

# HVAC and Energy Life Cycle Cost Report

**30 Year Life Cycle Cost**  
*for the*

## **Sonoma County Adult Detention Behavioral Health Unit**

Santa Rosa, California



*Prepared by Kitchell*

*For*

Sonoma County

**February 22, 2021**

**Job No. 6082C2**

**FINAL REPORT**



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**I. ANALYSIS**

**A. Purpose**

The Purpose of the Sonoma County Energy Model Analysis was to determine the 30-year Life Cycle Cost for the new Sonoma County Adult Detention Behavioral Health Unit.

**B. Modeling System**

The energy model analysis was performed using the TRANE TRACE 700 Energy Modeling Software in conjunction with ASHRAE 90.1 and ASHRAE 62.1 **modeling standards.**

**C. Assumptions**

The following design assumptions were made for the proposed Schematic Design Energy Model analysis and are intended to show the life cycle cost under the following conditions. Actual life cycle cost model may differ depending on final design, equipment system selections, facility operations, and utility costs at the time of construction and operation.

Weather Data (Based on ASHRAE Fundamental Handbook Standards):

City: Santa Rosa, California

Summer Design Conditions (Dry Bulb/Wet Bulb): 95°F/67°F

Winter Design Conditions (Dry Bulb): 29°F

Interior Design Conditions:

All spaces assume a 75°F summer and 70°F winter design set point.

Utility Rates: Based on PG&E Rates

Electricity On Peak (Jan-Dec.):

On Peak Demand: \$25.53/kw

On Peak Consumption: \$0.131860/kwh

Electricity (Jan-Dec.):

Off Peak Demand: \$5.00/kw

Off Peak Consumption: \$0.071170/kwh

Gas On Peak: \$0.71/therm

Gas Off Peak: \$0.53/therm

Water: \$1.85/1000 gallons

Waste: \$2.02/1000 gallons

**D. Summary**

The Schematic Design Energy Model was created to simulate the operating condition for the proposed Sonoma County Adult Detention Behavioral Health Unit with the purpose of developing a 30-year life cycle cost analysis.

The Sonoma County Adult Detention Behavioral Health Unit consist of a 36,383 square foot Administration Support and Housing facility. The facility will be served by a Variable Refrigerant Flow (VRF) Heat Pump system with dedicated make-up air units for thermal control and ventilation.

The results of the Energy Model indicate that the total annual utility cost will be \$336,299. The total maintenance and major repairs cost over the 30-year life of the building will be \$9,467,045. All utilities assume a 3% inflation cost. The total cost of the utilities, maintenance, and major repairs over the 30-year life of the building will be \$23,240,498.

Utility	Annual Cost (\$)
Electric	164,454
Gas	57,933
Water	64,176
Sewer	49,736
Total	336,299

Figure 1. Sonoma County Adult Detention Behavioral Health Unit Utility Annual Cost

Maintenance Item	Replacement Year	Estimated Replacement Cost (\$)
HVAC Equipment	15-30	\$ 799,061.00
Roofing	15 - 30	\$ 1,259,408.89
Plumbing Boilers & Accessories	15 - 30	\$ 61,308.00
Plumbing Fixtures	15 - 30	\$ 433,584.00
Water Management System	15 - 30	\$ 51,770.00
Transformers	15 - 30	\$ 16,042.00
Panelboards	15-30	\$ 45,314.00
Switchboards	15-30	\$ 78,912.00
Lights	15-30	\$ 514,219.00
Fire Alarm Control Panel	15-30	\$ 156,725.00
Security and Communication	15-30	\$ 1,422,128.00
Temporary Power and Lighting	15-30	\$ 36,463.00
Total		4,874,935

Figure 2. Sonoma County Adult Detention Behavioral Health Unit Maintenance Replacement Cost

Sonoma County Adult Detention Behavioral Health Unit  
Estimated Energy Model Analysis

Year	Utilities	Major Maintenance	Major Replacement	Total
Year 1	\$ 336,298.77	\$ 112,123.00		\$ 448,421.77
Year 2	\$ 346,387.74	\$ 115,486.69		\$ 461,874.43
Year 3	\$ 353,315.49	\$ 117,796.42		\$ 471,111.92
Year 4	\$ 360,381.80	\$ 120,152.35		\$ 480,534.15
Year 5	\$ 367,589.44	\$ 122,555.40		\$ 490,144.84
Year 6	\$ 374,941.23	\$ 125,006.51		\$ 499,947.73
Year 7	\$ 382,440.05	\$ 127,506.64		\$ 509,946.69
Year 8	\$ 390,088.85	\$ 130,056.77		\$ 520,145.62
Year 9	\$ 397,890.63	\$ 132,657.91		\$ 530,548.53
Year 10	\$ 405,848.44	\$ 135,311.06		\$ 541,159.51
Year 11	\$ 413,965.41	\$ 138,017.28		\$ 551,982.70
Year 12	\$ 422,244.72	\$ 140,777.63		\$ 563,022.35
Year 13	\$ 430,689.61	\$ 143,593.18		\$ 574,282.80
Year 14	\$ 439,303.41	\$ 146,465.05		\$ 585,768.45
Year 15	\$ 448,089.47	\$ 149,394.35	\$ 1,345,723.00	\$ 1,943,206.82
Year 16	\$ 457,051.26	\$ 152,382.23		\$ 609,433.50
Year 17	\$ 466,192.29	\$ 155,429.88		\$ 621,622.17
Year 18	\$ 475,516.13	\$ 158,538.48		\$ 634,054.61
Year 19	\$ 485,026.46	\$ 161,709.25		\$ 646,735.70
Year 20	\$ 494,726.99	\$ 164,943.43	\$ 2,269,803.00	\$ 2,929,473.42
Year 21	\$ 504,621.53	\$ 168,242.30		\$ 672,863.83
Year 22	\$ 514,713.96	\$ 171,607.15		\$ 686,321.10
Year 23	\$ 525,008.24	\$ 175,039.29		\$ 700,047.52
Year 24	\$ 535,508.40	\$ 178,540.07		\$ 714,048.47
Year 25	\$ 546,218.57	\$ 182,110.88		\$ 728,329.44
Year 26	\$ 557,142.94	\$ 185,753.09		\$ 742,896.03
Year 27	\$ 568,285.80	\$ 189,468.16		\$ 757,753.95
Year 28	\$ 579,651.51	\$ 193,257.52		\$ 772,909.03
Year 29	\$ 591,244.54	\$ 197,122.67		\$ 788,367.21
Year 30	\$ 603,069.44	\$ 201,065.12	\$ 1,259,408.89	\$ 2,063,543.45
		Total		\$23,240,497.76

Figure 3. Sonoma County Adult Detention Behavioral Health Unit  
30-Year Life Cycle Cost

**E. Appendix A: Energy Model Analysis**

## MONTHLY UTILITY COSTS

By KITCHELL

Utility	Jan	Feb	Mar	Apr	----- May -----	June	July	----- Aug -----	Sept	Oct	Nov	Dec	Total
Alternative 1													
Electric													
On-Pk Cons. (\$)	8,677	7,327	9,533	10,459	11,041	11,217	12,414	12,035	11,001	10,222	9,439	8,398	121,763
On-Pk Demand (\$)	3,355	2,615	2,746	3,098	3,677	4,325	4,970	4,722	4,218	3,169	3,240	2,556	42,691
Total (\$):	12,032	9,942	12,279	13,557	14,717	15,543	17,384	16,757	15,219	13,391	12,679	10,954	164,454
Monthly Total (\$):	12,032	9,942	12,279	13,557	14,717	15,543	17,384	16,757	15,219	13,391	12,679	10,954	164,454

Building Area = 23,594 ft²

Utility Cost Per Area = 6.97 \$/ft²

Figure 4. Sonoma County Adult Detention Behavioral Health Unit Monthly Utility Costs

## MONTHLY ENERGY CONSUMPTION

By KITCHELL

----- Monthly Energy Consumption -----													
Utility	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Total
Alternative: 1 ADBHHU													
Electric													
On-Pk Cons. (kWh)	65,805	55,569	72,296	79,319	83,731	85,069	94,147	91,275	83,428	77,522	71,580	63,686	923,427
On-Pk Demand (kW)	131	102	108	121	144	169	195	185	165	124	127	100	195
Energy Consumption				Environmental Impact Analysis									
Building	133,579	Btu/(ft2-year)			CO2	No Data Available							
Source	400,776	Btu/(ft2-year)			SO2	No Data Available							
					NOX	No Data Available							
Floor Area	23,594	ft2											

Figure 5. Sonoma County Adult Detention Behavioral Health Unit Monthly Energy Consumption

## By KITCHELL

Figure 6. Sonoma County Adult Detention Behavioral Health Unit Quadrant 1 Load Calculations



# System Checksums

By KITCHELL

SINGLE HOUSING QUAD - 2										Variable Refrigerant Flow									
COOLING COIL PEAK					CLG SPACE PEAK					HEATING COIL PEAK					TEMPERATURES				
Peaked at Time: Mo/Hr: 7 / 16 Outside Air: OADB/WB/HR: 94 / 67 / 55					Mo/Hr: 7 / 15 OADB: 95					Mo/Hr: Heating Design OADB: 29									
Space Sens. + Lat.		Plenum Sens. + Lat	Net Total	Percent Of Total (%)	Space Sensible		Percent Of Total (%)	Space Peak		Coil Peak	Percent Tot Sens Of Total (%)								
Btu/h	Btu/h	Btu/h			Btu/h			Btu/h	Sens Btu/h	Tot Btu/h									
Envelope Loads																			
Skylite Solar	42,233	0	42,233	43	44,449	46		0	0	0	0.00	SADB	Cooling	Heating					
Skylite Cond	0	2,404	2,404	2	0	0		0	-6,206	3.13		Ra Plenum	60.6	73.1					
Roof Cond	0	14,093	14,093	14	0	0		0	-20,531	10.37		Return	78.3	65.8					
Glass Solar	2,872	0	2,872	3	3,607	4		0	0	0	0.00	Ret/OA	75.3	67.1					
Glass/Door Cond	983	0	983	1	909	1		-2,790	-2,790	1.41		Fn MtrTD	0.2	0.0					
Wall Cond	5,821	1,643	7,464	8	5,875	6		-22,950	-29,522	14.91		Fn BldTD	0.5	0.0					
Partition/Door	0	0	0	0	0	0		0	0	0	0.00	Fn Frict	1.4	0.0					
Floor	0	0	0	0	0	0		0	0	0	0.00								
Adjacent Floor	0	0	0	0	0	0		0	0	0	0.00								
Infiltration	9,401	0	9,401	10	10,933	11		-23,971	-23,971	12.11									
Sub Total ==>	61,311	18,141	79,451	81	65,771	68		-49,711	-83,021	41.93									
Internal Loads																			
Lights	15,964	3,991	19,955	20	15,964	17		15,964	19,955	-10.08									
People	20,900	0	20,900	21	11,000	11		11,000	11,000	-5.56									
Misc	0	0	0	0	0	0		0	0	0.00									
Sub Total ==>	36,864	3,991	40,855	42	26,964	28		26,964	30,955	-15.63									
Ceiling Load	4,142	-4,142	0	0	3,848	4		-5,625	0	0.00									
Ventilation Load	0	-22,230	-22,230	-23	0	0		0	0	0.00									
Adj Air Trans Heat	0	0	0	0	0	0		0	0	0.00									
Dehumid. Ov Sizing	0	0	0	0	0	0		0	0	0.00									
Ov/Undr Sizing	0	0	0	0	0	0		0	14,405	-7.28									
Exhaust Heat	0	-14,284	-14,284	-15	0	0		0	-159,595	80.60									
Sup. Fan Heat	0	0	0	0	0	0		0	-743	0.38									
Ret. Fan Heat	0	0	0	0	0	0		0	0	0.00									
Duct Heat Pkcp	0	0	0	0	0	0		0	0	0.00									
Underflr Sup Ht Pkcp	0	0	0	0	0	0		0	0	0.00									
Supply Air Leakage	0	0	0	0	0	0		0	0	0.00									
Grand Total ==>	102,317	-18,526	97,492	100.00	96,583	100.00		-28,372	-197,999	100.00									
COOLING COIL SELECTION																			
Total Capacity ton	Capacity MBh	Sens Cap. MBh	Coil Airflow cfm	Enter DB/WB/HR °F	°F	gr/lb	Leave DB/WB/HR °F	°F	gr/lb										
Main Clg	8.1	97.5	91.8	5,780	77.5	61.7	57.7	60.6	55.4	57.7									
Aux Clg	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0.0	0.0									
Opt Vent	8.1	96.9	97.3	3,512	95.0	66.9	54.6	70.0	58.3	54.6									
Total	16.2	194.4																	
AREAS										HEATING COIL SELECTION									
Gross Total		Glass ft² (%)		Capacity MBh		Coil Airflow cfm		Ent °F		Lvg °F									
Floor Part	5,205			Main Htg		-39.2		5,731		67.0									
Int Door	0			Aux Htg		0.0		0		0.0									
ExFlr	0			Preheat		0.0		0		0.0									
Roof	5,205	565	11	Humidif		0.0		0		0.0									
Wall	6,598	139	2	Opt Vent		-159.6		3,512		29.0									
Ext Door	132	0	0	Total		-198.8													

Figure 7. Sonoma County Adult Detention Behavioral Health Unit Quadrant 2 Load Calculations

# System Checksums

By KITCHELL

## SINGLE HOUSING QUAD - 3

## Variable Refrigerant Flow

COOLING COIL PEAK					CLG SPACE PEAK					HEATING COIL PEAK					TEMPERATURES		
Peaked at Time: Mo/Hr: 7 / 16					Mo/Hr: 7 / 15					Mo/Hr: Heating Design							
Outside Air: OADB/WB/HR: 94 / 67 / 55					OADB: 95					OADB: 29							
Space Sens. + Lat.	Plenum Sens. + Lat.	Net Total	Percent Of Total		Space Sensible	Percent Of Total				Space Peak	Coil Peak	Percent			SADB	Cooling	Heating
Btu/h	Btu/h	Btu/h	(%)		Btu/h	(%)				Space Sens	Tot Sens	Of Total	(%)				
<b>Envelope Loads</b>					<b>Envelope Loads</b>					<b>Envelope Loads</b>					<b>AIRFLOWS</b>		
Skyline Solar	42,233	0	42,233	43	44,449	46				0	0	0.00			Diffuser	Cooling	Heating
Skyline Cond	0	2,404	2,404	2	0	0				0	-6,206	3.13			Terminal	5,780	5,731
Roof Cond	0	14,093	14,093	14	0	0				0	-20,531	10.37			Main Fan	5,780	5,731
Glass Solar	2,872	0	2,872	3	3,607	4				0	0	0.00			Sec Fan	0	0
Glass/Door Cond	983	0	983	1	909	1				-2,790	-2,790	1.41			Nom Vent	3,512	2,668
Wall Cond	5,821	1,643	7,464	8	5,875	6				-22,950	-29,522	14.91			AHU Vent	3,512	2,668
Partition/Door	0	0	0	0	0	0				0	0	0.00			Infil	538	538
Floor	0	0	0	0	0	0				0	0	0.00			MinStop/Rh	578	578
Adjacent Floor	0	0	0	0	0	0				0	0	0.00			Return	9,830	8,937
Infiltration	9,401	0	9,401	10	10,933	11				-23,971	-23,971	12.11			Exhaust	4,050	3,206
Sub Total ==>	61,311	18,141	79,451	81	65,771	68				-49,711	-83,021	41.93			Rm Exh	0	0
<b>Internal Loads</b>					<b>Internal Loads</b>					<b>Internal Loads</b>					<b>ENGINEERING CKS</b>		
Lights	15,964	3,991	19,955	20	15,964	17				15,964	19,955	-10.08			% OA	Cooling	Heating
People	20,900	0	20,900	21	11,000	11				11,000	11,000	-5.56			cfm/ft²	60.8	46.6
Misc	0	0	0	0	0	0				0	0	0.00			cfm/ton	1.11	1.10
Sub Total ==>	36,864	3,991	40,855	42	26,964	28				26,964	30,955	-15.63			ft²/ton	321.27	
Ceiling Load	4,142	-4,142	0	0	3,848	4				-5,625	0	0.00			Btu/hr-ft²	37.35	-38.20
Ventilation Load	0	-22,230	-22,230	-23	0	0				0	0	0.00			No. People	59	
Adj Air Trans Heat	0	0	0	0	0	0				0	0	0.00					
Dehumid. Ov Sizing	0	0	0	0	0	0				0	0	0.00					
Ov/Undr Sizing	0	0	0	0	0	0				0	14,405	-7.28					
Exhaust Heat	0	-14,284	-14,284	-15	0	0				0	-159,595	80.60					
Sup. Fan Heat	0	0	0	0	0	0				0	-743	0.38					
Ret. Fan Heat	0	0	0	0	0	0				0	0	0.00					
Duct Heat Pkup	0	0	0	0	0	0				0	0	0.00					
Underflr Sup Ht Pkup	0	0	0	0	0	0				0	0	0.00					
Supply Air Leakage	0	0	0	0	0	0				0	0	0.00					
Grand Total ==>	102,317	-18,526	97,492	100.00	96,583	100.00				-28,372	-197,999	100.00					
COOLING COIL SELECTION					AREAS					HEATING COIL SELECTION							
Total Capacity	Sens Cap.	Coil Airflow	Enter DB/WB/HR	Leave DB/WB/HR	Gross Total	Glass				Capacity	Coil Airflow	Ent	Lvg				
ton	MBh	cfm	°F	°F	gr/lb	ft²	(%)			MBh	cfm	°F	°F				
Main Clg	8.1	97.5	91.8	57.5	61.7	57.7				Main Htg	-39.2	5,731	67.0	73.1			
Aux Clg	0.0	0.0	0.0	0.0	0.0	0.0				Aux Htg	0.0	0	0.0	0.0			
Opt Vent	8.1	96.9	97.3	3,512	95.0	66.9				Preheat	0.0	0	0.0	0.0			
Total	16.2	194.4								Humidif	0.0	0	0.0	0.0			
										Opt Vent	-159.6	3,512	29.0	70.0			
										Total	-198.8						

Figure 8. Sonoma County Adult Detention Behavioral Health Unit Quadrant 3 Load Calculations

## By KITCHELL

Figure 9. Sonoma County Adult Detention Behavioral Health Unit Administration Load Calculations