Technical Report Three

Mechanical Systems Existing Conditions Evaluation

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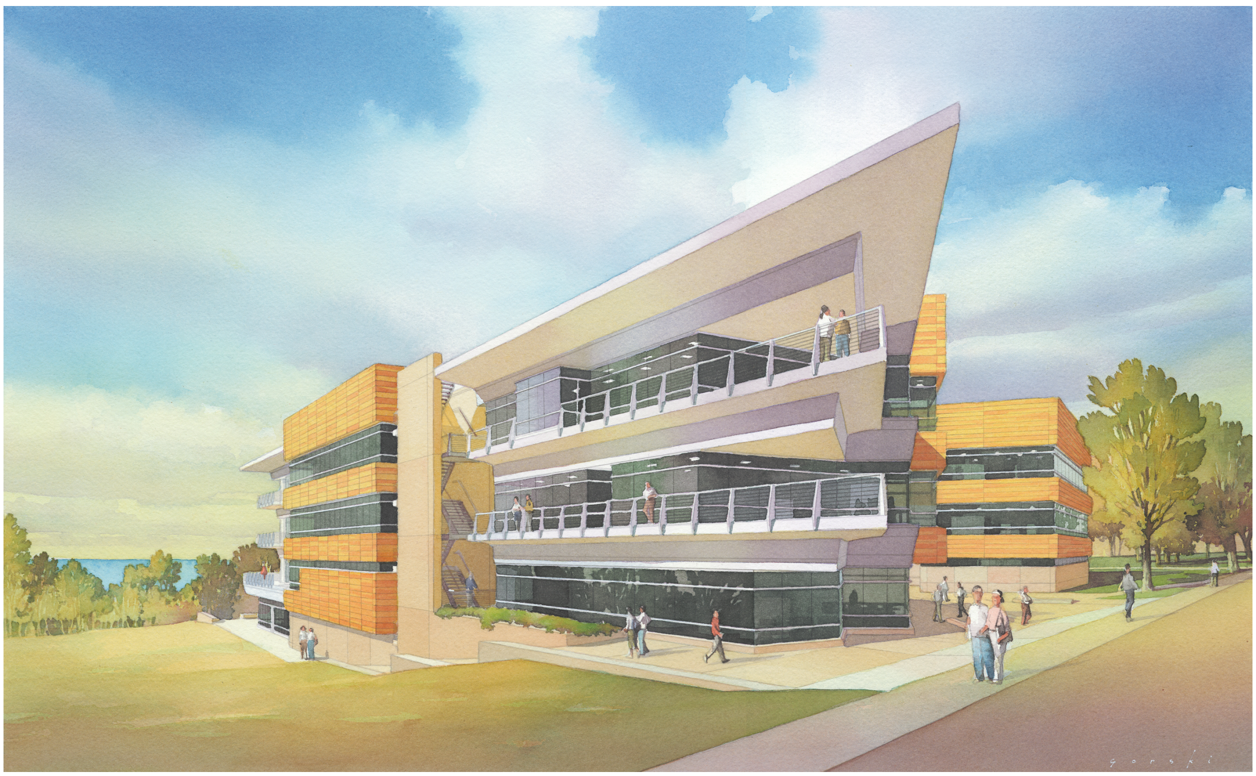

UNIVERSITY OF CALIFORNIA – SAN DIEGO

RADY SCHOOL OF MANAGEMENT

LA JOLLA, CA

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EXECUTIVE SUMMARY

This report is to evaluate overall design of the UCSD Rady School of Management's mechanical system.

It starts off with a quick overview of the building's use and the main components of the mechanical system are listed with a brief description. Then the report goes on to discuss the main design objectives and requirements.

Throughout the report, my findings from my first two technical reports are discussed and my calculations compared to that of the design engineer. After that, there is a more detailed description of the building's mechanical system and how it operates.

The report then discusses the costs of the system in terms of operation and first cost. These values were then turned into a cost per square foot of program area in order to evaluate the systems efficiency. Based on the values found, this building operates very efficiently.

A LEED-NC evaluation was then performed and determined that the building is in fact a LEED silver certification equivalent.

At the end of my report, a critique of the facility's mechanical system was done. I discuss the different aspects of the system and how well they perform. At the end of the evaluation I have provided some possible ideas to look into for redesigning next semester.

PART I

Mechanical System Overview

The UCSD Rady School of management is a roughly 91,000 SF, state-of-the-art, learning facility dedicated to the development of the next generation of science and technology business leaders. This building is home to a combination of learning/research facilities, faculty offices, and student services offices. Some sustainable design principles taken into consideration for this project were: Efficient lighting, recycled materials, and natural ventilation. In addition to these features, they plan on utilizing solar energy with photovoltaic panels that are to be installed in the future.

The mechanical load on the building will be mainly cooling load because of the building's location and usage. Air is distributed to the interior spaces by an over-head VAV system with reheat coils. The VAV system is supplied by three AHU's that are roof mounted to maximize the usable program area.

AHU's

The facility utilizes three roof-mounted air handling units with variable frequency drives. The air handlers supply air at 53^{0}F through the use of chilled-water cooling coils and utilize a minimum of 30% outdoor air. They have also been oversized in order to leave room for future expansion.

AHU-1 has a capacity of 40,000 CFM and serves the northern wing of the building, serving mainly classrooms and faculty offices. The current designed airflow is 33,660 CFM at maximum load with 19,368 CFM of outdoor air required.

AHU-2A and AHU-2B are combined into one system and work together cool the other two remaining wings of the building. These AHU's are similar to AHU-1, but they have a slightly smaller capacity. They can each handle 35,000 CFM, so together the combined system can handle up to 70,000 CFM. The current designed airflow on these air handlers is only 60,610 CFM at maximum load with 22,662 CFM of outdoor air required.

FCU's

There are a total of seven fan coil units located throughout the building. These units are located in rooms with high amounts of heat generation such as, the server room, elevator equipment room, and main electrical room, to help maintain them at the designed temperature. They are also located in the main and intermediate cross connects, which act as hubs for connecting telecommunications equipment. The FCU's take air in at 80^{O}F, cool it down to 55^{O}F and re-circulate it throughout the room in order to maintain acceptable ambient temperature.

Central Utility Plant (CUP)

The CUP is designed with one 3,000 ton York OT steam turbine driven centrifugal chiller which handles the majority of cooling requirements, as well as, a 2,000 ton York YK electric centrifugal chiller to handle peak loads and off-hour requirements. The combination of a steam and electric chillers is to provide UCSD with maximum energy efficiency and flexibility.

Chilled Water System

Chilled water is supplied by the university's CUP at 42^{O}F and circulated throughout the building by a 445 GPM base-mounted pump, as well as a 50 GPM in-line pump for off-hour loads. The chilled water supplies the 3 rooftop air handlers, as well as the seven fan coil units.

Hot Water System

Hot water is supplied by a Bell & Gossett water-to-water U-tube heat exchanger. The heat exchanger can heat 145 GPM of water from 140^{O}F to 180^{O}F with the use of high temperature water supplied by the CUP at 350^{O}F and 60 GPM. The hot water is then supplied to the building's VAV reheat coils and domestic water heater by a 145 GPM base-mounted pump.

Exhaust Fans

There are a total of 6 roof-mounted exhaust fans in the building to serve the bathrooms, electrical closets, and mechanical room. The fan serving the mechanical room moves between 600 and 2,000 CFM, and all others are designed for 4,000 CFM.

PART II

Design Objectives, Requirements, & Influences

The Rady School of Management is designed to be a state-of-the-art networking and videoconferencing facility, as well as the School of Management's education and research base. It is designed to encourage interactivity between students, business leaders, and faculty. The building's mission is to develop entrepreneurs and innovators into successful science and technology leaders.

The building is located on the northern part of campus and therefore has spectacular sights over the Pacific Ocean and surrounding mountains. The exterior glazing makes for extraordinary views, as well as provides ample daylighting.

It was a requirement of the University that this facility be designed to LEED certification standards. The facility was designed to be equivalent to a LEED silver certified building, although certification was never applied for. Later in the report an overview will be given of the LEED certification points, and verified that this facility is in fact a LEED silver equivalent.

In addition to these requirements, this building must also be designed to be in compliance with ASHRAE Standard 90.1, which deals with minimum envelope requirements, as well as defines standards for a litany of mechanical system components. Also, the minimum outdoor air requirements as defined by ASHRAE 62.1 must also be met.

As always, cost is a factor, too. There is always a desire to design a system with a small operating cost, but most of the time this means a higher first cost, which is not always desirable for the building owner. Also, this is a public building, which tend to go to the lowest bidder. In this case though, it seems they have a good balance between first cost and operational cost, probably due to design incentives. This point will be delved into deeper later in the report.

Along with all of these design criteria, it was necessary to leave extra space for expansion of the building in the future.

PART III

Outdoor and Indoor Design Conditions

The Rady School of Management is located in La Jolla, CA, which is located just south of San Diego. In order to create an energy model of the building, outdoor and indoor design condition needed to be found. The outdoor design conditions in Fig. III-1 show the data used to calculated building loads, as specified by the ASHRAE Handbook 2005.

Fig. III-1

Outdoor Design Conditions	
Latitude	32°
Longitude	117°
Elevation	50 ft
Summer Design DB	81°F
Summer Coincident WB	67°F
Summer Daily Range	10.5°F
Winter Design DB	46°F

In addition to the outdoor design conditions, the desired indoor design conditions must be established. Below, Fig. III-2 shows what these conditions are, as specified by the design documents.

Fig. III-2

Indoor Design Conditions	
Cooling Supply DB	75°F
Cooling Driftpoint	78°F
Heating Supply DB	75°F
Heating Supply Driftpoint	72°F
Relative Humidity	50%

PART IV

Design Ventilation Requirements

ASHRAE 62.1-2007 establishes the minimum outdoor air requirements for a building. An analysis of compliance to this standard was done and it confirmed that the building does provide a sufficient amount of outdoor air to maintain a healthy indoor environment. Below, Fig. IV-1 shows the outdoor air requirements calculated as calculated by me, as well as the designer's figures.

Fig. IV-1

OA Requirements (CFM)		
	AHU-1	AHU-2A&B
Designer	19,368	22,662
Calculated	17,221	19,638
% Diff	11.09%	13.34%

PART V

Lost Usable Space

An evaluation of the mechanical system layout in terms of lost usable space was done to show how well the designers maximized the program area. With the air handlers located on the roof and no on-site chillers or boilers, very little space was lost in terms of total program area. Of the roughly 90,000 ft^2 building, only 2,980 ft^2 was lost due to mechanical components. Not only that, but the main mechanical room is over-sized as of now, due to the fact that room needs to be left for expansion. Below, Fig. V-1 shows the breakdown of lost usable space, as well as the percentage of the total building area.

Fig. V-1

Lost Usable Space (ft^2)	
Mechanical Room	1580
Vertical Mechanical Shafts	1400
Total Lost Space	2980
% of Building Area	3.31%

PART VI

Mechanical System Design and Operation

The Rady School of Management has a very simple and straightforward design. For heating purposes there is a high temperature water loop and for cooling purposes there is a chilled water loop. It is so simple because the central utility plant is in charge of delivering chilled water and high temperature water, so there is no need for an on-site chiller plant or boilers.

Chilled Water System

For cooling purposes, chilled water is delivered to the building, from the University's central utility plant, at 42^{o}F and a maximum rate of 453 GPM. Two pumps, equipped with variable frequency drives(VFDs), are then used to circulated the water to the rooftop air handling units, as well as the building's seven fan coil units. One pump is base mounted and has a maximum design capacity of 445 GPM. This pump is designed to do all of the pumping during normal operational hours. To reduce electricity consumption, there is also an in-line pump with a maximum design capacity of 50 GPM to keep water circulating to any of the building's required loads during off-hour operation.

Differential pressure transmitters (DPTs) control the VFDs that regulate the pumps' flow rates. These DPTs are located on the supply and return lines coming from each of the three air handling units. There are also DPTs located on each of the VAV boxes to regulate airflow to the zones. The FCUs are regulated by thermostats and motorized control valves.

For a schematic of the chilled water loop, please refer to Appendix A, Fig. A-1. Schedule information on the AHUs, FCUs, and VAV boxes can be found in Appendix B. Chilled water pump data can be found in Fig VI-1 below, as well as in Appendix B, Table B.3.

Fig. VI-1

Chilled Water Pump Schedule

PUMP	SYSTEM	PUMP TYPE	DESIGN CAPACITY (GPM)	DESIGN HEAD (FT)
CHWP-1	CHILLED WATER	BASE MOUNTED	445	80
CHWP-2	CHILLED WATER	INLINE	50	35

Hot Water System

For heating purposes, high temperature water is delivered to the building, from the central utility plant, at 350°F and a rate of 60 GPM. This high temperature water is designed to pass through the shell-side of the water-to-water U-tube heat exchanger to increase the temperature of the building's hot water that runs through the tube-side. The shell-side water leaves the heat exchanger at 250°F and is circulated back to the CUP. On the tube side of the heat exchanger, water enters at 140°F and a maximum rate of 145 GPM. After heat transfer between the shell and tube, the water exits the heat exchanger at 180°F. This water is used to heat domestic water, and also supply the buildings VAV box reheat coils.

The hot water is delivered to these systems by a base mounted pump with a design capacity of 145 GPM and a VFD. The VFD regulates the pump speed based on differential pressure transmitters, just like the chilled water pumps.

For a schematic of the hot water loop, please refer to Appendix A, Fig. A-2. Schedule information on the heat exchanger, domestic water heater, and VAV boxes can be found in Appendix B. Data on the hot water pump is located in Fig. VI-2 below, and can also be found in Appendix B, Table B.3.

Fig. VI-2

Pump Schedule				
PUMP	**SYSTEM**	**PUMP TYPE**	**DESIGN CAPACITY (GPM)**	**DESIGN HEAD (FT)**
HWP-1	HEATING WATER	BASE MOUNTED	145	20

PART VII

Mechanical System First Cost

Below, Fig. VII-1 shows a breakdown of the mechanical system's first cost. The mechanical system first cost was slightly over $3 million and accounted for 8.5% of the total cost of construction, which was about $3.5 million. This first cost per square foot for this facility is $47.80. This is a pretty low number in terms of the average cost of a mechanical system. This is due to the fact that there are no on-site chillers or boilers. The mechanical system is very simple and does not have many components as compared to the average facility of this size. Because of this, this system is very inexpensive.

Fig. VII-1

First Cost		
Work Activity/Equipment	Cost	Cost/SF
HVAC – Mob/Demob	$17,670	$0.28
HVAC – Submittals	$84,716	$1.34
HVAC – Equipment/Material	$1,060,719	$16.84
HVAC – Installation	$1,420,385	$22.55
HVAC – Start Up	$35,340	$0.56
HVAC Controls – Submittals	$39,249	$0.62
HVAC Controls – Materials	$196,247	$3.12
HVAC Controls – Instillation	$147,185	$2.34
HVAC Controls – Start Up	$9,812	$0.16
TOTAL	**$3,011,323**	**$47.80**

PART VIII

Design Heating and Cooling Loads

Using Trane TRACE 700, a building energy model for the Rady School of Management was created. These results were compared to the design engineer's energy model which was created using EnergyPro 3.1. Below, Fig. VIII-1,2,&3 compares the results of these two energy models.

Fig. VIII-1

Cooling			
	Calculated	Design	% Diff
Load (ft^2/ton)	549	812	32%
Supply Air (CFM/ft^2)	1.98	1.47	35%
Ventilation Air (CFM/ft^2)	0.86	0.67	28%

Fig. VIII-2

Heating Load	
Design (ft^2/ton)	578.3
Calculated (ft^2/ton)	315.3
% Diff	45.48%

Fig. VIII-3

Annual Energy Use	
	kBTU/ft^2*yr
Designed	129.47
Calculated	153.14
% Diff	18%

As you can see from the results, my energy model had a few problems. It was hard to accurately model the different loads on a building that receives all its utilities from a central utility plant. From the designer's model though, you can see that this building was designed to be very energy efficient. The total design energy consumption was calculated to be 27.9% below that of what is required by Title 24 of California's building regulations. Because it is that much lower than the Title 24 requirements it qualifies for both owner and designer incentives. A utility incentive worksheet is included in Appendix C, along with a chart showing the designed percentages of energy consumption concerned with the different types of building loads. From the incentive sheet you will see the owner received $44,475 in incentives, and the designer $14,917.

PART IX

Operating History

From the assistant campus energy manager, I was able to obtain energy utilization data along with average cost rates for each type of service required for the Rady School of Management. The data supplied was from July '08 to June '09. Below, Fig. IX-1,2,3,&4 summarize the monthly consumption for each service.

Fig. IX-1 Electricity Consumption

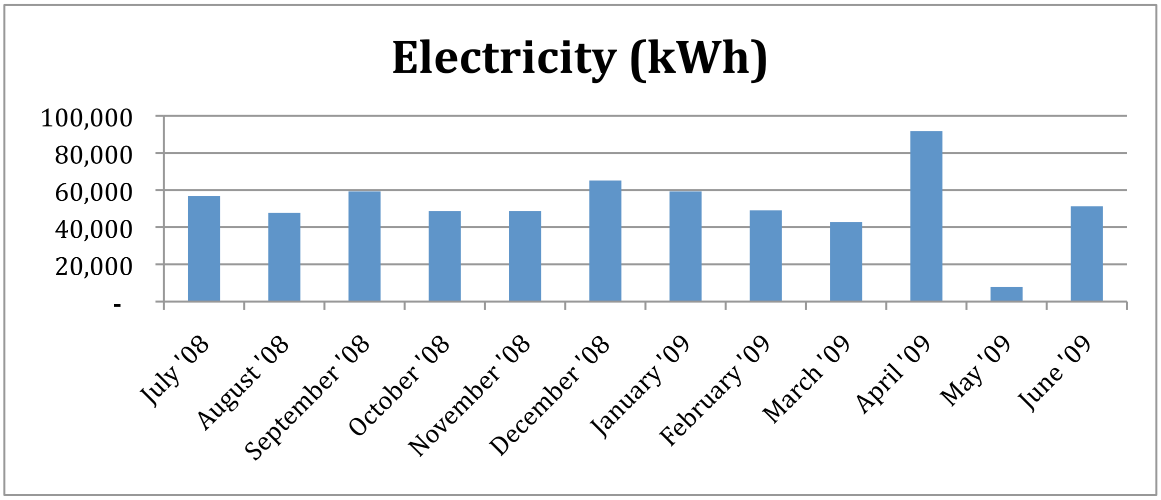


Fig. IX-2 Energy Consumption for Chilled Water

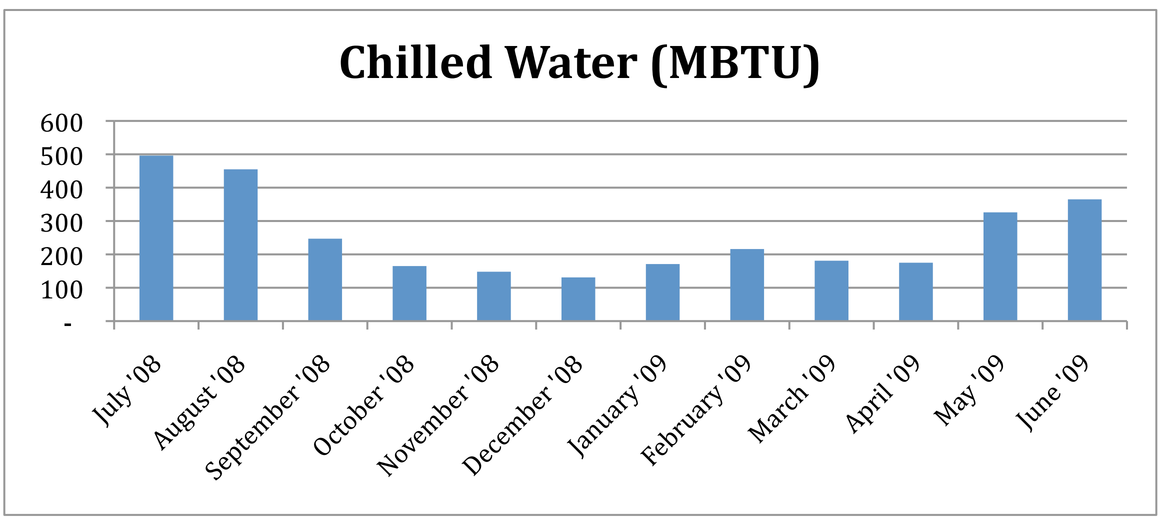


Fig. IX-3 Energy Consumption for Hot Water

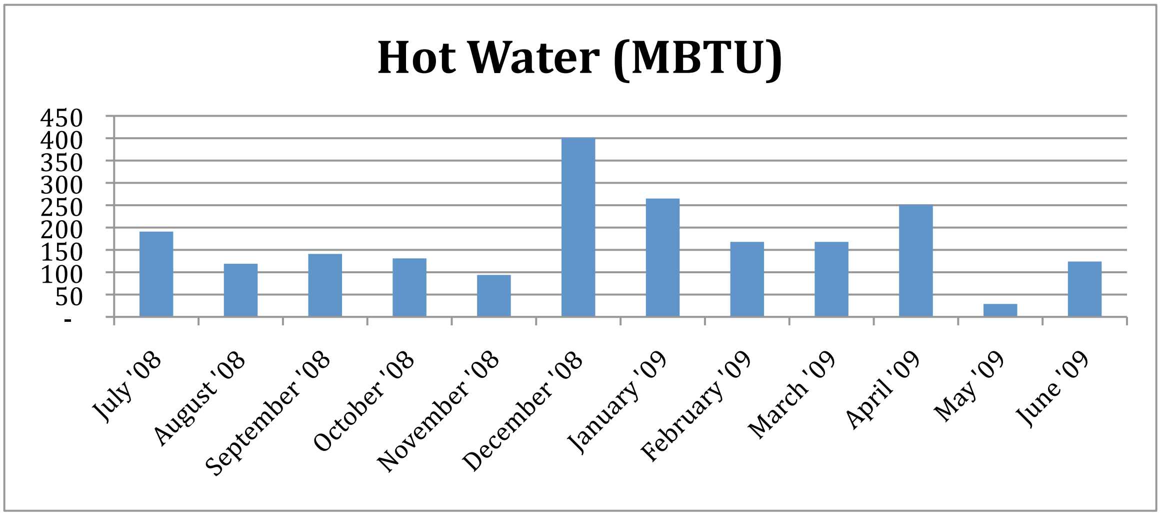
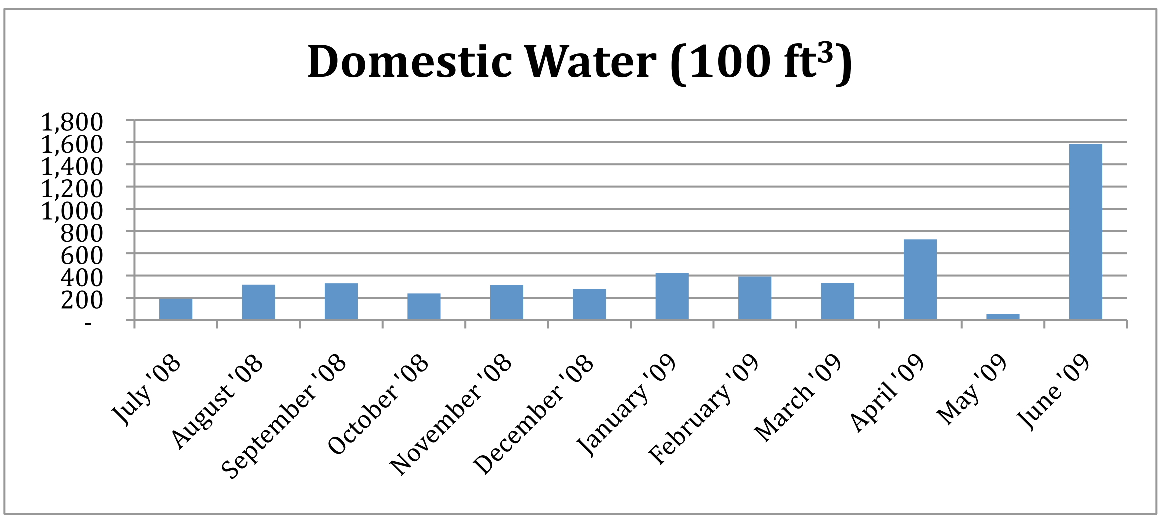


Fig. IX-4 Domestic Water Consumption



Compared to my energy model, the calculated electricity consumption was fairly close. The energy model slightly over estimated the electricity consumption, but only by 6.83%. For my other results, I was not able to deduce my other energy model results into a breakdown that would be comparable to the information I received.

PART X

Operating Costs

Energy Sources and Rates

Since the Rady School of Management is fed by the University's central utility plant, standard utility rates do not apply. The assistant campus energy manager was able to give me a breakdown of the rates for each service they receive. Below, Fig. X-1 gives these utility rates as they apply to consumption data provided.

Fig. X-1

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

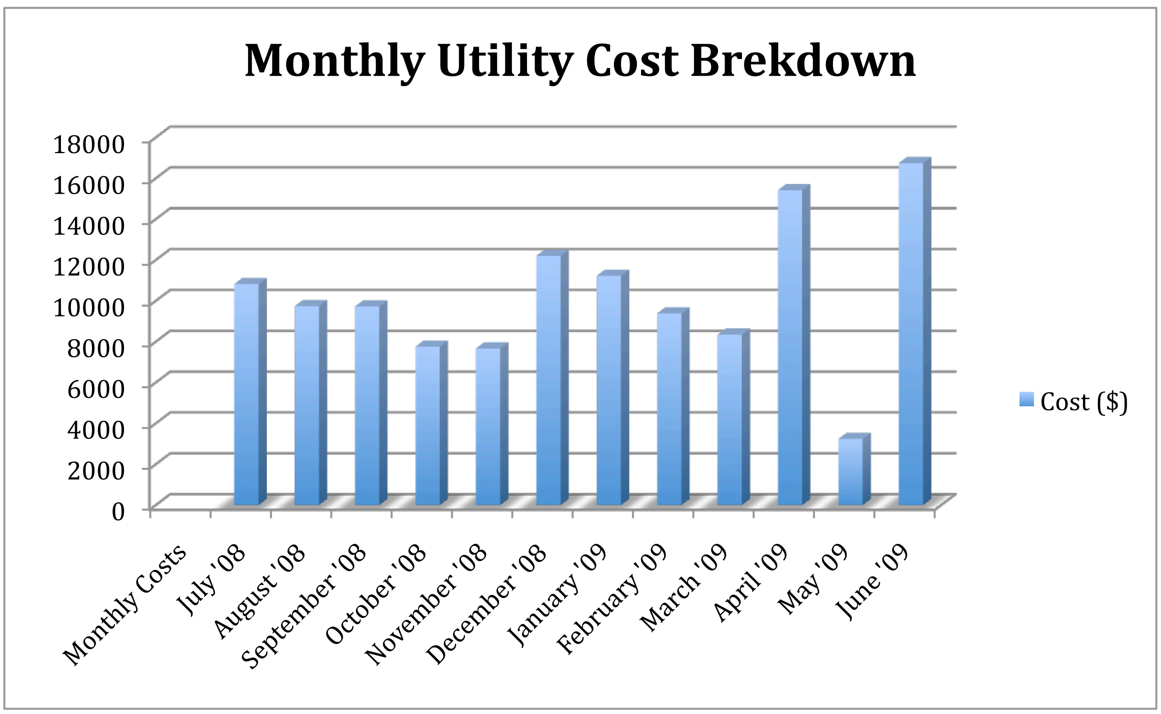
Annual Operating Cost

From rates and consumption history provided, I was able to calculate the annual cost of operation this facility from July'08 to June'09. Below, Fig. X-2 is a chart that breaks down the annual costs for each utility service. I have also provided a monthly breakdown of the cost of running this facility in Fig. X-3 on the next page. As you can see from the data, this building is very inexpensive to operate in comparison to other building of its size. This is due most likely due to the fact that the University's central utility plant supplies the building cheaply and efficiently. The quality of design also plays a big part. There is no doubt, that designing the building 27.9% above that required by Title 24 will pay off in the long run.

Fig. X-2

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/ft²	\$1.91

Fig. X-3


Monthly Utility Cost Brekdown
18000
16000
14000
12000
10000
8000
6000
4000
2000
0
Monthly Costs
July '08
August '08
September '08
October '08
November '08
December '08
January '09
February '09
March '09
April '09
May '09
June '09
Cost ($)

PART XI

LEED Credits

Project teams did not pursue LEED certification, although it was required by the university that the building be designed with LEED standards in mind. Below is a table showing the breakdown of possible LEED credits. It is shown that even though the building is not LEED certified, it is equivalent to a LEED silver certified building.

<u>Sustainable Sites:</u>

Prerequisite 1: Construction Activity Pollution Prevention - YES

Prerequisite 2: Environmental Site Assessment - YES

Credit 4.2: Alternative Transportation – Bicycle Storage and Changing Rooms
- Bicycle racks are provided within close proximity to the building access.

  Points: 1

Credit 5.1: Site Development – Protect or Restore Habitat
- An erosion and sedimentation control plan was incorporated in the contract documentation and implemented.

  Points: 1

Credit 5.2: Site Development – Maximize Open Space
- Vegetated open spaces equivalent in area to the building footprint are provided all around the building.

  Points: 1

Credit 7.1: Heat Island Effect - Non-Roof
- Reducing heat island effect on the site. Hardscape on the site has a Solar Reflectance Index greater than 29 and a substantial area of the courtyard is shaded by trees.

  Points: 1

Credit 7.2: Heat Island Effect – Roof

- Heat island effect on the roof is reduced by the utilization of "cool roof" top cap sheet that has a high Solar Reflectance Index.

  Points: 1

Credit 8: Light Pollution Reduction

- Light pollution reduction on the site is achieved by the use of high efficacy fixtures to reduce lighting power and illumination intensity.

  Points: 1

Water Efficiency:

Prerequisite 1: Water Use Reduction – 20% Reduction - YES

Credit 1: Water Efficient Landscaping

- Water efficient landscaping is achieved by the use of native and adaptive planting compounded with efficient irrigation system.

  Points: 2 to 4

Credit 2: Innovative Wastewater Technologies

- Irrigation system has been designed to use reclaimed and treated wastewater from the County.

  Points: 2

Credit 3: Water Use Reduction

- Plumbing fixture water use reduction with the use of low flow fixtures.

  Points: 2 to 4

Energy and Atmosphere:

Prerequisite 1: Fundamental Commissioning of Building Energy Systems -YES

Prerequisite 2: Minimum Energy Performance -YES

Prerequisite 3: Fundamental Refrigerant Management - YES

Credit 1: Optimize Energy Performance

- The total energy savings for the project is 28% over that required by Title 24 and 38% over that stipulated in ASHRAE 90.1.

  Points: 1 to 19

Credit 2: On-Site Renewable Energy

- A solar array is scheduled for installation on the roof that will provide a substantial portion of the lighting load of the building.

  Points: 1 to 7

Credit 3: Enhanced Commissioning

- There was an extensive commissioning process of the building energy systems.

  Points: 2

Credit 4: Enhanced Refrigerant Management

- All HVAC systems in the project are free of hydrochloroflurocarbons and chloroflurocarbons with presence of any in the sub systems planned for a phase-out, effectively minimizing any ozone depletion.

  Points: 1

Credit 5: Measurement and Verification

- Separate metering is installed to monitor the heating and cooling requirements for the building. The gas and electric supply is also separately monitored for efficiencies.

  Points: 2

Credit 6: Green Power

- A solar array is scheduled for installation on the roof that will provide a substantial portion of the lighting load of the building.

  Points: 2

<u>Materials and Resources:</u>

Prerequisite 1: Storage and Collection of Recyclables - YES

Credit 3: Materials Reuse

- The exterior skin assembly is designed as a rain screen system with the major opaque element of the assembly being composite panels `Trespa' that has a long and useful life and can be potentially reused or relocated.

  Points: 1 to 2

Credit 4: Recycled Content

- In addition, the 'trespa' panels consist of approximately 15% post-industrial waste.

  Points: 1 to 2

Credit 5: Regional Materials

- A major area of the carpeting is manufactures in a plant located within a 500 mile radius from the jobsite.

  Points: 1 to 2

Credit 6: Rapidly Renewable Materials

- The panels are comprised of cellulose or wood fibers from harvested forests that make up 70% of its total content. Harvested forests are considered `rapidly renewable'.

  Points: 1

Indoor Environmental Quality:

Prerequisite 1: Minimum Indoor Air Quality Performance - YES

Prerequisite 2: Environmental Tobacco Smoke (ETS) Control - YES

Prerequisite 3: Minimum Acoustical Performance - YES

Credit 2: Increased Ventilation

- Meets minimum ventilation effectiveness requirements without displacement ventilation.

  Points: 1

Credit 3.1: Construction IAQ Management Plan – During Construction

- The facility has a construction indoor air quality plan.

  Points: 1

Credit 3.2: Construction IAQ Management Plan – Before Occupancy

- The facility has a post occupancy indoor air quality plan.

  Points: 1

Credit 4: Low-Emitting Materials

- The exterior Trespa panels do not contain urea-formaldehyde and is classified as a low emitting material.

  Points: 1 to 4

Credit 6.2: Controllability of Systems – Thermal Comfort

- Meets thermal comfort and permanent monitoring with an automation system that can monitor/trend all room statistics and equipment performance.

  Points: 1

Credit 7.1: Thermal Comfort – Design

- Meets thermal comfort and permanent monitoring with an automation system that can monitor/trend all room statistics and equipment performance.

  Points: 1

Credit 7.2: Thermal Comfort – Verification

- Thermal comfort has been verified.
  Points: 1

Credit 8.1: Daylight and Views – Daylight

- Daylighting is provided to 75% of all interior spaces.

  Points: 1 to 3

Credit 8.2: Daylight and Views – Views

- Panoramic views of the Pacific Ocean and the mountains
- A series of strategically placed Terraces at each level provide framed views of the waterfront

  Points: 1

Credit 10: Mold Prevention

- Mist eliminators and filters have been provided to inhibit the growth of mold.

  Points: 1

From the evaluation above, it shows that this facility could qualify for anywhere from 35-71 points. It was verified by the design team that they receive 53 points, which is eligible for LEED silver certification.

Part XII

Mechanical System Critique

After thorough evaluation of the UCSD Rady School of Management's mechanical system, it seems like the design team has done a superb job. They have created a system that works efficiently with an operating cost of only $\$1.91/ft^2$. They managed to do this while still maintaining a low first cost at $47.80. It worked in their favor that the building is supplied with cheap energy by the University's central utility plant, but even in light of this, they did not neglect to create a highly efficient system. The building exceeds the minimum requirements by a fairly large amount in several categories. It is 28% above the Title 24 requirements and 38% above ASHRAE 90.1 standards. It is no doubt a very efficient system and improving on the design will be a tough task. One thing to look into will be the feasibility of using different sustainability principals. They plan to install a solar array in the future, and evaluation of a solar system might be something to look into. Another possibility would be to add more sophisticated controls to the system, or maybe alter some architectural features.

APPENDIX A

System Schematics

Fig. A-1 Chilled Water Loop Schematic

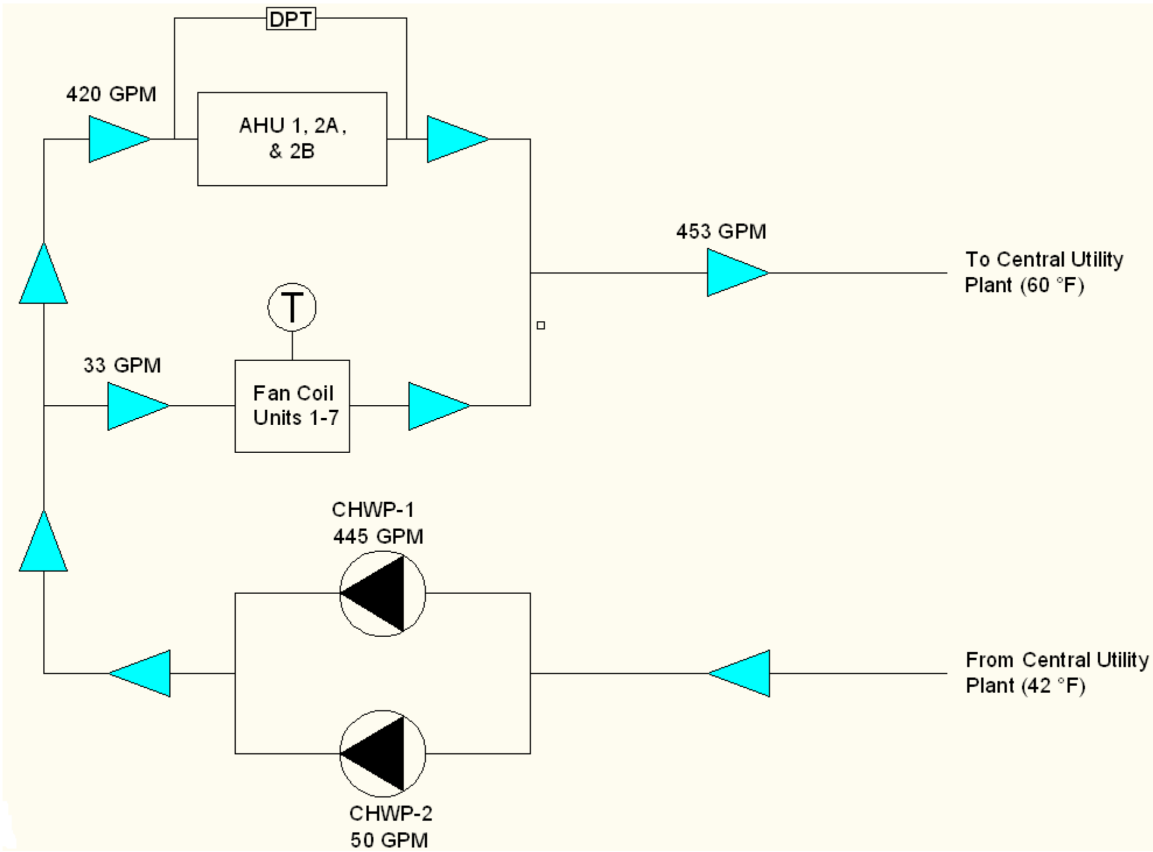
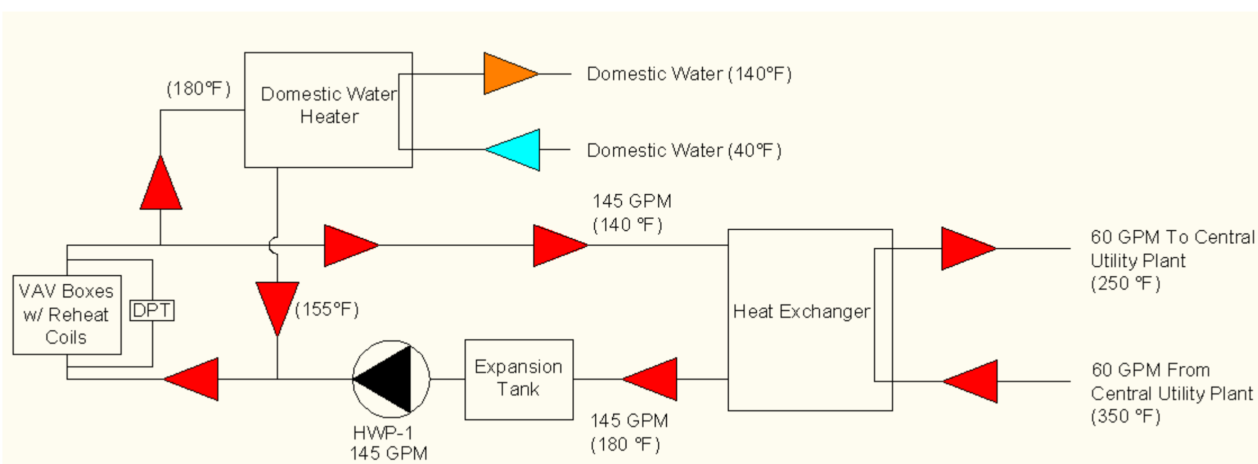


Fig. A-2 Hot Water Loop Schematic



APPENDIX B

Equipment Data

Table B.1

AIR HANDLING UNIT SCHEDULE						
UNIT	LOCATION	AIR VOL. (CFM)	SA TEMP (°F)	SUPPLY FAN PRESSURE (IN. WG.)	SUPPLY FAN MOTOR SIZE (HP)	OA VOLUME (CFM)
AHU-1	ROOF	40000	53	4.5	50	12,000
AHU-2A	ROOF	35000	53	4.5	40	10,500
AHU-2B	ROOF	35000	53	4.5	40	10,500

Table B.2

Heat Exchanger Schedule					
Fluid Type	Temp In (°F)	Temp Out (°F)	Max. PD (ft)	GPM	Pressure (PSIG)
Tube Side					
Water	140	180	5	145	400
Shell Side					
Water	350	250	5	60	150

Table B.3

Pump Schedule				
PUMP	**SYSTEM**	**PUMP TYPE**	**DESIGN CAPACITY (GPM)**	**DESIGN HEAD (FT)**
CHWP-1	CHILLED WATER	BASE MOUNTED	445	80
CHWP-2	CHILLED WATER	INLINE	50	35
HWP-1	HEATING WATER	BASE MOUNTED	145	20

Table B.4

Domestic Water Heater Schedule	
Unit	**DWH-1**
Storage Capacity (Gallons)	130
Inlet Water Temp. (°F)	40
Outlet Water Temp. (°F)	140
Heating Capacity (GPH)	480
Heating Water Inlet Temperature (°F)	180
Heating Water Outlet Temperature (°F)	155

Table B.5

Fan Coil Unit Schedule				
Unit Number	FCU-1 1st FLR	FCU-2 2nd FLR	FCU-3 3rd FLR	FCU-4
Room Served	MCC	ICC	ICC	Server
Rated CFM	425	200	200	200
ESP (IN. W.G.)	0.3	0.25	0.25	0.25
HP	1/8	1/12	1/12	1/12
Entering Air Temp DB/WB (°F)	80.5/64.5	80.5/64.5	80.5/64.5	80.5/64.5
Leaving Air Temp DB (°F)	55	55	55	55
Inlet/Outlet Water Temp (°F)	42/60	42/60	42/60	42/60
Sensible Cooling Capacity (BTUH)	7800	3400	3400	3400
Cooling Control Valve (GPM)	4	2.5	2.5	2.5
Cooling Coil PD. (ft)	5	5	5	5
Maximum NC Level	30	30	30	30

Unit Number	FCU-5	FCU-6	FCU-7
Room Served	4th FLR ICC	Elevator Equipment	Main Elec. Room
Rated CFM	200	1500	6000
ESP (IN. W.G.)	0.25	0.3	0.3
HP	1/12	.5	2
Entering Air Temp DB/WB (°F)	80.5/64.5	80.5/64.5	80/67
Leaving Air Temp DB (°F)	55	55	55
Inlet/Outlet Water Temp (°F)	42/60	42/60	42/60
Sensible Cooling Capacity (BTUH)	3400	42000	152000
Cooling Control Valve (GPM)	2.5	8	27
Cooling Coil PD. (ft)	5	5	5
Maximum NC Level	30	30	30

Table B.6

VAV Schedule	
UNIT TYPE	**CFM RANGE**
A	0-250
B	0-350
C	0-500
D	0-750
E	0-900
F	0-1000
G	0-1600
H	0-2200
J	0-2900
K	0-5600

Table B.7

AHU Fan Schedule			
Unit	RF-1	RF-2A	RF-2B
Service	AHU-1	AHU-2A	AHU-2B
Location	AHU-1	AHU-2A	AHU-2B
Max. CFM	32000	28000	28000
Min. CFM	9600	8400	8400
Static Pressure (In. W.G.)	2	2	2
Outlet Velocity (FPM)	-	-	-
Wheel Diameter (In.)	44	44	44
Fan RPM	800	750	750
Fan Type	Airfoil	Airfoil	Airfoil
Style	Plenum	Plenum	Plenum
Motor HP	20	20	20
Motor BHP	16	13.5	13.5
Motor RPM	1750	1750	1750

Table B.8

Exhaust Fan Schedule						
Unit	E-2	E-5	E-6	E-7	E-8	E-9
Service	Mech. Room	Toilet Exhaust Area A	Toilet Exhaust Area B	Elec. Closet Area A	Elec. Closet Area B	Elec. Closet Area C
Location	Roof	Roof	Roof	Roof	Roof	Roof
Max. CFM	2000	4000	4600	4000	4000	4000
Min. CFM	600	4000	4600	4000	4000	4000
Static Pressure (In. W.G.)	1	1	1	1	1	1
Outlet Velocity (FPM)	1965	2170	2065	2170	2170	2170
Wheel Diameter (In.)	13	18	20	18	18	18
Fan RPM	1700	1320	1170	1320	1320	1320
Fan Type	BI	BI	BI	BI	BI	BI
Style	Utility	Utility	Utility	Utility	Utility	Utility
Motor HP	1	2	2	2	2	2
Motor BHP	0.75	1.35	1.5	1.35	1.35	1.35
Motor RPM	1750	1750	1750	1750	1750	1750

Table B.9

Lighting Power Density					
	ENTIRE BUILDING	CLASSROOMS	OFFICES	HALLWAYS	RESTROOMS
LOAD (W/SF)	0.95	1.1	1.3	0.5	0.5

Table B.10

Lighting Loads	
TIME	LIGHTS
12 AM-6AM	5
6AM-7AM	80
7AM-8AM	90
8AM-5PM	95
6PM-7PM	80
7PM-12AM	90

Table B.11

Equipment Loads	
TIME	EQUIPMENT
12 AM-7AM	5
7AM-8AM	80
8AM-10AM	90
10AM-12PM	95
12PM-2PM	80
2PM-4PM	90
4PM-5PM	95
5PM-6PM	80
6PM-7PM	70
7PM-8PM	60
8PM-9PM	40
9PM-10PM	30
10PM-12AM	20

Table B.12

U-value	
Roof	0.033
Walls	0.054
Glass	0.3

APPENDIX C

Designed Energy Consumption

UTILITY INCENTIVE WORKSHEET — UTIL-1

SAVINGS BY DESIGN

PROJECT NAME: 60661-Rady School of Management

DATE: 10/26/2006

Step 1 — ANNUAL SOURCE ENERGY USE (kBtu/sqft-yr)

ENERGY COMPONENT	Standard	Proposed	Margin
Space Heating	25.14	18.92	6.22
Space Cooling	45.00	26.49	18.51
Indoor Fans	17.07	13.74	3.33
Heat Rejection	12.83	13.01	-0.17
Pumps	10.58	2.76	7.82
Domestic Hot Water	0.00	0.00	0.00
Lighting	38.53	27.96	10.57
Receptacle	16.75	16.75	0.00
Process	9.85	9.85	0.00
TOTALS:	175.75	129.47	46.27

Step 2 — PERCENT BELOW TITLE 24

Adjusted Source Energy Use

(Excludes Process Energy)

Standard Design		Proposed Design		Margin
165.90	-	119.62	=	46.27

Margin		Standard Design		% Below Title 24*
46.27	/	165.90	=	27.9%

* % Below Title 24 is limited to a maximum of 30% in the incentive rate calculation.

Project Eligibility	Yes	No
Owner Incentive (>=10%):	X	
Designer Incentive (>=15%):	X	

Conditioned Floor Area = 63,531 sq. ft.

Step 3 — ANNUAL SITE ENERGY USE

	Standard	Proposed	Margin
Peak Demand (kW)	411.7	271.4	140.3

The values shown here are based upon the results of an EnergyPro Compliance energy analysis that uses Title 24 profiles as specified in the Alternative Calculation Method manual.

ENERGY COMPONENT	Standard Electricity (kWh)	Standard Natural Gas (therms)	Proposed Electricity (kWh)	Proposed Natural Gas (therms)	Margin Electricity (kWh)	Margin Natural Gas (therms)
Space Heating	0	15,969	0	12,017	0	3,952
Space Cooling	279,197	0	164,372	0	114,826	0
Indoor Fans	105,889	0	85,233	0	20,656	0
Heat Rejection	79,637	0	80,721	0	-1,084	0
Pumps	65,661	0	17,111	0	48,550	0
Domestic Hot Water	. 0	0	0	0	0	0
Lighting	239,086	0	173,513	0	65,573	0
Receptacle	103,926	0	103,926	0	0	0
Process	61,119	0	61,119	0	0	0
TOTALS:	934,515	15,969	685,995	12,017	248,520	3,952

Step 4 — POTENTIAL INCENTIVE CALCULATION

SDGE — A Sempra Energy utility

		% Below Title 24* (from step 2)		Incentive Rate		Savings (from step 3)		Subtotal
Electricity	6.0¢ · [(	27.9%	- 10%) x 0.6] =	16.7 ¢ :Wh	X	248,520 kWh	=	$ 41,503
Natural Gas	34.0¢ [(	27.9%	- 10%) x 2.3] =	75.2 ¢ herm	X	3,952 therm	=	$ 2,972

Owner Incentive → ($150,000 max) = $ 44,475

Electricity	3.0¢ · [(	27.9%	- 15%) x 0.2] =	5.6 ¢ :Wh	X	248,520 kWh	=	$ 13,917
Natural Gas	15.0¢ · [(	27.9%	- 15%)x 0.8] =	25.3 ¢ herm	X	3,952 therm	=	$ 1,000

Design Team Incentive → ($50,000 max) = $ 14,917

This worksheet is for estimating potential incentives only. Contact San Diego Gas & Electric regarding the Nonresidential New Construction Program for eligibility and participation requirements.

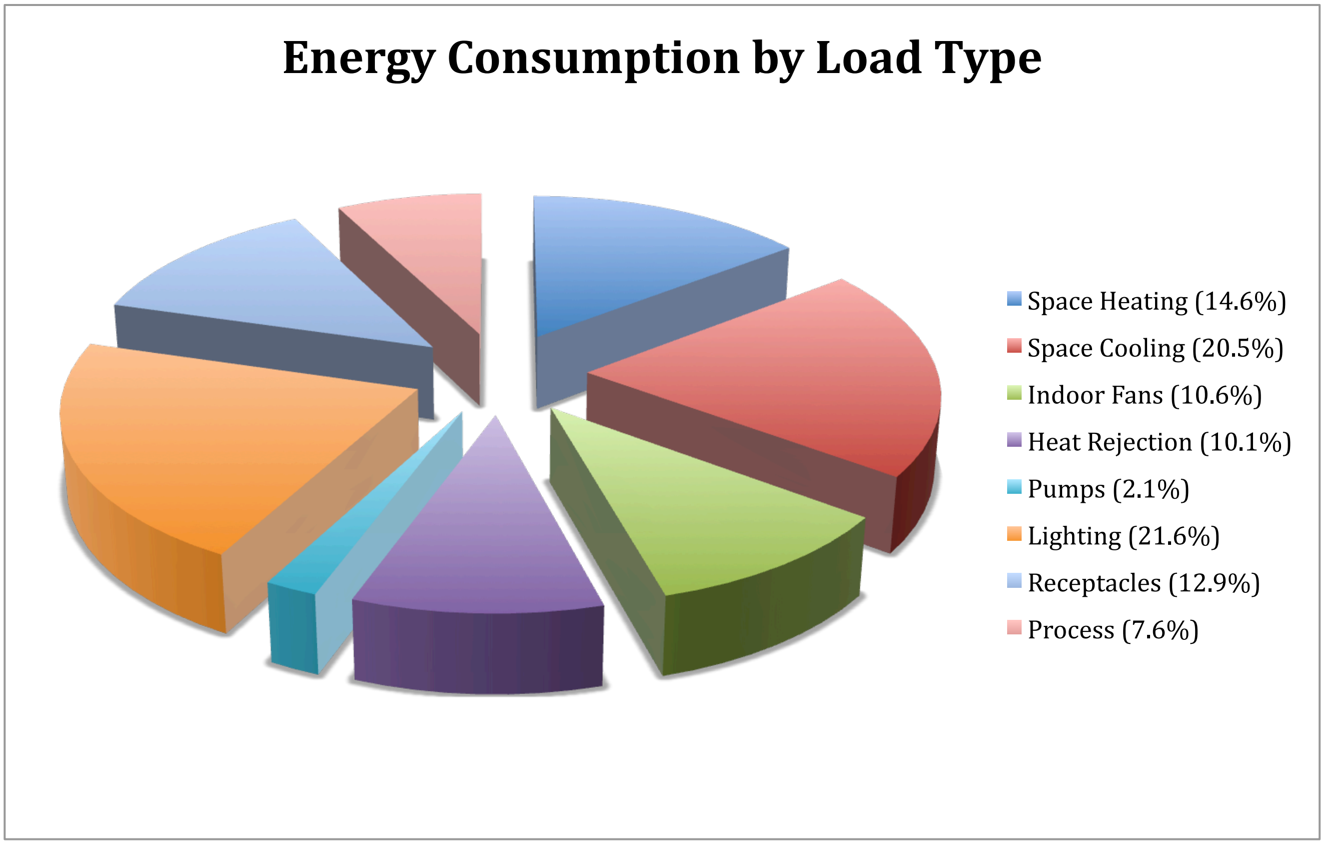
* % Below in this equation is limited to 30%

Total Incentive $ 59,392

Run Initiation Time: 10/26/06 11:55:08 Run Code: 1161881708

EnergyPro 3.1 By EnergySoft User Number: 5936 Job Number: 1359.0001 Page:1 of 1

Fig. C.1


Energy Consumption by Load Type
Space Heating (14.6%)
Space Cooling (20.5%)
Indoor Fans (10.6%)
Heat Rejection (10.1%)
Pumps (2.1%)
Lighting (21.6%)
Receptacles (12.9%)
Process (7.6%)

REFERENCES

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