

## Introduction

Santa Clara Valley Medical Center Bed Building 1 is pursuing a LEED® Gold certification. This report addresses Energy & Atmosphere (EA) Prerequisite 2 and EA Credit 1, which establishes the energy performance of the proposed building versus a baseline building, designed per ASHRAE Standard 90.1 Appendix G, as well as EA Credit 2 On-Site Renewable Energy. Bed Building 1 must demonstrate a 14% energy cost savings to meet EA prerequisite 2 requirements. The projected energy savings of the proposed building is 24.65%, which correlates to 5 points in LEED® New Construction EA credit 1.

## Summary of Results

The baseline building for the LEED® evaluation conforms to ASHRAE Standard 90.1. The baseline system assumes a recirculation Variable-Air-Volume (VAV) air system with chilled water coil and heating hot water coil in the air-handling units, with the chiller and hot water boiler per ASHRAE Standard 90.1. The proposed system is a 100% outside air variable air volume system with chilled water air-handling units and a hot water heating loop. The energy analysis includes the therapy pool building, which assumes the designed system of a recirculation DX unit.

The total energy savings of the proposed model over the baseline model is **24.65%**. This translates to 5 LEED® credit points under EA Credit 1 Optimize Energy Performance. In addition, the SCVMC campus is building a photovoltaic (PV) system which will be dedicated to Bed Building 1. If the energy generated from the new PV system being included in the analysis, the energy savings would be **35.6%**. This translates to 8 LEED® credit points under EA Credit 1.

Moreover, the PV system accounts for 14.3% of the proposed building total energy cost. This translates to 3 LEED® credit points under EA Credit 2 On-Site Renewable Energy. However, please note that the on-site renewable energy savings are based on the current energy model and the proposed PV system designed by others, and subject to change in the future.

	Baseline	Proposed
	Cost	Cost
Electricity	\$989,162	\$741,389
Gas	\$338,659	\$259,088
Total	\$1,327,821	\$1,000,477
% Savings		<b>24.65%</b>

**Table 1: Energy Cost Savings**

	Baseline	Proposed
	Cost	Cost
Electricity	\$989,162	\$741,389
Gas	\$338,659	\$259,088
PV Panels		<b>-\$145,526</b>
Total	\$1,327,821	\$854,951
% Savings		<b>35.6%</b>

**Table 2: Energy Cost Savings including PV**

## SCVMC Bed Building Mechanical 1- LEED®

January 23, 2009

131840/TK

Page 2 of 7

	Proposed Cost
Electricity + Gas	\$1,000,477
PV Panels	\$143,000
% On-Site Renewable Energy	<b>14.3%</b>

**Table 3: On-Site Renewable Energy**

Percent Savings	Points
10.5%	1
14.0%	2
17.5%	3
21.0%	4
24.5%	5
28.0%	6
31.5%	7
35.0%	8
38.5%	9
42.0%	10

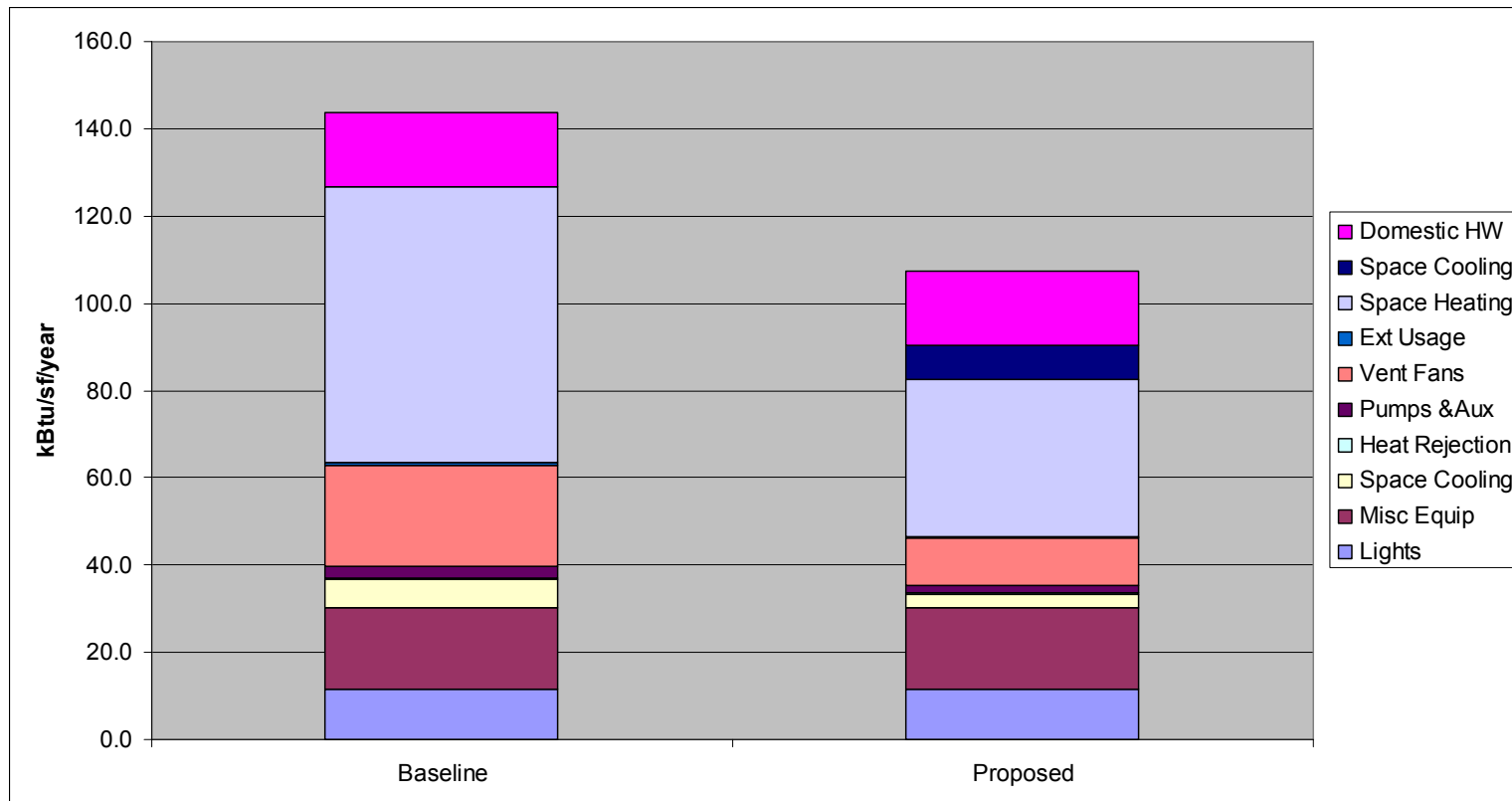
**Table 4: LEED® EA Credit 1 – Optimize Energy Performance Point Distribution**

Percent Renewable Energy	Points
2.5%	1
7.5%	2
12.5%	3

**Table 5: LEED® EA Credit 2 – On-Site Renewable Energy Point Distribution**

The climate zone, as per ASHRAE 90.1, is climate zone 3C. The climate is defined as a marine climate which consists of: (1) the mean temperature of the coldest month is between 27°F and 65°F, (2) the warmest month mean is greater than 72°F, and (3) at least four months have a mean temperature over 50°F. The climate is also characterized as having the dry season in the summer, which means that the heaviest precipitation is in the cold season. The cold season ranges from the month of October through March.

The energy savings for the proposed building versus the baseline model are largely due to the savings in heating and fan energy. Additionally, the air-handling units in the proposed building model are fitted with a 50% effective runaround coil to recover heat from the exhaust airflow. The runaround coil increases fan energy in the proposed building model because of the pressure drop across the coil but reduces the ventilation air heating load. Overall the ventilation fan energy savings shows a 54% reduction for the proposed model. The proposed 100% outside air systems allow an overall reduction of airflow thereby reducing fan energy when compared with a recirculation system. This is based on CMC-2007 Chapter 4 Table 4-A.



## Building Simulation Methodology and Assumptions

Bed building 1 was simulated using eQuest, a whole-building simulation tool that uses the DOE-2.2 thermal calculation engine. The program uses hourly weather data, actual building constructions, indoor condition set-points, and mechanical system characteristics to simulate the building loads and mechanical system energy use. As all models are approximations of reality and are based on many sets of assumptions, eQuest is considered less effective at producing absolute estimates of energy use than it is at producing relative comparisons between two different building features or systems. Relative comparisons tend to mitigate the impact of model assumptions by holding the assumptions constant between two different simulations. Absolute energy and cost results should be used only if actual utility data is available and if the model can be calibrated to reflect measured information.

### Facade

The proposed and baseline models were modeled separately. The façade is assumed to include 16.5% (7'-10" height) glazing with the following average effective properties:

- Wall U-Value: 0.052 (R-19 insulation with thermal bridging effects)
- Glazing Assembly Properties (including framing): 0.41 U-Value, 0.37 Shading Coefficient, 0.54 Visible Transmittance, 3'-0" overhang

The baseline model, based on ASHRAE 90.1 Standard, in contrast, assumes lower performance glazing (1.22 U-Value, 0.39 Shading Coefficient for all vertical glazing, and no overhang).

### Internal Loads

The internal lighting load is based upon 0.7-1.5 watts per square foot, depending on the use of the space. For instance, patient rooms were modeled at 0.7 watts per square foot and corridor spaces were modeled at 1.0 watts per square foot. The patient room exam lights were modeled as a process load as defined per LEED® NC Manual. The lighting levels in both models are based on ASHRAE 90.1 lighting power densities using the space-by-space method. There are no energy savings for Bed Building 1 due to lighting levels.

### Central Plant

The central plant serving the Bed Building 1 proposed model includes steam boilers, two (2) electric centrifugal chillers, and a two-stage absorption chiller. The boilers are modeled by the software as steam boilers with an 80% efficiency. The chillers are sequenced seasonally so that the periods from May to October and from November to April represent different operation modes. The summer months are served first by the absorption chiller; the two electric chillers sequence on together if the load exceeds that of the absorption chiller capacity. The winter months are served first by the electric chillers; the absorption chiller only cycles on if the load exceeds the capacity of the electric chillers. Since the plant is "central" and serves both buildings, it cannot be applied accurately to the individual building models with regard to partial loading and equipment part-load efficiency. As a result, the simulation has been conducted sizing the central plant "fictitiously" to appropriately serve the load in each building. This method assumes the following:

1. The equipment is appropriately sized for the anticipated building loads. At the peak cooling/heating condition, the plant is operating near full load.

The baseline model includes a central plant per ASHRAE 90.1 Appendix G. It includes two (2) water cooled electrical centrifugal chillers, a cooling tower, and two (2) heating hot water boilers.

The domestic hot water loop is modeled the same in the baseline and proposed buildings.

#### *Airside Mechanical Systems*

The baseline variable-air-volume air-handling units are sized to meet the peak internal load, with 50% outdoor air to meet the ventilation requirements based on the California Mechanical Code Table 4-A. The proposed VAV air-handling units are sized to meet the peak coincident load (takes into account load diversity), using typical internal load schedules and weather conditions, and also include no additional capacity. Thus, the baseline variable-air-volume units supply more peak airflow than the proposed units, and the first cost and energy cost increases are reflected in the results.

In the proposed building model, all 100% outdoor air units are fitted with a 50%-effective runaround coil to recover heat from the exhaust airflow. The runaround coil increases fan energy because of the pressure drop across the coil, but reduces the ventilation air-heating load. The heat recovery device modulates output with a flow bypass in the constant flow runaround loop. The proposed building model's air-handling units use the Fanwall technology, which consists of an array of small (~18-20") plenum fans in each unit. The system provides redundancy, reduces low-frequency sound levels, and provides more even flow across cooling coils and filters. The proposed system's supply fans operate at  $7.01 \times 10^{-4}$  kW/cfm and the exhaust fans at  $4.85 \times 10^{-4}$  kW/cfm at peak flow conditions. The baseline building follows ASHRAE 90.1 for the calculation of the supply fan to operate at  $1.10 \times 10^{-3}$  kW/cfm and the return fan at  $7.33 \times 10^{-4}$  kW/cfm at peak flow conditions.

#### *Therapy Pool*

As stated above, both models have the same HVAC system serving the therapy pool area on the first floor of Bed Building 1. The design promotes occupant comfort and control space humidity. The design setpoint will be 86°F with a maximum relative humidity of 60%. The HVAC system mixes outdoor and return air and uses a DX cooling coil for dehumidification. The refrigerant condenser is placed in the supply air stream to reheat the supply air. A hot water heating coil provides whatever additional heat is needed beyond what the condenser coil provides.

For a summary of the assumptions and more detail, please refer to appendix A.

### **Basis of Design Utility Analysis**

The chart below illustrates the anticipated monthly utility charge for Bed Building 1. Though actual utility rates were used and the energy simulation is very detailed, the utility bill amounts shown in the chart should be considered **approximations**. Energy simulation tools, even when populated with extensive, accurate design data, should not be used to predict actual energy costs since they are only estimates of real system behavior.

The natural gas use increases slightly in the summer because the gas boilers are supplying heat to the absorption chiller for cooling. Furthermore, the utility rates we received from SCVMC indicate that the unit price of natural gas in 2007 decreased in the temperate seasons and increased during both summer and winter. The fluctuation in resource price accounts somewhat for the seasonal variation in energy use. The actual central plant should be configured to use roughly the same amount of natural gas throughout the year.

## SCVMC Bed Building Mechanical 1- LEED®

January 23, 2009

131840/TK

Page 6 of 7

The spike in electricity cost between May and October reflects the summer and winter rate schedules offered by Pacific Gas and Electric. Site electricity use actually decreases slightly between April and May according to the energy simulation, but the increase in energy cost creates a large increase in overall energy cost.

	Proposed Model-100% OA VAV			Baseline Model-VAV Recirc		
	Electricity	Gas	Total	Electricity	Gas	Total
JAN	\$46,466.39	\$23,110.20	\$69,576.59	\$59,599.16	\$35,132.40	\$94,731.56
FEB	\$43,435.70	\$20,218.50	\$63,654.20	\$57,266.03	\$30,573.00	\$87,839.03
MAR	\$47,794.20	\$22,012.20	\$69,806.40	\$62,822.68	\$33,129.00	\$95,951.68
APR	\$53,263.61	\$18,482.80	\$71,746.41	\$70,410.19	\$27,661.06	\$98,071.25
MAY	\$72,398.11	\$22,914.08	\$95,312.19	\$98,716.57	\$27,217.44	\$125,934.01
JUN	\$77,581.41	\$21,318.36	\$98,899.77	\$103,909.58	\$27,217.44	\$131,127.02
JUL	\$79,019.95	\$21,974.36	\$100,994.31	\$106,121.22	\$24,207.22	\$130,328.44
AUG	\$78,713.19	\$21,631.60	\$100,344.79	\$106,047.50	\$24,717.26	\$130,764.76
SEP	\$74,768.10	\$21,151.90	\$95,920.00	\$100,567.80	\$24,376.14	\$124,943.94
OCT	\$74,799.87	\$22,186.74	\$96,986.61	\$100,844.26	\$24,103.90	\$124,948.16
NOV	\$46,339.49	\$21,018.60	\$67,358.09	\$61,037.38	\$28,531.80	\$89,569.18
DEC	\$46,808.90	\$23,068.80	\$69,877.70	\$61,820.06	\$31,792.50	\$93,612.56
<b>TOTAL</b>	<b>\$741,389</b>	<b>\$259,088</b>	<b>\$1,000,477</b>	<b>\$989,162.41</b>	<b>\$338,659.16</b>	<b>\$1,327,821.57</b>

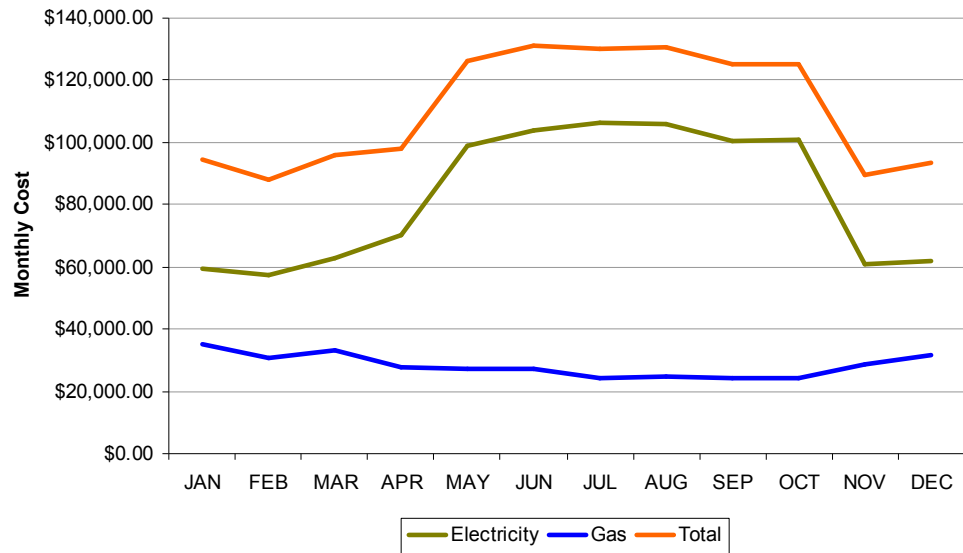
**Table 6: Annual Cost of Proposed vs. Baseline**  
(Does not account for PV System in Electricity load)

## SCVMC Bed Building Mechanical 1- LEED®

January 23, 2009

131840/TK

Page 7 of 7



## Appendix A

### 1 Assumptions

#### 1.1 Utility Rates

Pacific Gas and Electric (PG &E) electricity utility rates provided by Santa Clara Valley Medical Center were used in the model. PG&E Schedule E-20 Primary rate distribution was used. The demand and energy rates used are summarized in Table 1.

**Table 1: PG&E Schedule E-20**

Season Distribution	Total Demand Rates (\$ per kW)	Total Energy Rates (\$ per kWh)
Peak Summer	\$10.69	\$0.13141
Part-Peak Summer	\$2.47	\$0.08914
Off-Peak Summer	\$5.84	\$0.07088
Part-Peak Winter	\$0.64	\$0.07667
Off-Peak Winter	\$5.84	\$0.06743

The gas rates used were based on historic rates supplied by SCVMC and include transmission and energy costs. Energy simulation tools, even when populated with extensive, accurate design data, should not be used to predict actual energy costs since they are only estimates of real system behavior.

**Table 2: SCVMC Gas Rate**

Season	Simplified Energy Rate (\$/therm)
Summer gas rate	\$0.82
Winter gas rate	\$0.90

#### 1.2 Inputs: Building Envelope and Loads

The following tables outline the differences in the building envelope, electrical systems, and process loads between the two models. The baseline design inputs are based on ASHRAE 90.1 Appendix G.

**Table 3: Comparison of Building Envelope**

Envelope	Proposed Design Input	Baseline Design Input
Above Grade Wall Construction(s)	U-0.052	U-0.124
Below Grade Wall Construction	U-0.052	C-1.140
Roof Construction	U-0.043	U-0.034
Floor Construction	U-0.941	U-0.107

Slab-On-Grade Floors	U-0.941	F-0.730
Window-to-Gross Wall Ratio	16.5%	16.5%
Fenestration Type(s)	Viracon Vision Glass	Requirements as per Table 5.5-3
Fenestration U-factor	0.41	1.22
Fenestration Assembly SHGC	0.37	0.39
Fenestration Visual Light Transmittance	0.54	0.54
Fixed Shading Devices	3'-0" overhangs 2'-1" below top of window on South, East, and West Orientations.	None
Automated Movable Shading Devices	None	Same as proposed

**Table 4: Comparison of Electrical Systems & Process Loads**

Envelope	Proposed Design Input	Baseline Design Input
Ambient Lighting Power Density, and Lighting Design Description	Spaces were designed using lighting densities in 90.1, Table 9.6.1	Same as proposed
Process Lighting	Doctor exam light included in process lighting	Same as proposed
Lighting Occup Sensor Controls	None	Same as proposed
Daylighting Controls	None	Same as proposed
Exterior Lighting Power	20 kW for exterior lighting	Same as proposed
Other Process Loads	Annual pool load: 112,301 KWH	Same as proposed
Equipment Loads-Office	1.5W/sf	Same as proposed
Loads-Workstations	4.0 W/sf	Same as proposed
Loads-Patient Room	2.0 W/sf	Same as proposed
Loads-Conference	Range between 2-5 W/sf based on assumption on computer density based on people, 1 projector, and 2 screens	Same as proposed

### 1.3 Selecting Baseline System

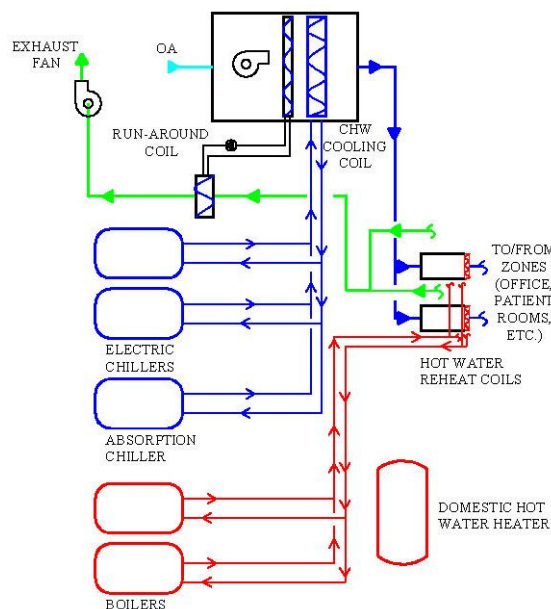
The size and use of the building defines the baseline system, as per Table G3.1.1A in ASHRAE Standard 90.1, as system 7- variable air volume (VAV) with reheat. The baseline model was defined per the budget system descriptions in ASHRAE 90.1 and also was assumed to be a recirculation air-handling unit.

### 1.4 Inputs: Mechanical and Plumbing Systems

The following tables outline the difference between the baseline and proposed models in terms of the mechanical HVAC and plumbing systems.

Mechanical & Plumbing Systems	Proposed Design Input	Baseline Design Input
HVAC System Type(s)	VAV w/Hot water reheat	VAV w/Hot water reheat
Outdoor Air	100% OA	50% OA
Design Supply Air Temperature	55°F	55°F
Fan Control	Variable Air Volume	Variable Air Volume
Fan Power	Supply Fan:0.0007013 kW/cfm Return Fan: 0.0004854 kW/cfm	Supply Fan: 0.001099 kW/cfm Return Fan: 0.000733 kW/cfm
Humidity Control	30-60% in Intensive Care Units on 2nd Floor (Gas hydronic)	Same as proposed
Heat Recovery	Run-Around Coil with 50% effectiveness	None
Economizer Control	OA Temperature 75°F	Not included because of zone size does not exceed limit (Table G3.1.2.6A)
Demand Control Ventilation	None	Same as proposed
Unitary Equipment Cooling Efficiency	None	None
Unitary Equipment Heating Efficiency	None	None
Chiller Type, Capacity, and Efficiency	(2) Elec Hermetic Centrifugal, 3.5 Mbtu/h, COP:6.8 (1) 2-Stage Absorption, 2.0 Mbtu/h, COP:1.24	(2) Elec Hermetic Centrifugal, COP:6.8
Cooling Tower	Open Tower w/ Two- Speed Fan	Open Tower w/ Two- Speed Fan
Boiler Efficiency	80%	80%
Chilled Water Loop and Pump Parameters	Design CHW Temp: 42°F Loop Design DT: 14.0°F; Pump Mech Efficiency: 77% and min speed: 0.4	Design CHW Temp: 44°F Loop Design DT: 12.0°F; Pump Overall Efficiency: 65% and min speed: 0.4

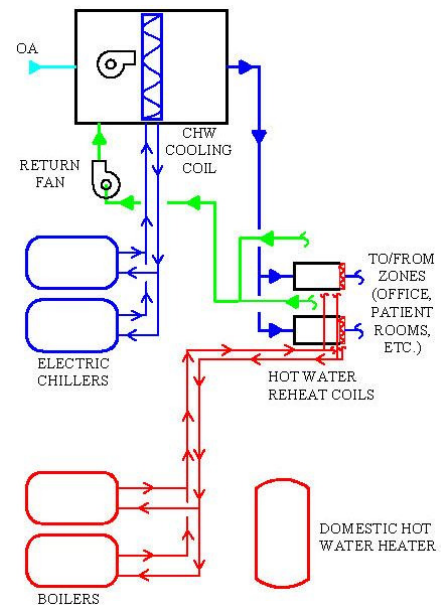
Mechanical & Plumbing Systems	Proposed Design Input	Baseline Design Input
Condenser Water Loop and Pump parameters	Design CW Temp: 78°F Loop Design DT: 10.0°F; Pump Mech Efficiency: 77% Capacity Control: One Speed Pump	Design CW Temp: 78°F Loop Design DT: 10.0°F; Pump Overall Efficiency: 60% Capacity Control: One Speed Pump
Hot Water Loop and Pump Parameters	Design HW Temp: 180°F Loop Design DT: 40.0°F; Pump Mech Efficiency: 77% Minimum Efficiency:0.40	Design HW Temp: 180°F Loop Design DT: 40.0°F; Pump Overall Efficiency: 65% Minimum Efficiency:0.40
Domestic Hot water System(s)	80% Efficiency on a domestic hot water heater	Same as proposed



**Figure 1: Proposed — VAV 100% OA with Heat Recovery**

**System Description**

Cooling: provided by chilled water cooling coil at unit with electric chillers and absorption chillers  
 Heating: Hot water Reheat provided at zone level  
 Ventilation: minimum ventilation per CMC Table 4A for 100% outside air and 4 ACH in patient rooms per comfort study



**Figure 2: Baseline — VAV Recirc with ASHRAE Central Plants**

**System Description**

Cooling: provided by chilled water cooling coil at unit with electric chillers as defined by ASHRAE 90.1  
 Heating: Hot water Reheat provided at zone level  
 Ventilation: Recirculation unit with minimum ventilation per table 4A