**$11,316.72**	**-$28,737.26**

As the chart indicates there is a higher initial cost for the Proposed System, but from the Mechanical Feasibility study, based on the kilo-watts that each system consumes, and the expected electric bills for summer and winter months, the Proposed System could offer an annual energy savings of almost **$30,000.00.** In the building industry, initial cost seems to be the driving force, so to make the case for my proposed Geothermal Heat Pump System, I want to establish a payback period based on the annual electric savings that my system could offer, and show that it could be a wise decision to go with a higher first cost capital investment given the projected life of the system and the volatility of electricity rates.

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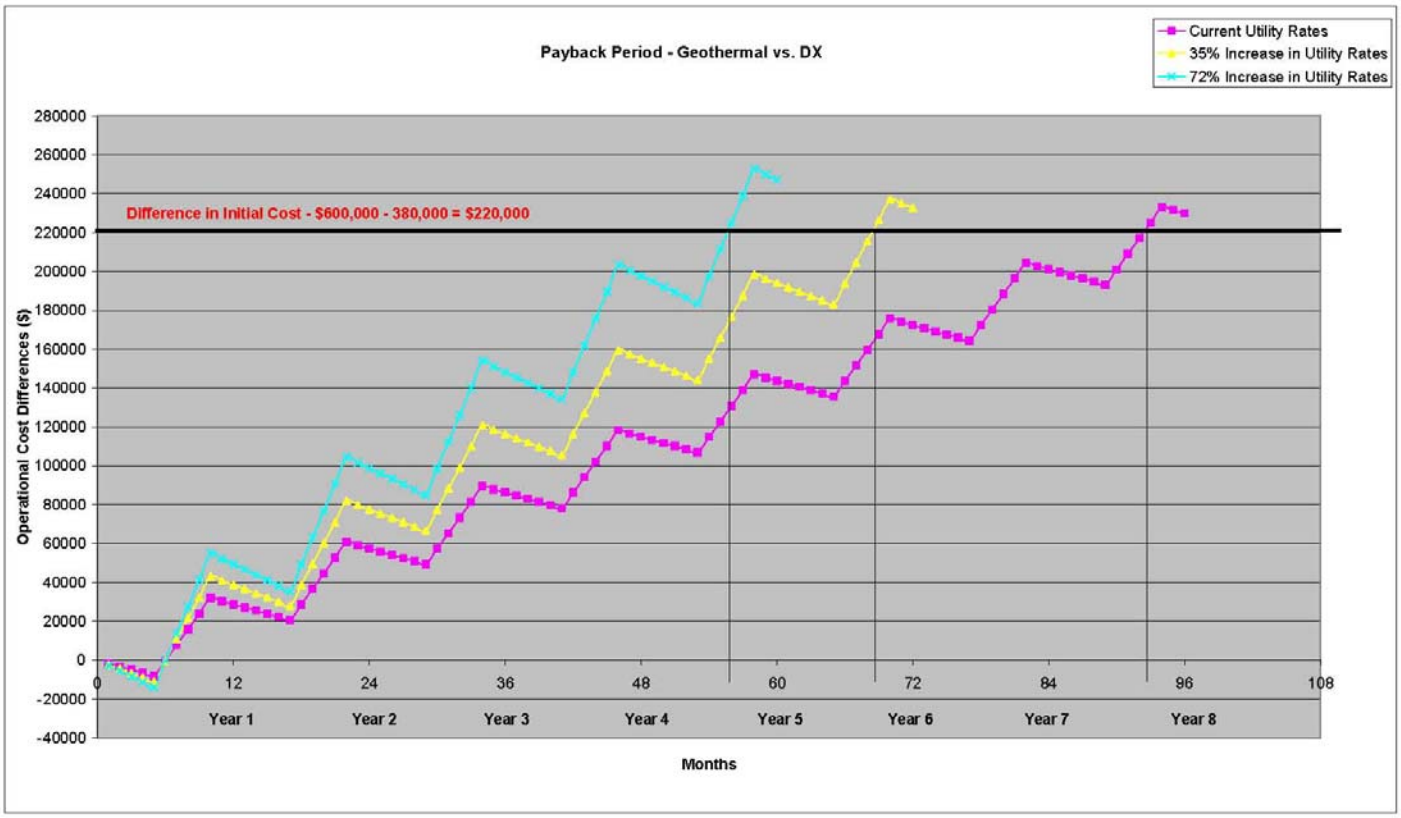
PAYBACK PERIOD OF GEOTHERMAL HEAT PUMP SYSTEM



As this graph indicates, and what one would assume, the higher the electric rates get, the faster the initial cost of the Geothermal Heat Pump System is offset. As it was already mentioned, Baltimore/Washington customers will probably not see an electricity rate increase of 72%. But this graph does makes a strong case: Given the local situation of electricity rates in the Baltimore/Washington area, and the ever growing national demand for electricity, the payback on an energy efficient system could be worth the higher initial first cost. Another way of looking at the annual energy savings offered by the Geothermal Heat Pump System is to compare the Net Present Value of the annual electrical cost savings over a 25 year projected life.

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Net Present Value and Rate of Return

Current Electric Rate					
Annual Savings	Uniform Series Present Worth Factor	Annual Interest or Discount Rate	Term Years	Present Worth	
$ 30,000	11.14694586	7.500%	25	$	334,408
$ 30,000	10.67477619	8.000%	25	$	320,243
$ 30,000	9.077040018	10.000%	25	$	272,311
$ 30,000	7.843139112	12.000%	25	$	235,294
$ 30,000	7.579005012	12.500%	25	$	227,370
$ 30,000	7.329984978	**13.000%**	25	$	219,900

Assuming that the Assisted Living Facility could borrow money at the current "Prime-Rate" of 7.5%, an investment of $220,000 (the initial cost difference) in the Geothermal System provides an annual savings at current electric rates of approximately $30,000. Therefore the "Net Present Value" of the Geothermal System over its projected life of 25 years would be:

Present Value of Savings	**$334,408.00**
Less Initial Investment	**$220,000.00**
Net Present Value	**$114,408.00**

Also over this 25 year projected life, at current electric rates, the investment in my proposed Geothermal System would yield a **"Rate of Return"** of approximately**13%.** As I had mentioned before, the current PEPCO electric rates have been held artificially low due to rate caps, which are due to expire in the summer of 2006. The utility has, in fact, already filed for 35%-72% rate increases. Given present and future projections that global demand for energy will continue to exceed supply, electric rates are also expected to escalate. Therefore, the calculated Net Present Value as well as the Rate of Return provided by the energy cost savings of the Geothermal installation can be considered quite conservative. But, to further illustrate with numbers the potential energy savings, I considered the Net Present Value and Rates of Return with a 35% and a 72% rate increase.

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35% Rate Increase				
Annual Savings	Uniform Series Present Worth Factor	Annual Interest or Discount Rate	Term Years	Present Worth
$ 38,795	11.14694586	7.500%	25	$ 432,446
$ 38,795	10.67477619	8.000%	25	$ 414,128
$ 38,795	9.077040018	10.000%	25	$ 352,144
$ 38,795	7.843139112	12.000%	25	$ 304,275
$ 38,795	7.579005012	12.500%	25	$ 294,027
$ 38,795	7.329984978	13.000%	25	$ 284,367
$ 38,795	7.094965203	13.500%	25	$ 275,249
$ 38,795	6.872927437	14.000%	25	$ 266,635
$ 38,795	6.662939894	14.500%	25	$ 258,489
$ 38,795	6.464149085	15.000%	25	$ 250,777
$ 38,795	6.27577249	15.500%	25	$ 243,469
$ 38,795	6.097091972	16.000%	25	$ 236,537
$ 38,795	5.927447859	16.500%	25	$ 229,955
$ 38,795	5.766233608	17.000%	25	$ 223,701
$ 38,795	5.612891007	17.500%	25	$ 217,752

Present Value of Savings	**$432,446.00**
Less Initial Investment	**$220,000.00**
Net Present Value	**$212,446.00**
Rate of Return	**17-17.5%**

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72% Rate Increase				
Annual Savings	Uniform Series Present Worth Factor	Annual Interest or Discount Rate	Term Years	Present Worth
$ 49,428	11.14694586	7.500%	25	$ 550,972
$ 49,428	10.67477619	8.000%	25	$ 527,634
$ 49,428	9.077040018	10.000%	25	$ 448,661
$ 49,428	7.843139112	12.000%	25	$ 387,671
$ 49,428	7.579005012	12.500%	25	$ 374,616
$ 49,428	7.329984978	13.000%	25	$ 362,307
$ 49,428	7.094965203	13.500%	25	$ 350,691
$ 49,428	6.872927437	14.000%	25	$ 339,716
$ 49,428	6.662939894	14.500%	25	$ 329,336
$ 49,428	6.464149085	15.000%	25	$ 319,510
$ 49,428	6.27577249	15.500%	25	$ 310,199
$ 49,428	6.097091972	16.000%	25	$ 301,368
$ 49,428	5.927447859	16.500%	25	$ 292,982
$ 49,428	5.766233608	17.000%	25	$ 285,014
$ 49,428	5.612891007	17.500%	25	$ 277,434
$ 49,428	5.466905847	18.000%	25	$ 270,219
$ 49,428	5.327804013	18.500%	25	$ 263,343
$ 49,428	5.195147959	19.000%	25	$ 256,786
$ 49,428	5.068533518	19.500%	25	$ 250,528
$ 49,428	4.94758702	20.000%	25	$ 244,550
$ 49,428	4.83196268	20.500%	25	$ 238,835
$ 49,428	4.721340232	21.000%	25	$ 233,367
$ 49,428	4.615422787	21.500%	25	$ 228,132
$ 49,428	4.513934883	**22.000%**	25	$ 223,115
$ 49,428	4.41662072	22.500%	25	$ 218,305
$ 49,428	4.323242549	23.000%	25	$ 213,690

Present Value of Savings	**$550,972.00**
Less Initial Investment	**$220,000.00**
Net Present Value	**$330,972.00**
Rate of Return	**22-22.5%**

CONCLUSION

As the numbers and graphs indicate, the higher initial cost of the Geothermal System can be offset by the amount of money it saves in electricity cost on a yearly basis. With the assumptions I made in the Mechanical Feasibility Study, two annual electric bills could be developed from which I could suggest a possible payback period of 4 ½ - 7 ½ years on the higher initial investment in the Geothermal System. I also found that the Net Present Value of the electric savings could be from $115,000 - $331,000 over a 25 year projected life; and that the investment in the Geothermal System could yield a 13% - 22.5% Rate of Return. Because the Assisted Living Facility Addition has yet to be built, I had to make some assumptions about the electric bills that each of the two mechanical systems might produce. But, given my assumptions, I feel that this cost analysis demonstrates the potential savings that could be offered by the proposed Geothermal System.