ECONOMIC COMPARISON OF HEATING FACILITIES

75 Unit Apartment
Stewart-Lennox Area
Klamath Falls, Oregon

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The following economic study is the result of a request to the Geo-Heat Utilization Center for Technical Assistance.

Introduction

Mrs. Eva Kight has under consideration the construction of an apartment complex to be located in the Stewart-Lennox area of Klamath Falls. The initial apartment building would consist of about 75 units of about 900 square feet each. Also included would be an outdoor swimming pool and an enclosed activity wing of about 11,000 square feet. Though no deep geothermal wells have been drilled in the immediate area, Mrs. Kight has obtained opinions that 150°F water would be present at 2,500 feet and 80°F water at about 1,000 feet. Based on this information we have developed the comparative economics of using geothermal as a heat source versus conventional electrical heating. The purpose of this comparison is to determine if there is economic incentive for the expenditure necessary to define and prove the extent of the geothermal resource.

Description of systems

Four systems were compared, each would provide space heating, supply domestic hot water, and heat the swimming pool. A brief description of each of the systems follows. Please refer to the appropriate diagrams.

SYSTEM #1 Conventional All Electric (Figure 1)

Space heating is provided by electric baseboard convectors. Domestic hot water is furnished by individual electric water heaters. The swimming pool is heated by an electric water heater installed in the pool circulating system. This system is thought to require the least capital investment. A forced air duct system would provide ventilation but would cost more.

SYSTEM #2 150°F Geothermal Water (Figure 2)

150°F Geothermal water is pumped from a 2,500 feet deep fully cased production well. The water passes through a heat exchanger and is injected at 105°F. The injection well is also 2,500 feet deep and fully cased. A secondary circulating loop system furnishes 145°F water for heating the pool and the building. Domestic hot water is drawn directly from this circulating loop. The pool is heated by heat exchange with the 145°F loop water. Space heating utilizes individual fan coil units.

SYSTEM #3 80°F Geothermal with Water-to-Air Heat Pump (Figure 3)

This system is based on 80°F geothermal water from a 1,000' deep fully cased production well. The water after heat exchange is injected at 60°F into a 1,000' fully cased injection well. Secondary circulating loop water is heated by the exchanger to 75°F, is pumped to the water-to-air heat pumps, and returns to the exchanger at 55°F. The system utilizes 6 proprietary heat pumps of the roof mounted type. A system of forced air ducts circulates the heated air throughout the apartment building. Return ducting brings the air back to the heat pumps. Domestic water heating and swimming pool heating are by conventional electric water heaters. This system has ventilating as well as air conditioning capabilities. For the purpose of this economic comparison the heat pumps were operated only for space heating.

SYSTEM #4 80°F Geothermal with Water-to-Water Heat Pump (Figure 4)

80°F Geothermal water from a 1,000' deep fully cased production well is pumped through heat exchange and injected into a similar well at a water temperature of 65°F. Two circulating systems are required. The evaporator circulation picks up heat from the geothermal/secondary exchanger and gives it up to the evaporator. The loop operates between 60°F and 75°F. The condenser circulating loop meets the requirements of space heating and water heating loads. Water circulating through the condenser is raised in temperature from 120°F to 140°F. No supplementary conventional electrical heating is needed. Two proprietary water-to-water heat pumps of 50% capacity are included in the cost.

Capital and Operating Costs

Capital and operating costs are summarized in Table 1. System #1, Conventional All Electric, has the lowest capital cost ($110,000), but the highest operating cost ($111,876 for 1st year). The lowest operating cost is achieved by System #2, 150°F Geothermal Water, at $11,585 for the 1st year. The highest capital cost is for System #3, 80°F Geothermal Water with Water-to-Air Heat Pump ($600,000). This is largely due to the expensive forced air ducting needed in this multi-story building.

Economic Comparison

The economic comparisons were made, each using System #1, Conventional All Electric as the base. For each comparison, maintenance costs were escalated at 7%. The cost of electricity was inflated at 9.5% through 1986 then 8.58% thereafter. These inflation rates on electricity are those forecasts for Oregon by the State Department of Energy. The comparisons are based on the difference in capital investment, operating and maintenance cost (O & M), and electrical cost between the base case and the case under consideration. A series of computer runs were made to establish the rate of return (before taxes) on the difference in capital investment generated by the savings in electrical costs over the 20 year life cycle. These results are summarized as follows:

	Difference in Capital Investment $	Return on Investment (Before Taxes) %
150°F Geothermal	190,000	65
80°F Geothermal (water/air heat pump)	490,000	7
80°F Geothermal (water/water heat pump)	420,000	20

Conclusions: This appears to be ample economic incentive to justify consideration of the expenditure of the money necessary to define and prove the extent of the geothermal resource. If 150°F water is in fact found in quantity at 2,500 feet, the savings in electric power made possible with a 150°F geothermal system is dramatic. Of course, the 65% return indicated above does not include exploration costs. However, if geothermal water of less than 150°F, but more than 80°F, is found a viable geothermal heating scheme using water-to-water heat pumps is possible.

Table 1

COST SUMMARY

Eva Kight Apartments
Stewart-Lennox Area

	SYSTEM #1 Electric	SYSTEM #2 Geothermal	SYSTEM #3 Heat Pump (Water to Air)	SYSTEM #4 Heat Pump (Water to Water)
CAPITAL COST SUMMARY				
Geothermal and injection well	-	140,000	58,000	58,000
Turbine pump w/torque converter	-	30,000	28,000	47,000
Geothermal and secondary piping	-	53,000	38,000	97,000
Secondary circulating pumps and spare	-	14,000	11,000	36,000
Well head building	-	3,000	3,000	3,000
Geo./secondary heat exchanger	-	12,000	5,000	9,000
Heat pumps	-	-	96,000	220,000
Duct system w/return fans	-	-	248,000	-
Water heating facilities	65,000	-	65,000	-
Electric based board heaters	30,000	-	-	-
Fan coil heaters	-	21,000	-	21,000
Misc. electrical and mechanical	5,000	7,000	18,000	17,000
Sub-Total	100,000	280,000	570,000	508,000
Contingency	10,000	20,000	30,000	22,000
(1) Total Capital Cost	$110,000	$300,000	$600,000	$530,000
OPERATING COST SUMMARY				
Maintenance -				
Piping and ducting @ 1/2%	-	283	1,505	506
Heat pumps @ 5%	-	-	5,053	13,200
Pumps, exch., coils, heaters, well bldg. @ 3%	3,300	3,439	3,537	4,163
Total Maintenance	3,300	3,722	10,095	17,869
Taxes and insurance @ 2 1/2%	2,750	3,750	13,474	11,737
Electric power @ $.0260/KWH	105,826	4,113	71,412	35,329
Total Operating Cost (1st year)	$111,876	$ 11,585	$ 94,981	$ 64,935

(1) Excludes any engineering or contractors fees, permits or licenses, or cost escalation

ECONOMIC COMPARISON

150° Geothermal (System #2) Versus Conventional All Electric (System #1)

Table 2

ELECT COST	O + M COST	ELECT GTHML COST	O + M GTHML COST	$/YR	P.W. 10. %	P.W. 65.
105826.00	6050.00	4113.00	7472.00			
			7995.04	109854.20	99867.45	66578.30
115879.47	6473.50	4503.74	8554.69	120328.38	99444.94	44197.75
126888.02	6926.65	4931.59	9153.52	131800.28	99023.50	29340.30
138942.38	7411.51	5400.09	9794.27	144364.86	98603.14	19477.16
152141.91	7930.32	5913.10	10479.87	158126.12	98183.88	12929.56
166595.39	8485.44	6474.84	11213.46	173197.96	97765.73	8583.00
182421.95	9079.42	7089.95	11998.40	189705.12	97348.72	5697.59
199752.04	9714.98	7763.50	12838.29	206017.89	96108.87	3750.02
216890.76	10395.03	8429.61	13736.97	223732.83	94884.56	2468.17
235499.99	11122.68	9152.87	14698.55	242970.41	93675.61	1624.48
255705.89	11901.27	9938.18	15727.45	263861.47	92481.84	1069.18
277645.45	12734.35	10790.88	16828.38	286548.08	91303.05	703.70
301467.43	13625.76	11716.74	18006.36	311184.50	90139.07	463.16
327333.34	14579.56	12722.03	19266.81	337938.28	88989.71	304.83
355418.54	15600.13	13813.59	20615.48	366991.32	87854.80	200.63
385913.45	16692.14	14998.79	22058.57	398541.16	86734.17	132.05
419024.82	17860.59	16285.69	23602.67	432802.32	85627.63	86.91
454977.15	19110.83	17683.00	25254.85	470007.73	84535.02	57.20
494014.19	20448.59	19200.20	27022.69	510410.33	83456.17	37.65
536400.61	21879.99	20847.58	28914.28	554284.79	82390.90	24.78
582423.78	23411.59	22636.30				
				5632668.01	1848418.76	197726.42

ECONOMIC COMPARISON

$80^{o}F$ Geothermal with W/A Heat Pump (System #3) Versus Conventional All Electric (System #1)

Table 3

ELECT COST	O + M COST	ELECT GTHML COST	O + M GTHML COST	S/YR	P.W. 10. %	P. 7.
105826.00	6050.00	71412.00	23569.00			
115879.47	6473.50	78196.14	25218.83	18938.00	17216.36	17699.07
126888.02	6926.65	85624.77	26984.15	21205.74	17525.41	18521.92
138942.38	7411.51	93759.13	28873.04	23721.73	17822.48	19363.99
152141.91	7930.32	102666.24	30894.15	26511.83	18107.94	20225.75
166595.39	8485.44	112419.54	33056.74	29604.55	18382.10	21107.63
182421.95	9079.42	123099.39	35370.71	33031.26	18645.29	22010.13
199752.04	9714.98	134793.84	37846.66	36826.52	18897.83	22933.70
216890.76	10395.03	146359.15	40495.93	40430.71	18861.23	23531.04
235499.99	11122.68	158916.76	43330.65	44375.26	18819.44	24137.20
255705.89	11901.27	172551.82	46363.79	48691.54	18772.70	24752.31
277645.45	12734.35	187356.77	49609.26	53413.79	18721.21	25376.50
301467.43	13625.76	203431.98	53081.90	58579.31	18665.17	26009.92
327333.34	14579.56	220886.44	56797.64	64228.82	18604.80	26652.68
355418.54	15600.13	239838.50	60773.47	70406.70	18540.29	27304.93
385913.45	16692.14	260416.64	65027.61	77161.34	18471.81	27966.82
419024.82	17860.59	282760.39	69579.55	84545.48	18399.56	28638.48
454977.15	19110.83	307021.23	74450.12	92616.64	18323.71	29320.06
494014.19	20448.59	333363.65	79661.62	101437.51	18244.43	30011.70
536400.61	21879.99	361966.25	85237.94	111076.41	18161.88	30713.55
582423.78	23411.59	393022.95	91204.59	121607.83	18076.23	31425.77
				1158410.97	367259.85	497703.15

ECONOMIC COMPARISON

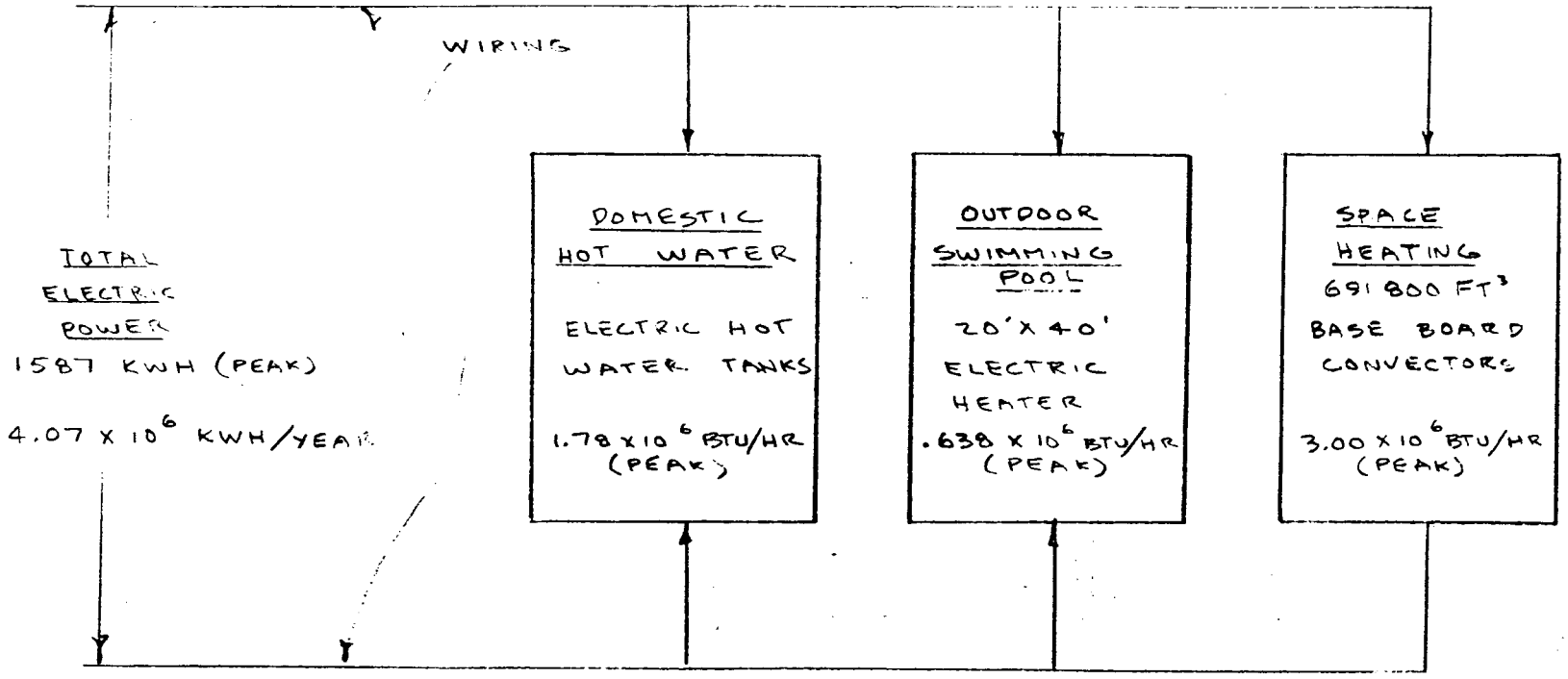
80°F Geothermal with W/W Heat Pump (System #4) Versus Conventional All Electric (System #1)

Table 4

ELECT COST	O + M COST	ELECT GTHML COST	O + M GTHML COST	S/YR	P.W. 10. %	P.W. 20.
105826.00	6050.00	35329.00	29606.00			
115879.47	6473.50	38685.26	31678.42	51989.30	47263.00	43324.41
126888.02	6926.65	42360.35	33895.91	57558.40	47568.93	39971.11
138942.38	7411.51	46384.59	36268.62	63700.68	47859.26	36863.82
152141.91	7930.32	50791.12	38807.43	70473.67	48134.47	33986.15
166595.89	8485.44	55616.28	41523.95	77940.60	48394.98	31322.58
182421.95	9079.42	60899.83	44430.62	86170.92	48641.24	28858.47
199752.04	9714.98	66685.31	47540.77	95240.94	48873.66	26580.00
216890.76	10395.03	72406.91	50868.62	104010.26	48521.55	24189.46
235499.99	11122.68	78619.42	54429.42	113573.82	48166.39	22011.37
255705.89	11901.27	85364.97	58239.48	124002.70	47808.41	20027.13
277645.45	12734.35	92689.28	62316.25	135374.28	47447.86	18219.75
301467.43	13625.76	100642.02	66678.38	147772.78	47084.96	16573.70
327333.34	14579.56	109277.11	71345.87	161289.92	46719.94	15074.78
355418.54	15600.13	118653.09	76340.08	176025.50	46353.02	13710.02
385913.45	16692.14	128833.52	81683.89	192088.18	45984.38	12467.57
419024.82	17860.59	139887.44	87401.76	209596.22	45614.24	11336.62
454977.15	19110.83	151889.78	93519.88	228678.32	45242.79	10307.27
494014.19	20448.59	164921.92	100066.27	249474.58	44870.20	9370.52
536400.61	21879.99	179072.22	107070.91	272137.46	44496.65	8518.14
582423.78	23411.59	194436.62	114565.88	296832.87	44122.32	7742.60
				2913931.40	939168.24	430455.48

CONVENTIONAL ALL ELECTRIC (SYSTEM #1)

FIGURE #1



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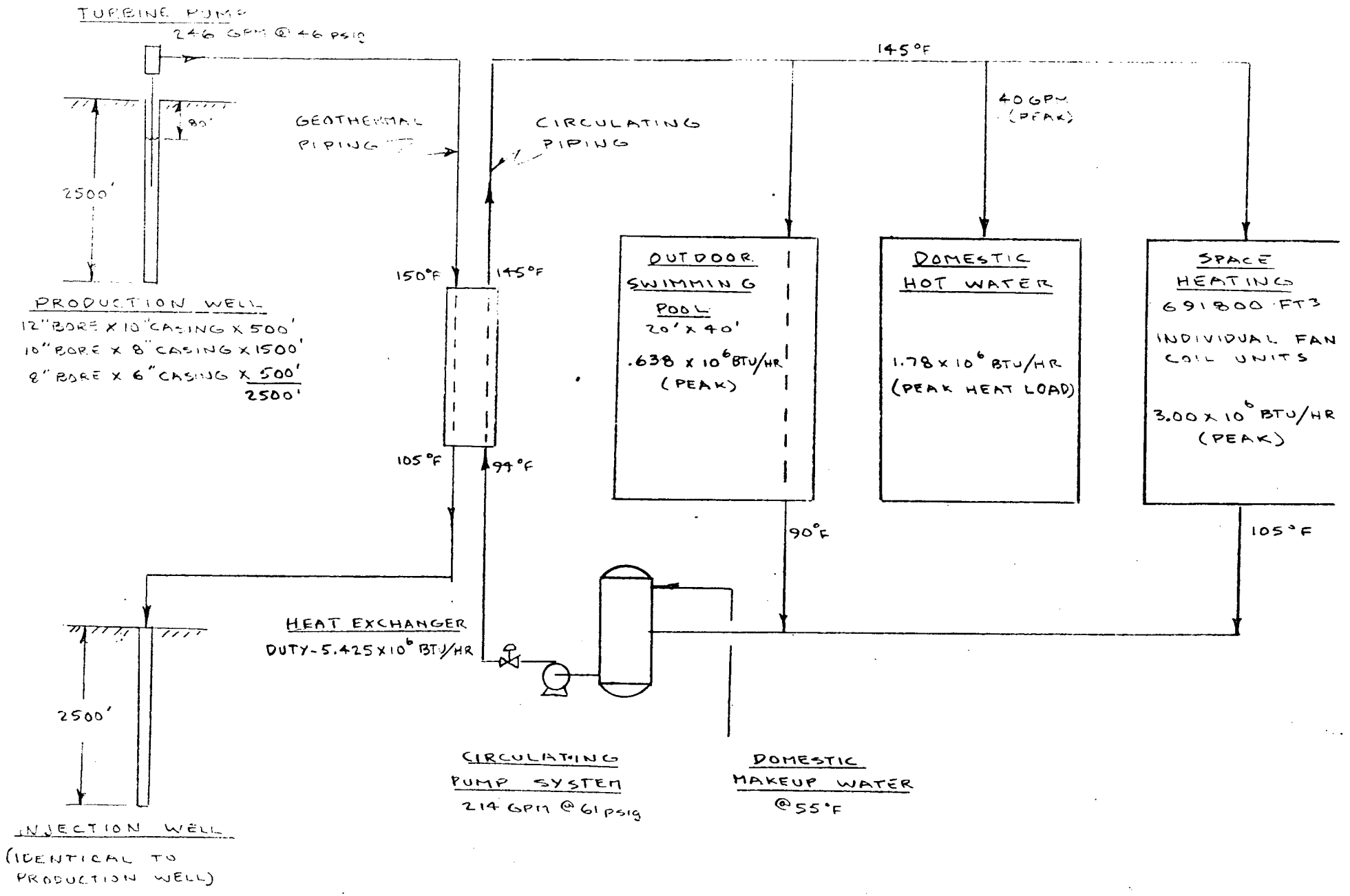
150° GEOTHERMAL WATER (SYSTEM #2)

FIGURE #2



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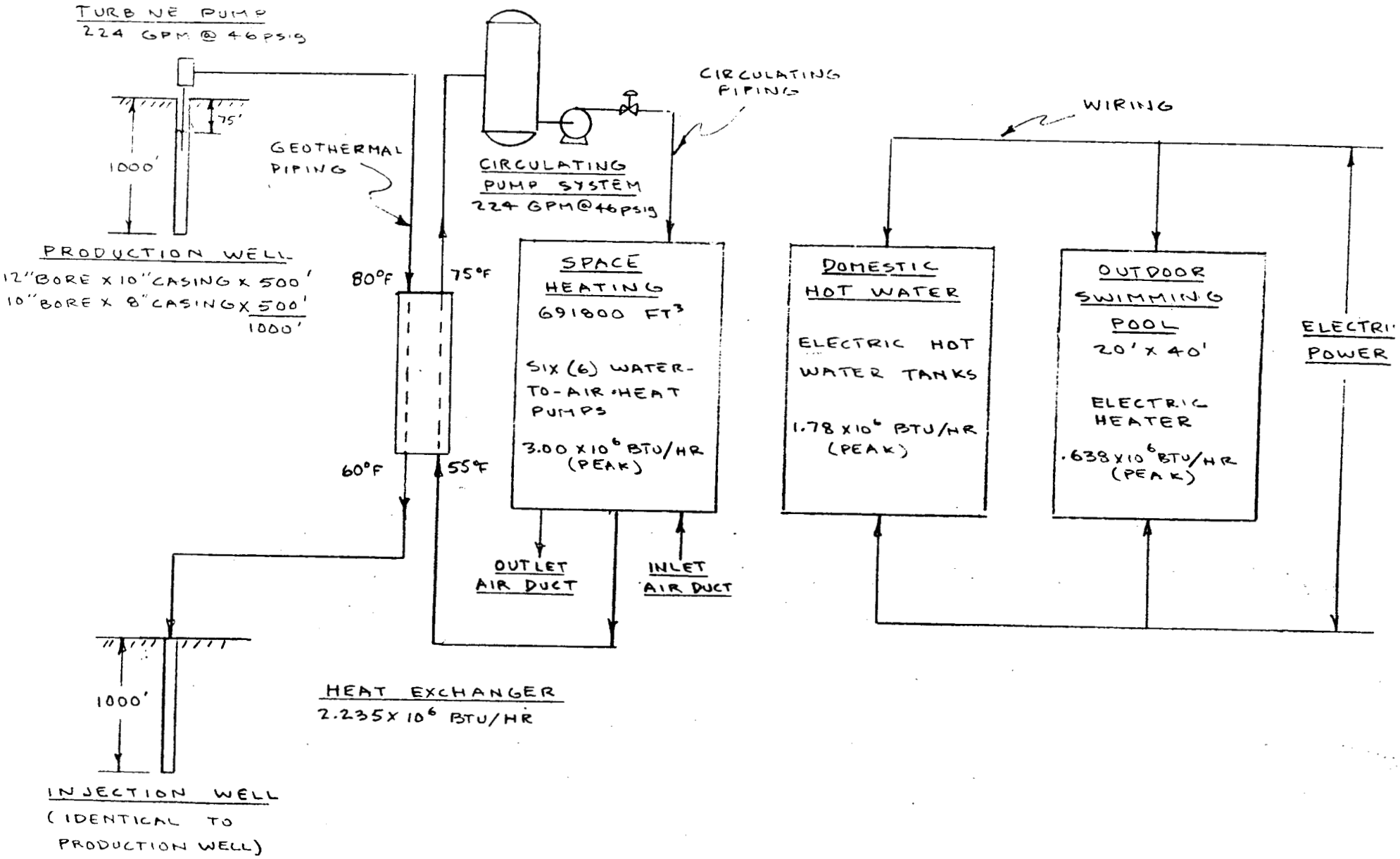
80°F GEOTHERMAL WITH WATER-TO-AIR HEAT PUMPS (SYSTEM #3)

FIGURE #3



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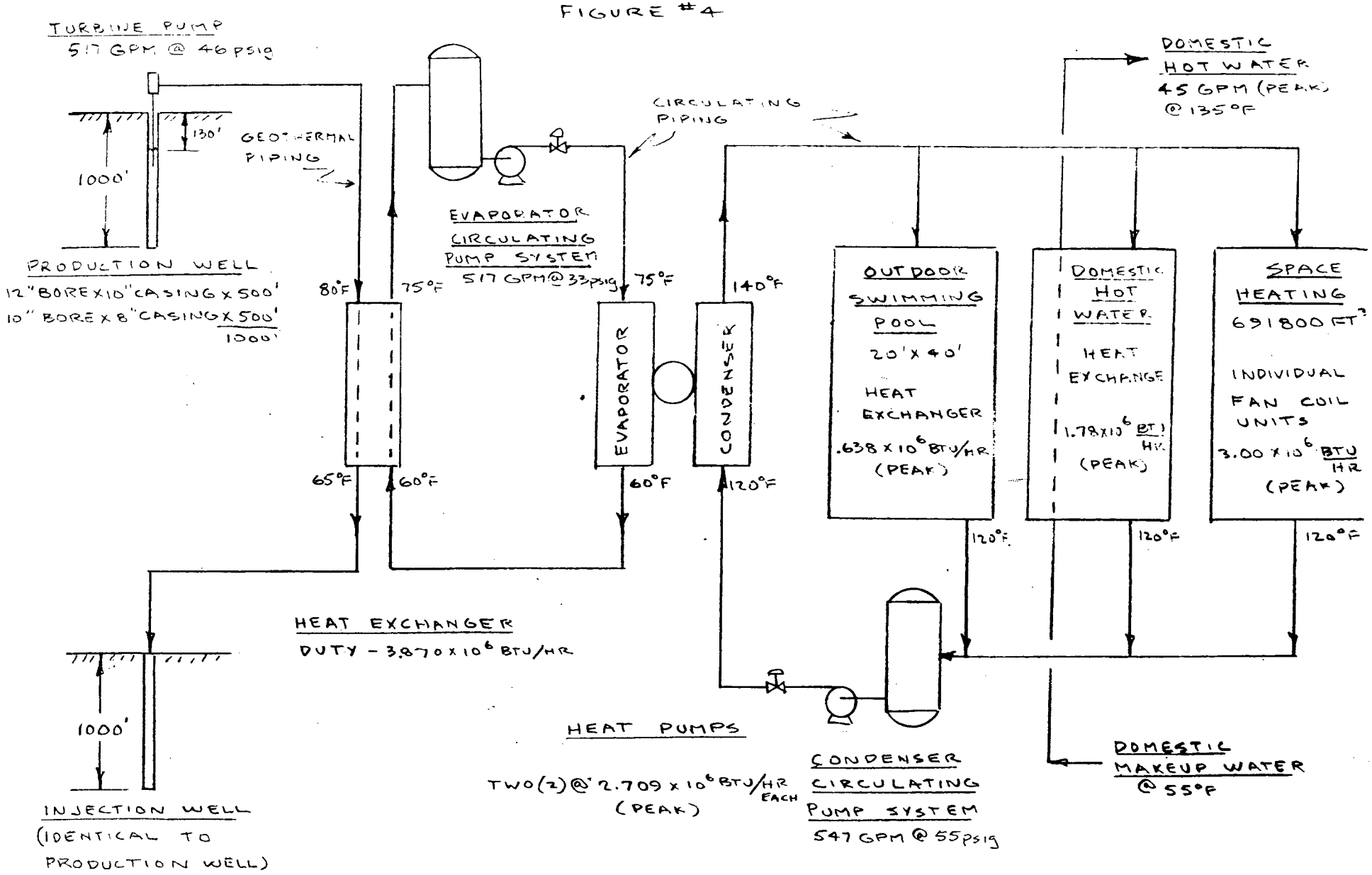
80°F GEOTHERMAL WITH WATER-TO-WATER HEAT PUMPS (SYSTEM #4)

FIGURE #4



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