University of California San Diego

Rady School of Management

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Mechanical Option

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Building Information

Location: La Jolla, Ca

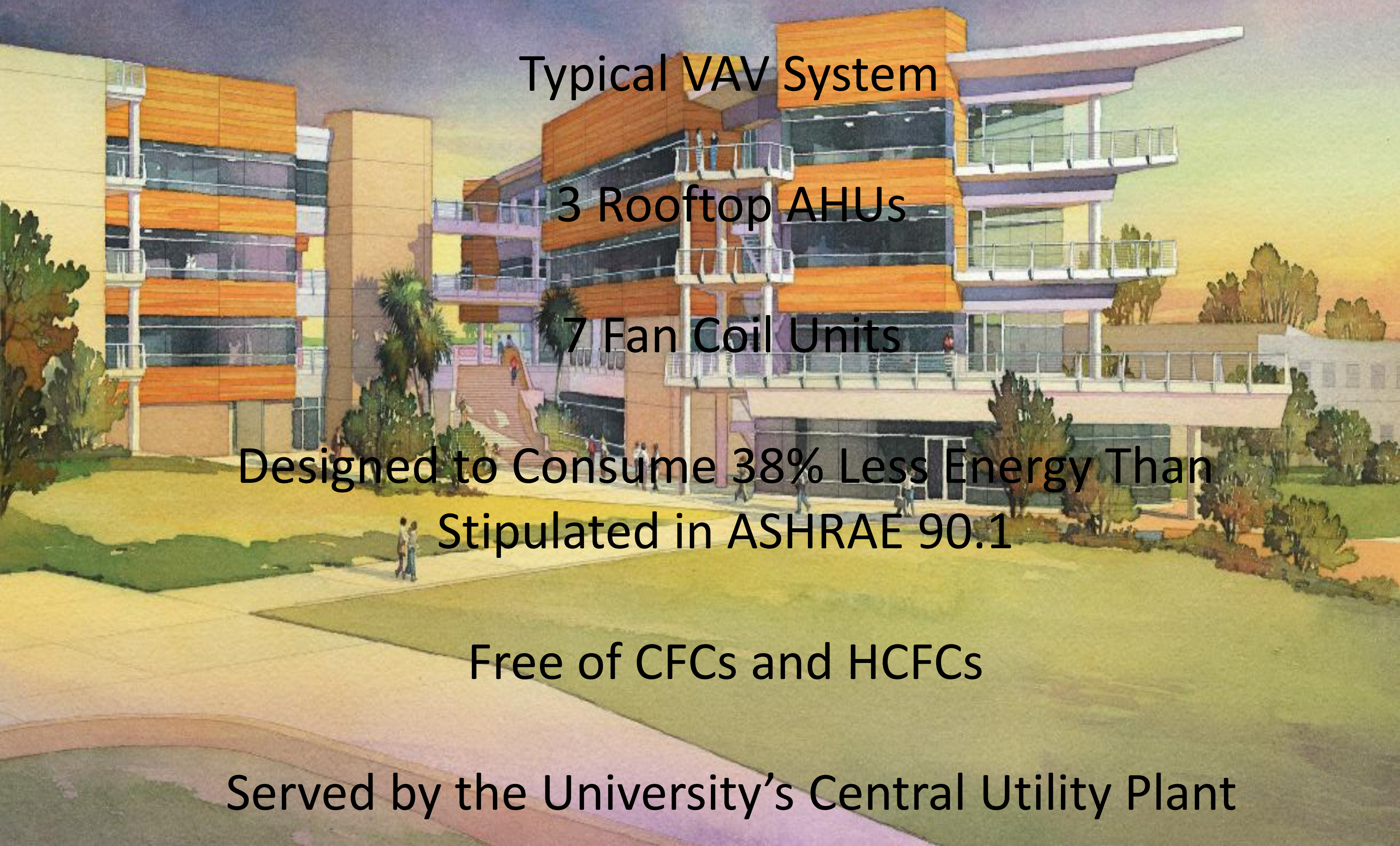
Size: 4 Stories, 101,000 SF

Cost: $35.3 Million

Delivery Method: Design-Bid-Build

Construction Dates:
September 2005 - February 2007

Existing Mechanical System



Typical VAV System

3 Rooftop AHUs

7 Fan Coil Units

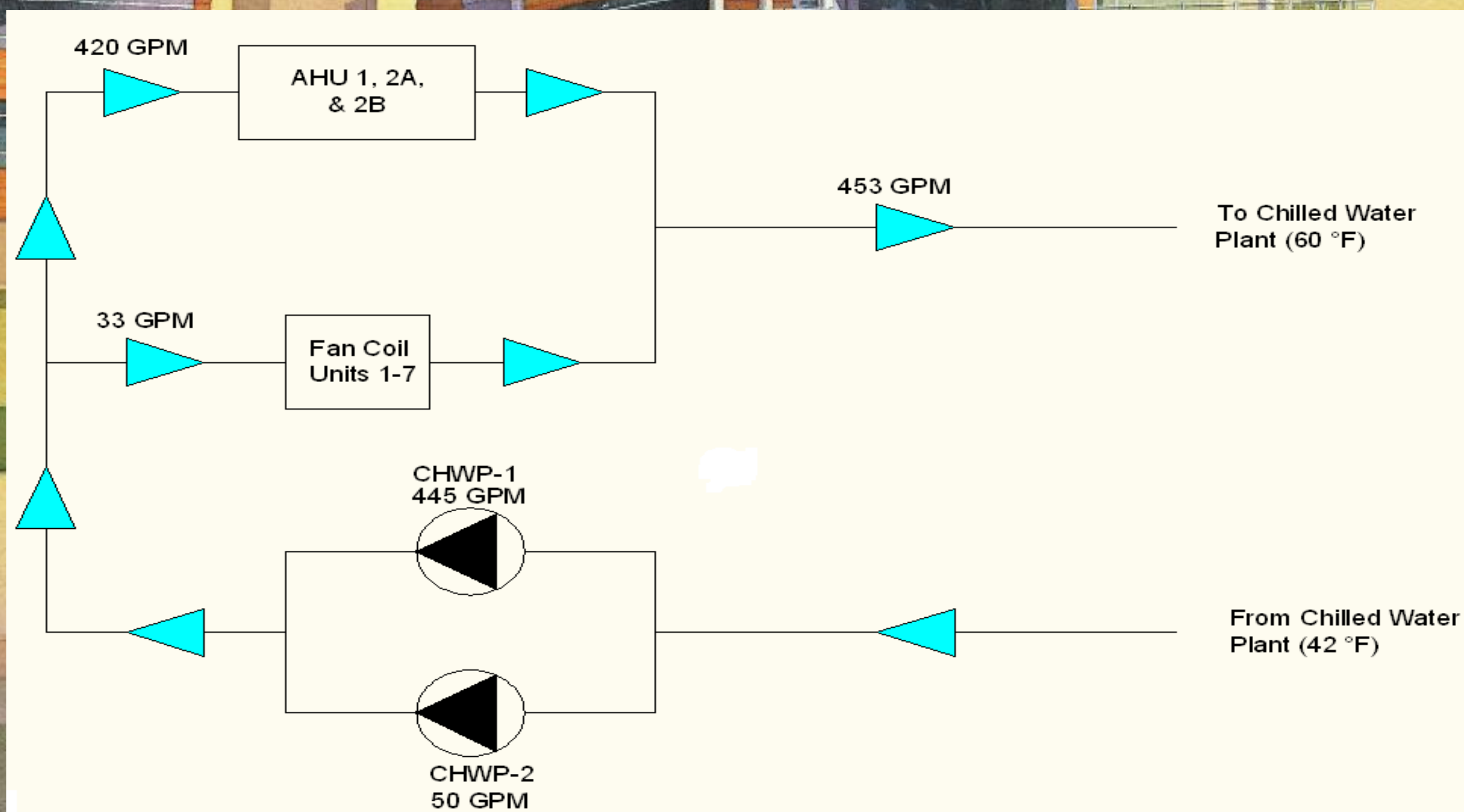
Designed to Consume 38% Less Energy Than Stipulated in ASHRAE 90.1

Free of CFCs and HCFCs

Served by the University's Central Utility Plant

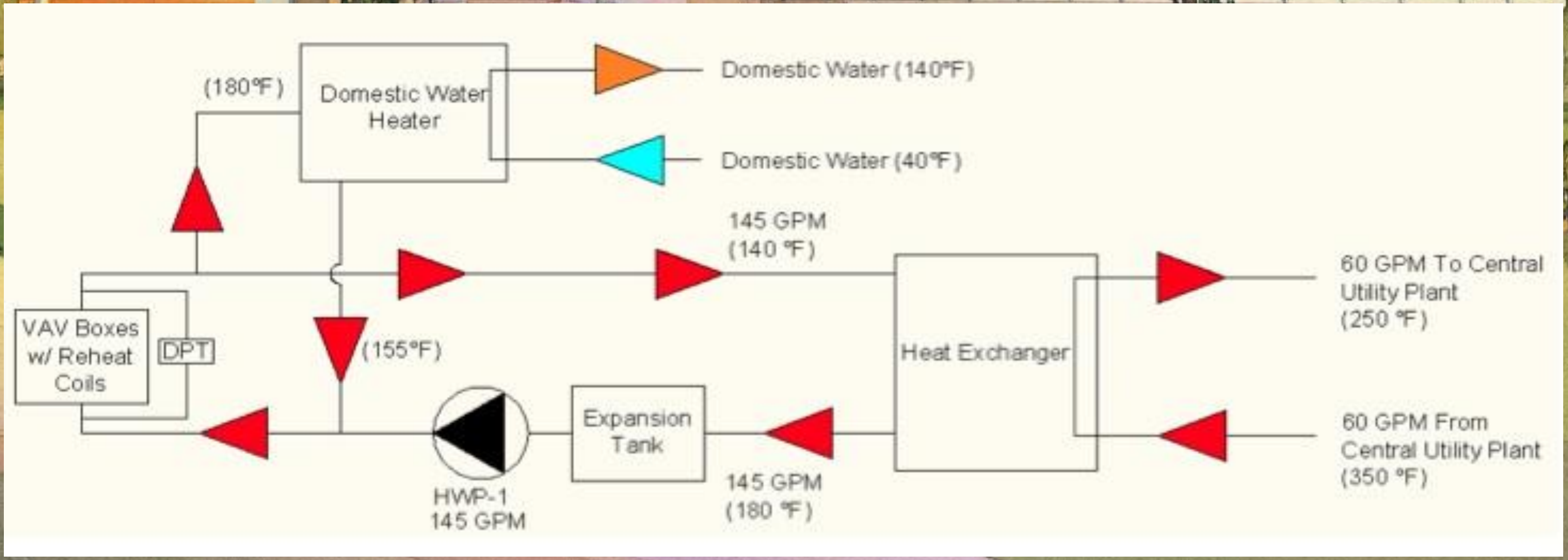
Chilled Water System

Water Supplied by CUP at 42 deg. F
445 GPM Primary Pump

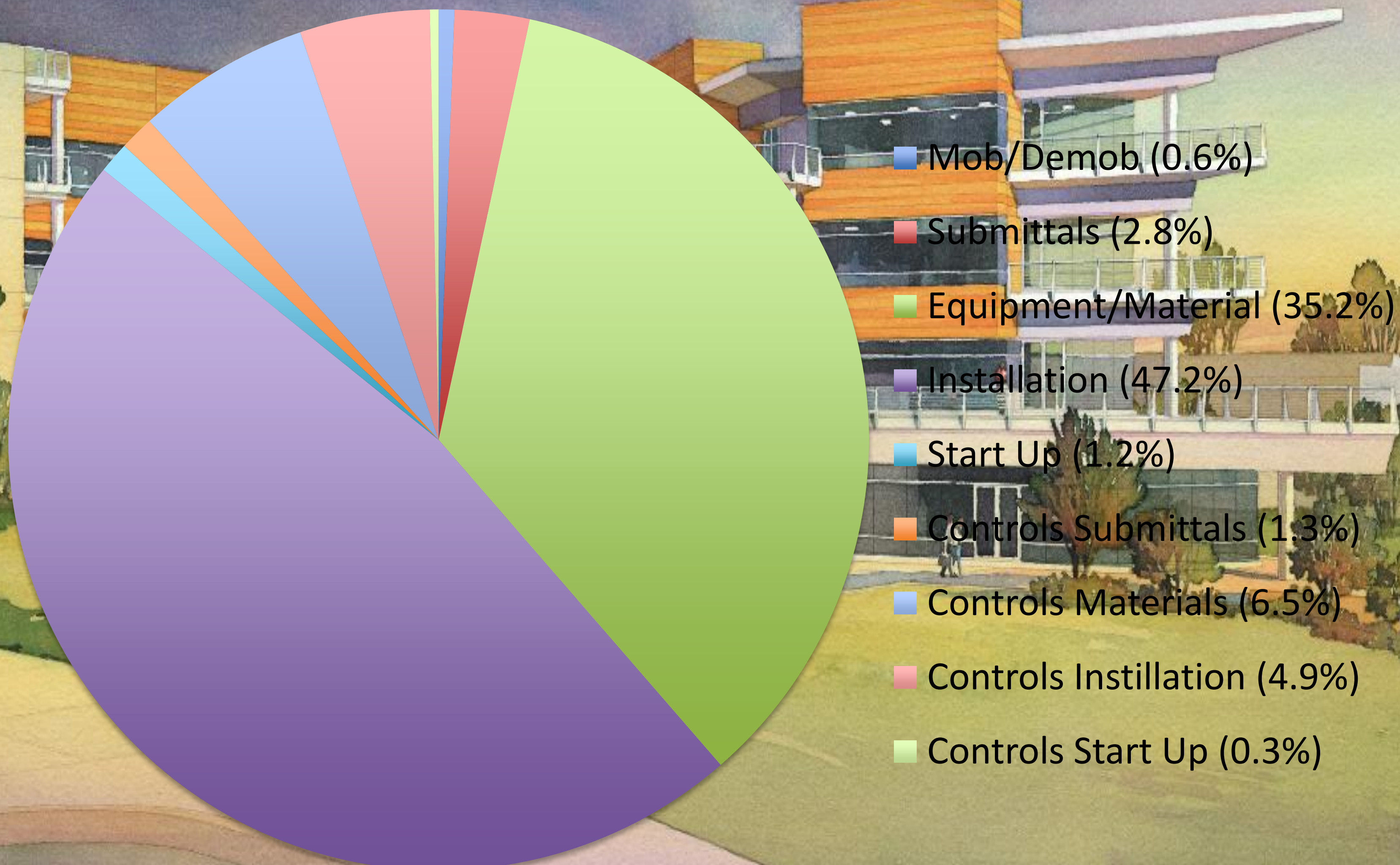


Hot Water System

Water Supplied by CUP at 350 deg. F
145 GPM Primary Pump
Bell & Gossett Shell-Tube Hx
Building Served at 180 deg. F



First Cost



Mob/Demob (0.6%)
Submittals (2.8%)
Equipment/Material (35.2%)
Installation (47.2%)
Start Up (1.2%)
Controls Submittals (1.3%)
Controls Materials (6.5%)
Controls Instillation (4.9%)
Controls Start Up (0.3%)

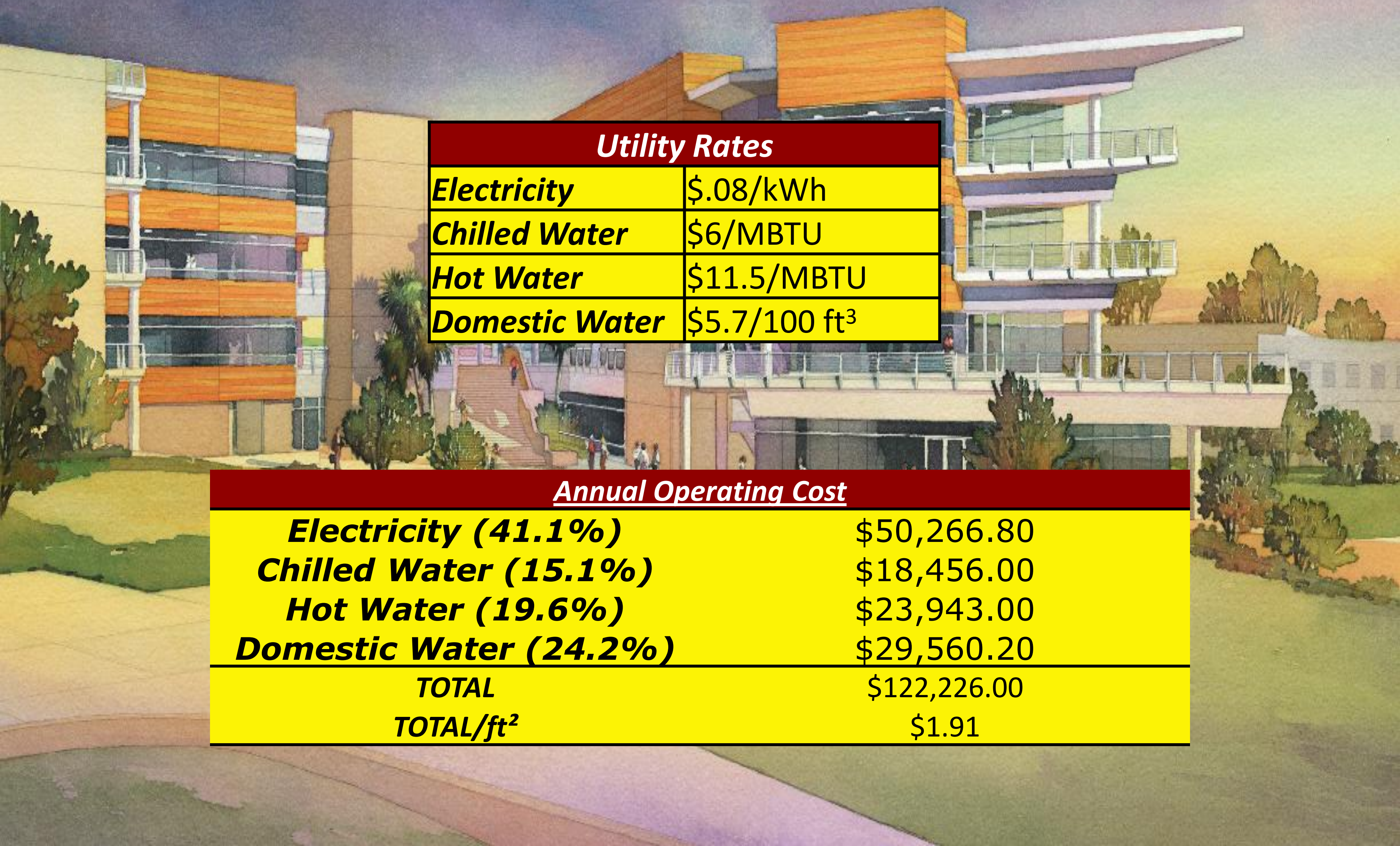
Building Loads

Cooling	
Load (ft^2/ton)	812
Supply Air (CFM/ft^2)	1.47
Ventilation Air (CFM/ft^2)	0.67

Heating Load	
Design (ft^2/ton)	578.3

Annual Energy Use (kBTU/ft^2*yr)	
Space Cooling	26.49
Space Heating	18.92
Fans	13.73
Heat Rejection	13.01
Pumps	2.76
TOTAL	**74.91**

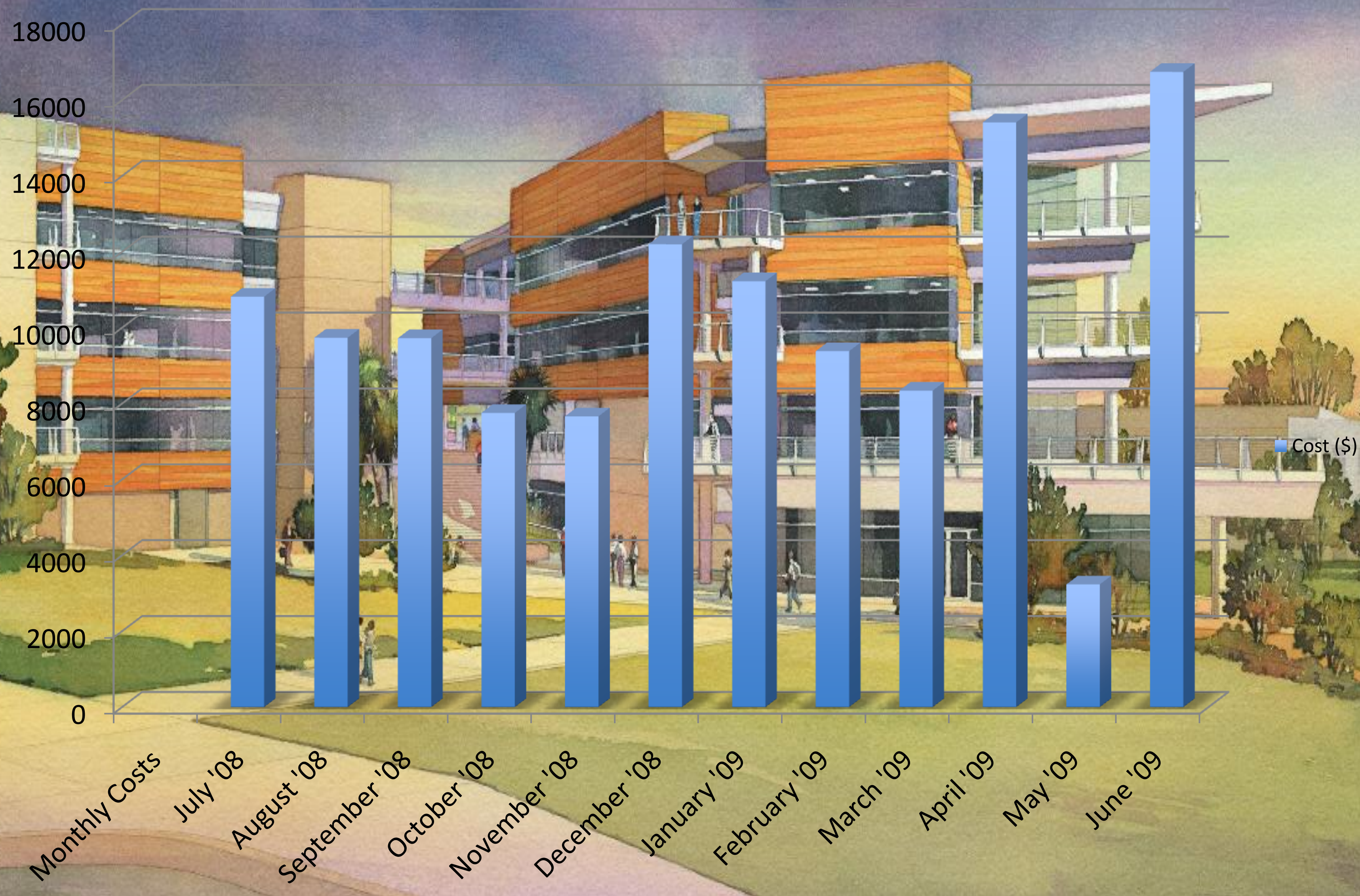
Utility Rates & Consumption



Utility Rates	
Electricity	$.08/kWh
Chilled Water	$6/MBTU
Hot Water	$11.5/MBTU
Domestic Water	$5.7/100 ft^3

Annual Operating Cost	
Electricity (41.1%)	$50,266.80
Chilled Water (15.1%)	$18,456.00
Hot Water (19.6%)	$23,943.00
Domestic Water (24.2%)	$29,560.20
TOTAL	$122,226.00
TOTAL/ft^2	$1.91

Monthly Utility Cost Breakdown



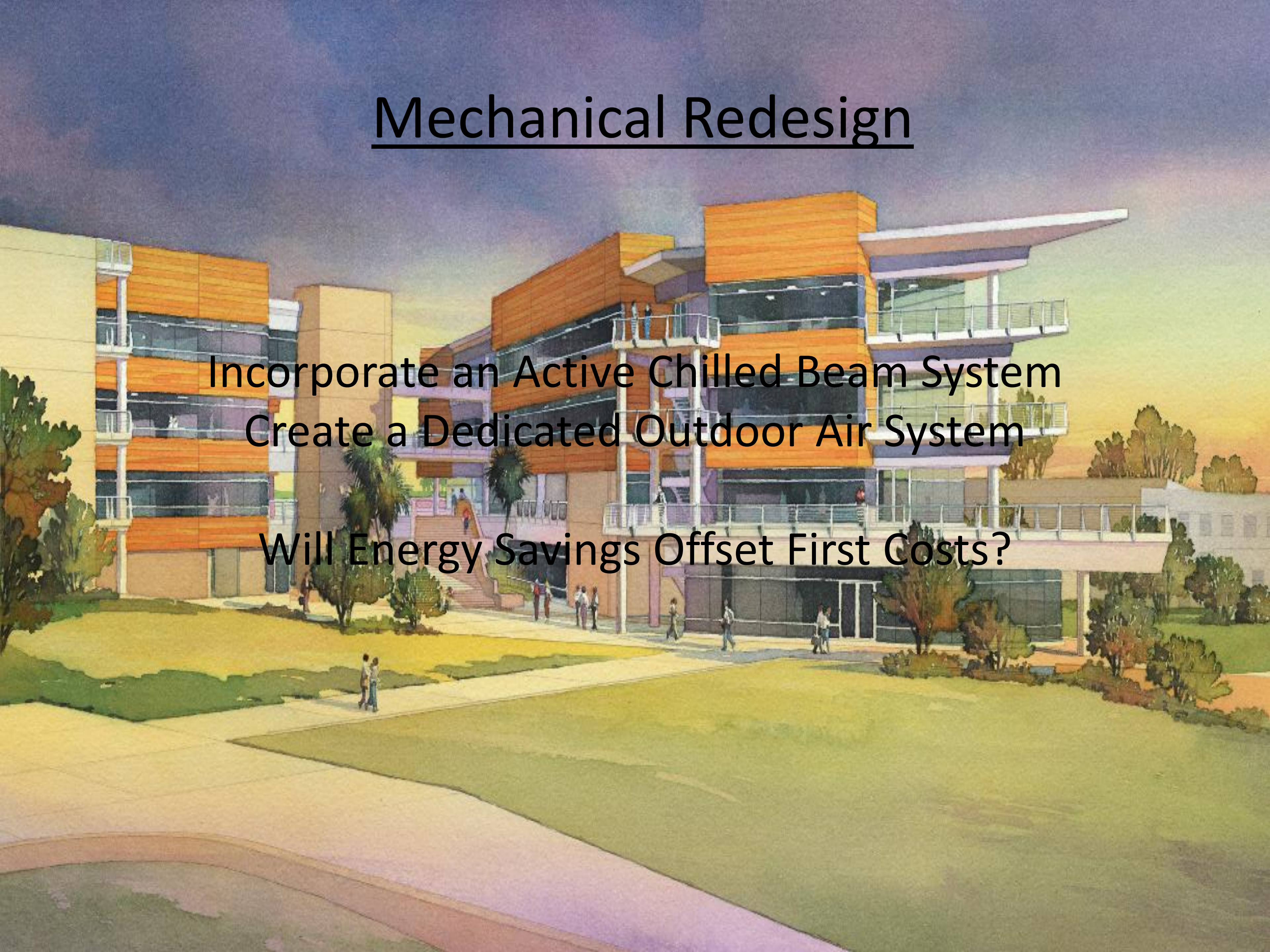
Mechanical Redesign Objectives

Reduce Operational Costs

Maintain a Reasonable First Cost

Maintain or Increase Thermal Comfort Level

Increase Indoor Air Quality

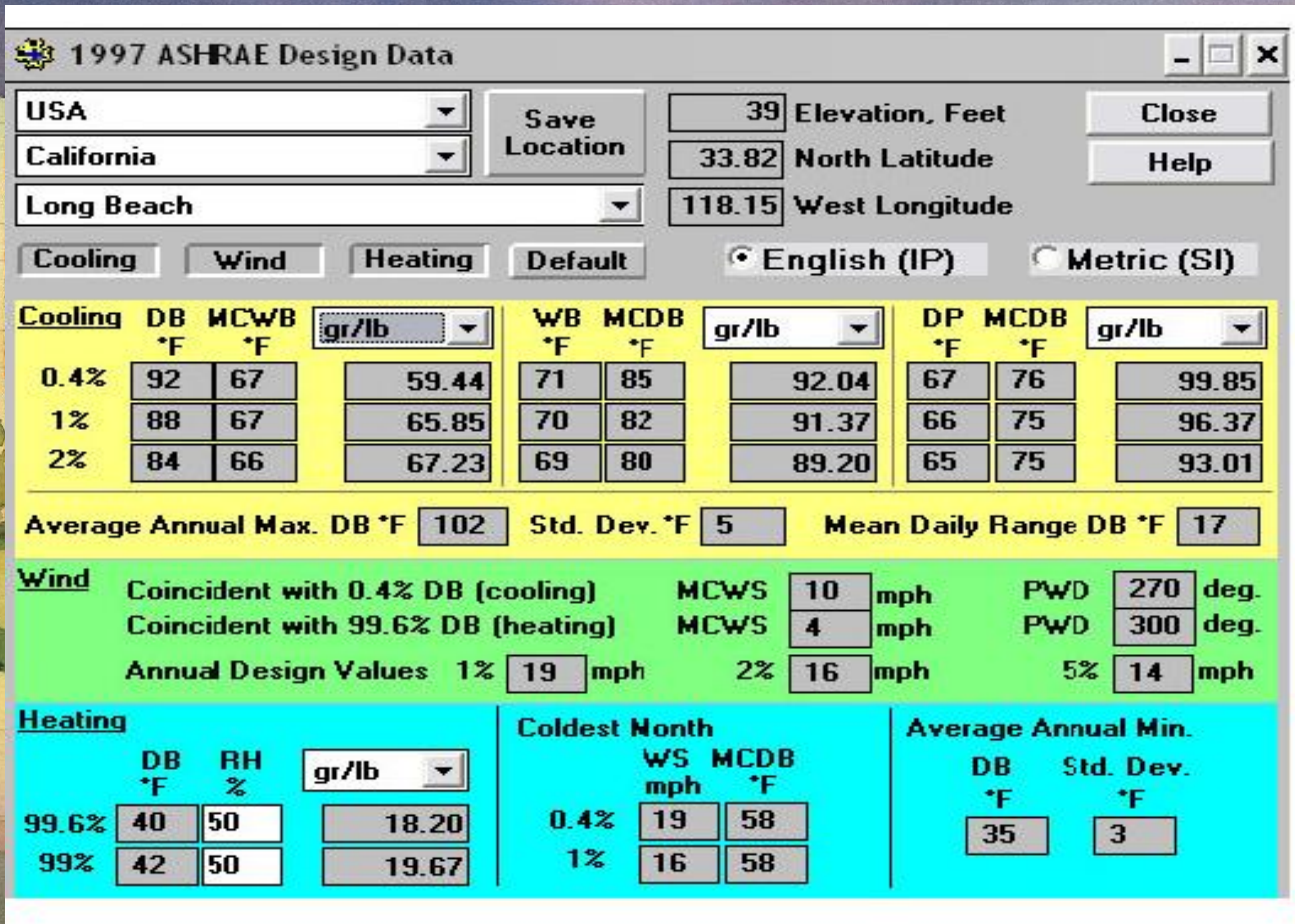


Mechanical Redesign

Incorporate an Active Chilled Beam System
Create a Dedicated Outdoor Air System

Will Energy Savings Offset First Costs?

Outdoor Air Design Conditions



1997 ASHRAE Design Data

USA
California
Long Beach

Save Location

39	Elevation, Feet
33.82	North Latitude
118.15	West Longitude

Close
Help

Cooling | Wind | Heating | Default

English (IP) | Metric (SI)

Cooling

	DB °F	MCWB °F	gr/lb	WB °F	MCDB °F	gr/lb	DP °F	MCDB °F	gr/lb
0.4%	92	67	59.44	71	85	92.04	67	76	99.85
1%	88	67	65.85	70	82	91.37	66	75	96.37
2%	84	66	67.23	69	80	89.20	65	75	93.01

Average Annual Max. DB °F 102 | Std. Dev. °F 5 | Mean Daily Range DB °F 17

Wind

Coincident with 0.4% DB (cooling)	MCWS	10 mph	PWD	270 deg.
Coincident with 99.6% DB (heating)	MCWS	4 mph	PWD	300 deg.

Annual Design Values 1% 19 mph | 2% 16 mph | 5% 14 mph

Heating

	DB °F	RH %	gr/lb
99.6%	40	50	18.20
99%	42	50	19.67

Coldest Month

	WS mph	MCDB °F
0.4%	19	58
1%	16	58

Average Annual Min.

DB °F	Std. Dev. °F
35	3

Indoor Design Conditions

Set Points	
Space Dry Bulb Temp.	79°F
Space Relative Humidity	50%
Space Humidity Ratio	74.35 gr/lb
Space Dew Point Temp.	58.8°F
ACB Surface Temp.	63°F

Supply Air Conditions

From ASHRAE 62.1: 36,200 CFM of OA Required

Wsa=Wsp-Q/(0.68Vsa)

40 gr/lb of dry air

45 Deg. F

Sensible Loads

$Q = 1.08 V_{sa} (\Delta T)$

ΔT = 34 Deg. F

ACB Cooling Capacity: 2,162 BTU/hr

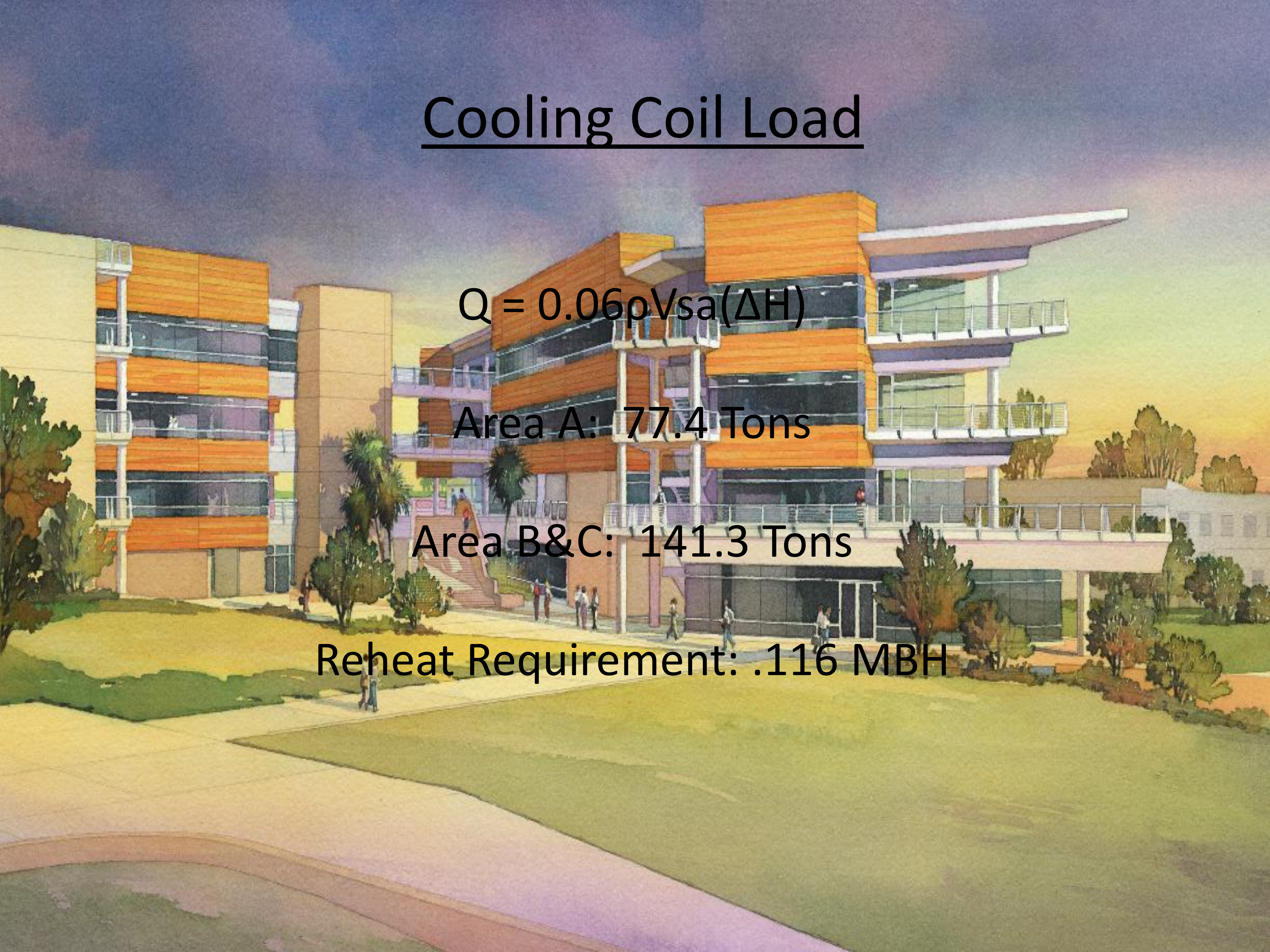
Required # of ACBs: 1,396

Pumping Requirements for ACBs

Cooling:
1,500 GPM
3,200 Ft. of Head

Heating:
1,200 GPM
1,120 Ft. of Head

Cooling Coil Load



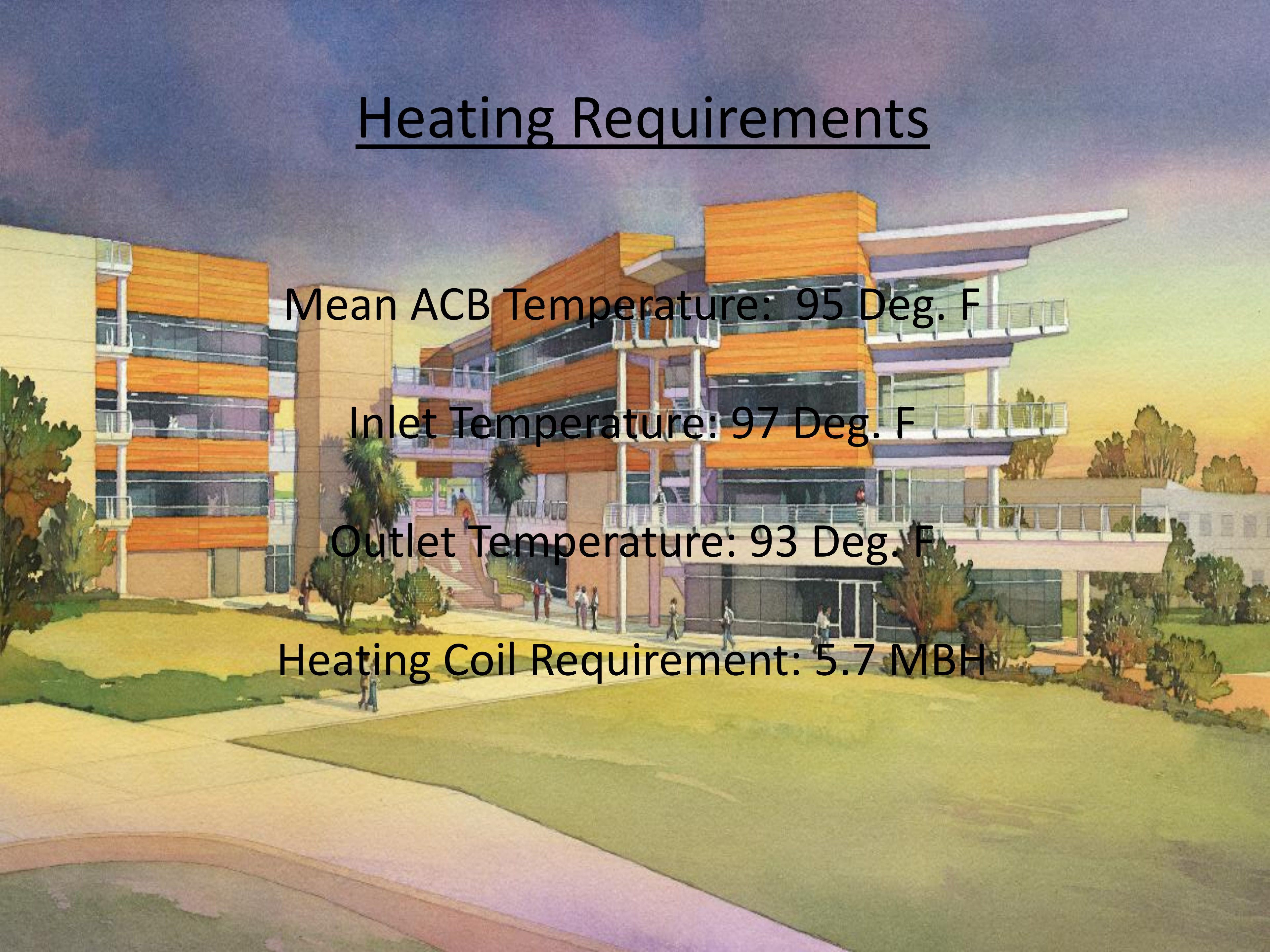
$Q = 0.06\rho V_{sa}(\Delta H)$

Area A: 77.4 Tons

Area B&C: 141.3 Tons

Reheat Requirement: .116 MBH

Heating Requirements



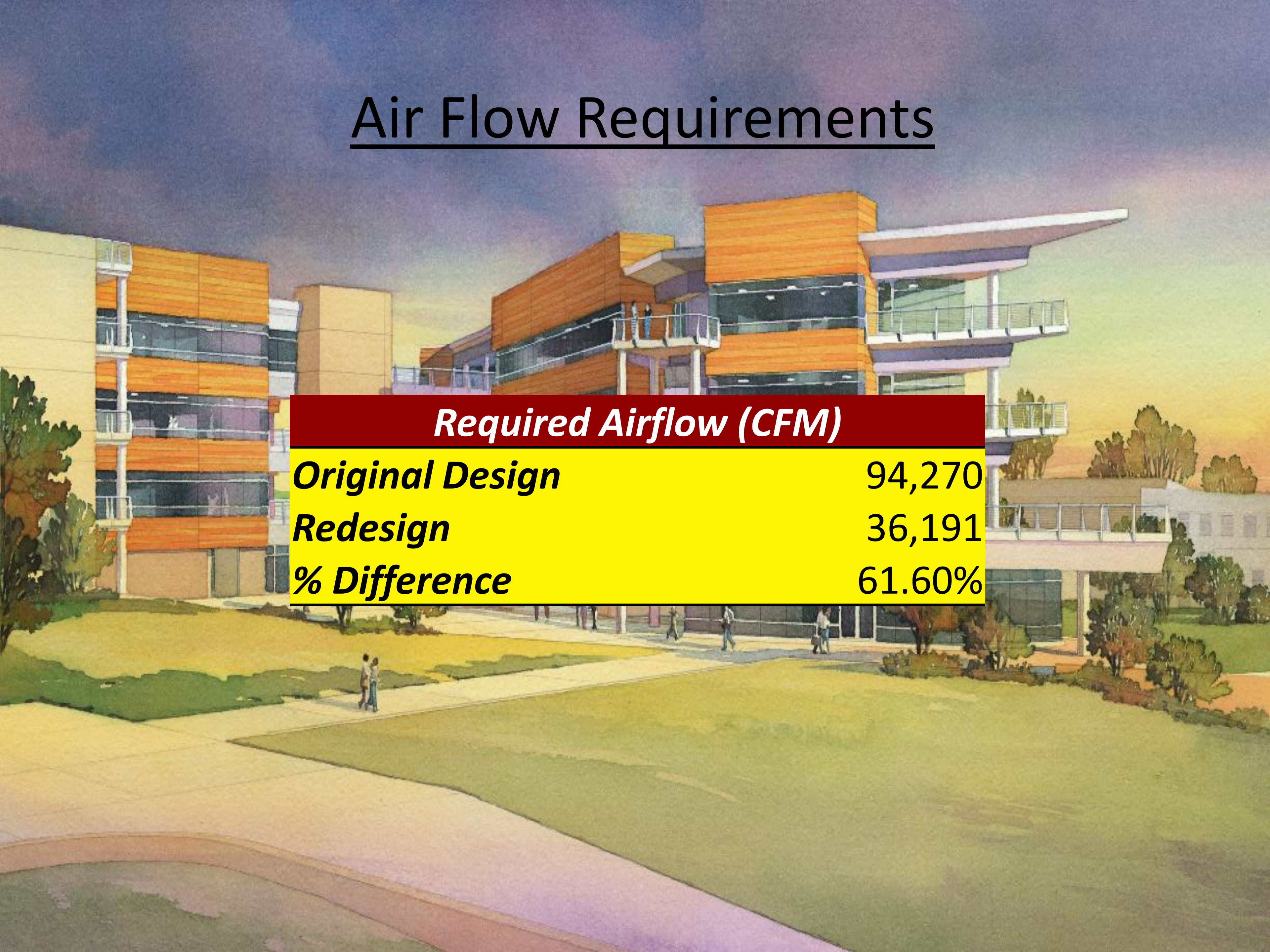
Mean ACB Temperature: 95 Deg. F

Inlet Temperature: 97 Deg. F

Outlet Temperature: 93 Deg. F

Heating Coil Requirement: 5.7 MBH

Air Flow Requirements



Required Airflow (CFM)	
Original Design	94,270
Redesign	36,191
% Difference	61.60%

Reduction of VAV Units

Savings on VAV Units				
	Old	New	Cost/Unit	Total Savings
A	0	55	$762	($41,910)
B	4	0	$773	$3,092
C	15	0	$773	$11,595
D	10	0	$810	$8,100
E	1	0	$810	$810
G	21	0	$908	$19,068
H	7	0	$1,035	$7,245
J	1	0	$1,119	$1,119
				$9,119

Fans and FCUs

Savings on FCUs			
	# of Units	Cost/Unit	Total Savings
1/2 ton	5	$1,139	$5,695
12.5 tons	1	$4,795	$4,795
			$10,490

Fan Savings	
	Savings
28,000 CFM, 20 hp	$8,355
32,000 CFM, 20 hp	$10,725
15,000 CFM, 10 hp	($5,565)
	$13,515

Pumping Requirements

CHW: 2,150 GPM & 3,650 Ft. of Head

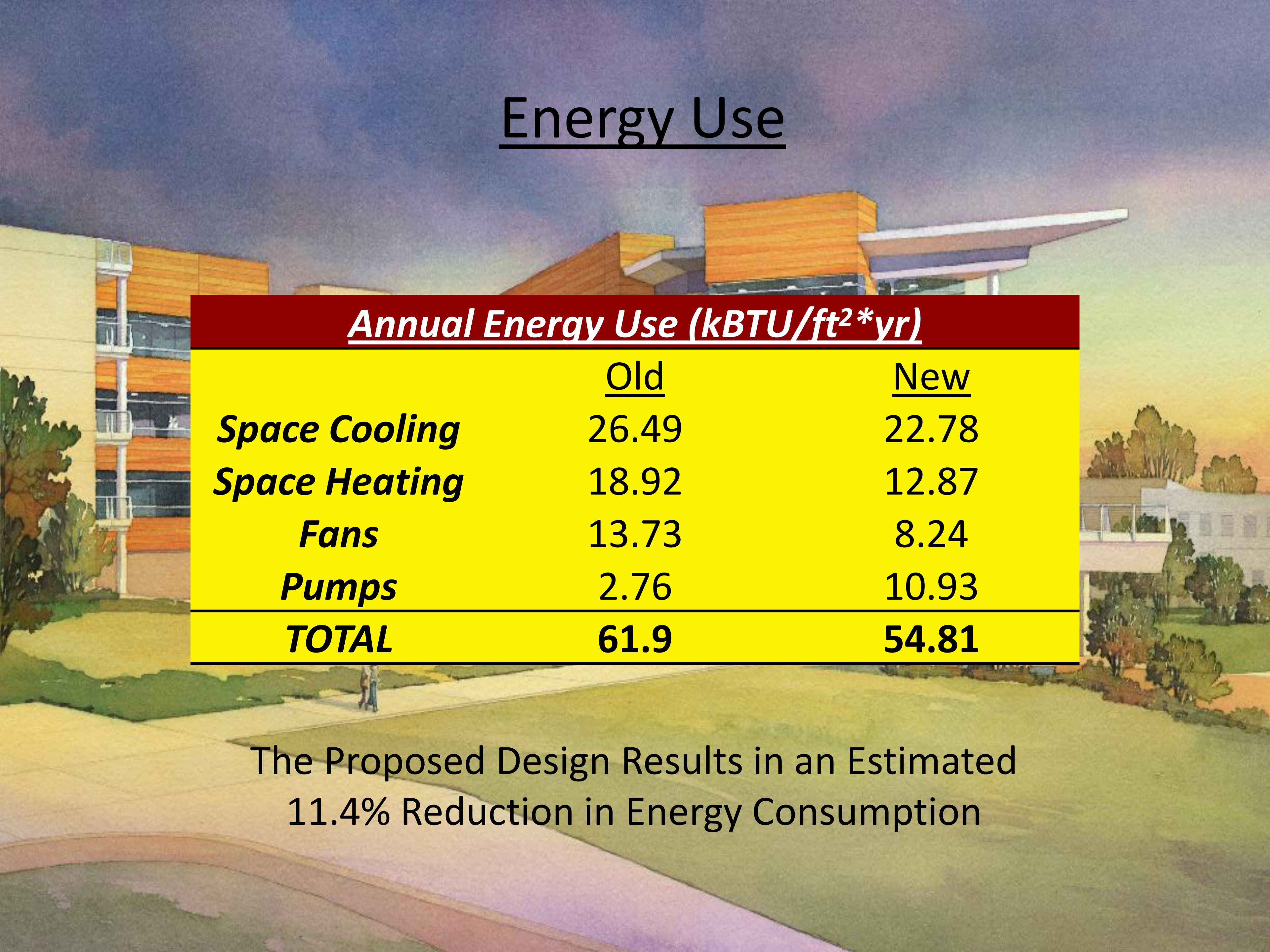
HTW: 1,450 GPM & 1,300 Ft. of Head

Pump Costs		
	# of Units	Total Cost
15 HP, Centrifugal	1	($9,930)
5 HP Centrifugal	1	($7,425)
100 HP, Centrifugal	8	$200,000
		$182,645

First Costs

Added Costs	
Equipment Type	Cost
AHUs	($56,000)
VAV Boxes	($9,119)
FCUs	($10,490)
Pumps	$182,645
Fans	($13,515)
ACBs	$558,400
	$651,921

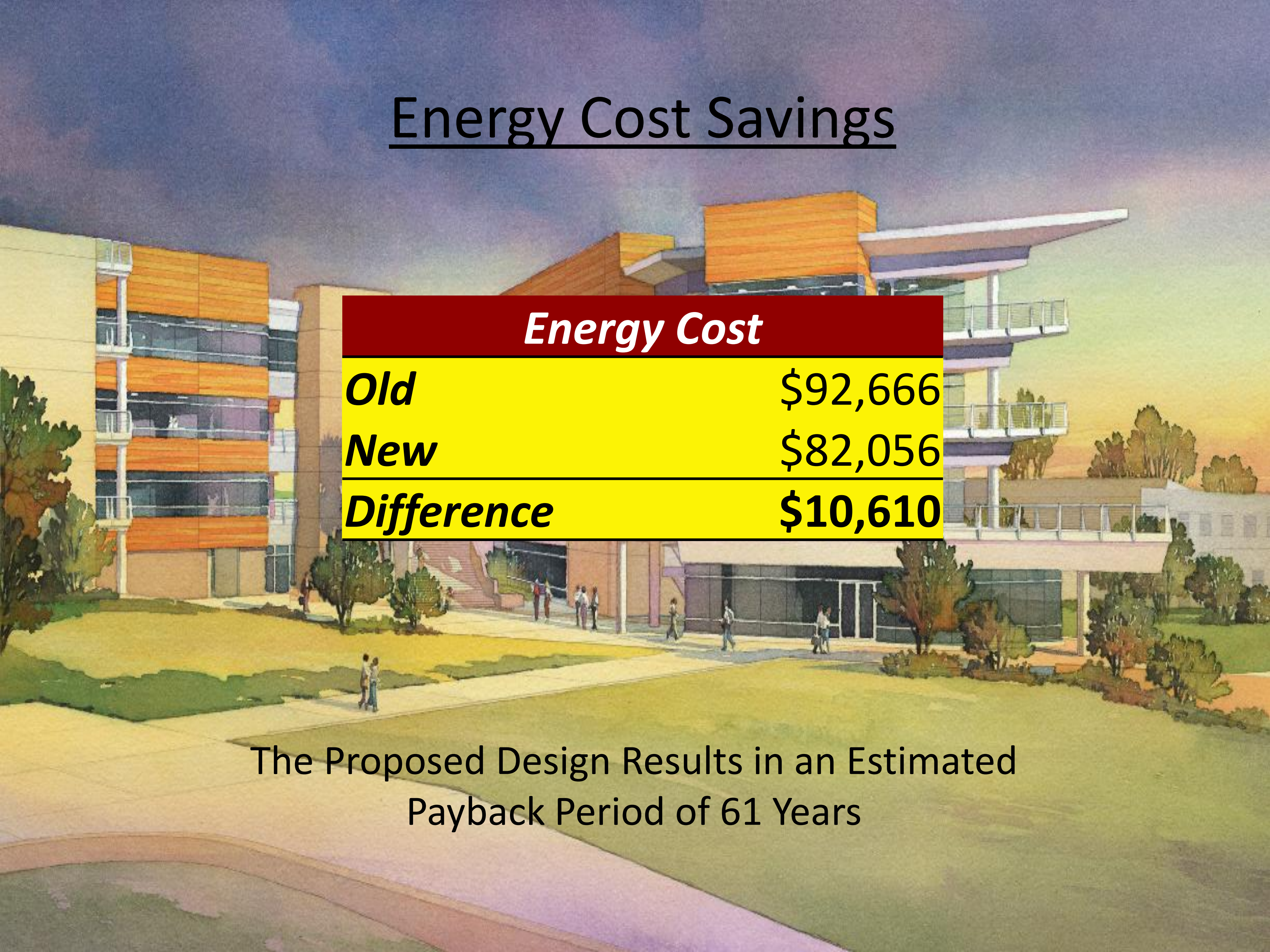
Energy Use



Annual Energy Use (kBTU/ft²*yr)		
	Old	New
Space Cooling	26.49	22.78
Space Heating	18.92	12.87
Fans	13.73	8.24
Pumps	2.76	10.93
TOTAL	**61.9**	**54.81**

The Proposed Design Results in an Estimated 11.4% Reduction in Energy Consumption

Energy Cost Savings



Energy Cost	
Old	$92,666
New	$82,056
Difference	**$10,610**

The Proposed Design Results in an Estimated Payback Period of 61 Years

Conclusion

More Energy Efficient

Higher Indoor Air Quality

Easy Maintenance

Possible Increase in Thermal Comfort Level

Operating Costs Do Not Offset First Costs Enough

NOT AN ECONOMICALLY VIABLE OPTION

Electrical Breadth

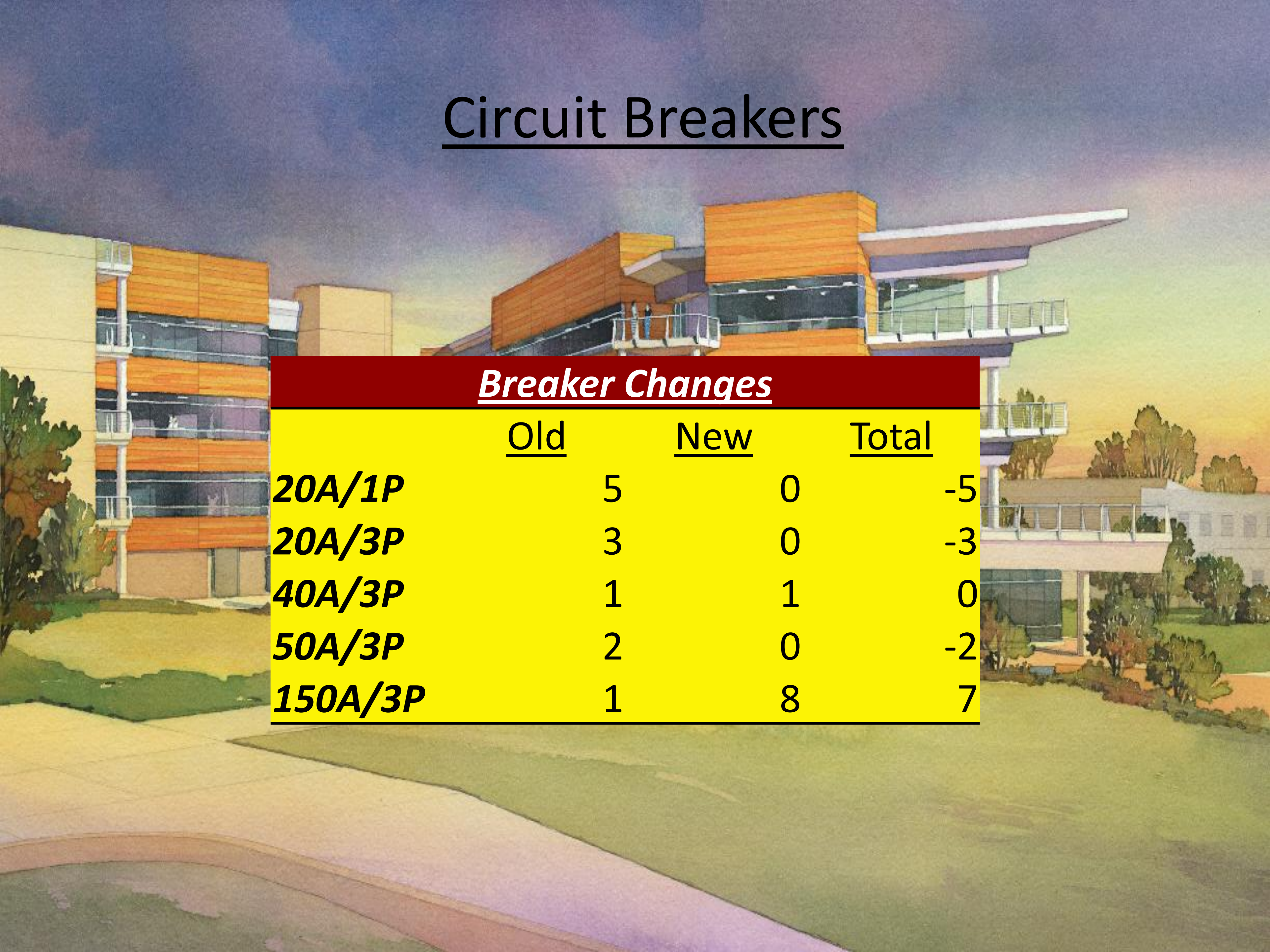
What Effect Would This System Have On The Electrical System?

Existing Equipment Connections						
Equipment	HP	Volts	PH	Fuse/Pole	Source	Wire Size
AHU-1	50	480	3	150A/3P	4MCC/1,2,3	1.25"C - 3 #2 & 1 #6 GND
RF-1	20	480	3	50A/3P	4MCC/10,11,12	3/4"C - 3 #10 & 1 #10 GND
RF-2A	20	480	3	50A/3P	4MCC/13,14,15	3/4"C - 3 #10 & 1 #10 GND
FCU-1	1/8	120	1	20A/1P	1EPB1/1	3/4"C - 3 #12 & 1 #12 GND
FCU-2	1/12	120	1	20A/1P	1EPB1/3	3/4"C - 3 #12 & 1 #12 GND
FCU-3	1/12	120	1	20A/1P	1EPB1/5	3/4"C - 3 #12 & 1 #12 GND
FCU-4	1/12	120	1	20A/1P	1EPB1/2	3/4"C - 3 #12 & 1 #12 GND
FCU-5	1/12	120	1	20A/1P	1EPB1/4	3/4"C - 3 #12 & 1 #12 GND
FCU-7	2	480	1	20A/3P	1EHA/13,15,17	3/4"C - 3 #12 & 1 #12 GND
CHWP-1	15	480	3	40A/3P	1MCC/1,2,3	1"C - 3 #8 & 1 #10 GND
HWP-1	5	480	3	20A/3P	1MCC/10,11,12	3/4"C - 3 #12 & 1 #12 GND

New Equipment Connections

New Equipment Connections						
Equipment	HP	Volts	PH	Fuse/Pole	Source	Wire Size
New RF-2A	10	480	3	40A/3P	4MCC/13,14,15	1"C - 3 #8 & 1 #10 GND
New CHWP-1	100	480	3	150A/3P	1MCC/1,2,3	1.25"C - 3 #2 & 1 #6 GND
New CHWP-2	100	480	3	150A/3P	1MCC/4,5,6	1.25"C - 3 #2 & 1 #6 GND
New CHWP-3	100	480	3	150A/3P	1MCC/7,8,9	1.25"C - 3 #2 & 1 #6 GND
New CHWP-4	100	480	3	150A/3P	1MCC/10,11,12	1.25"C - 3 #2 & 1 #6 GND
New CHWP-5	100	480	3	150A/3P	1MCC/13,14,15	1.25"C - 3 #2 & 1 #6 GND
New HWP-1	100	480	3	150A/3P	1MCC/16,17,18	1.25"C - 3 #2 & 1 #6 GND
New HWP-2	100	480	3	150A/3P	1MCC/19,20,21	1.25"C - 3 #2 & 1 #6 GND
New HWP-3	100	480	3	150A/3P	1MCC/22,23,24	1.25"C - 3 #2 & 1 #6 GND

Circuit Breakers



Breaker Changes			
	Old	New	Total
20A/1P	5	0	-5
20A/3P	3	0	-3
40A/3P	1	1	0
50A/3P	2	0	-2
150A/3P	1	8	7

QUESTIONS?