Alternative Energy Concept Plan

Crafton Hills College

Final Report—January 12, 2010

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Executive Summary

Scope

San Bernardino Community College District (SBCCD), one of 72 community college districts within the California Community College system, is comprised of Crafton Hills College, San Bernardino Valley College, the Economic Development and Corporate Training program and KVCR. The goal of the District is to reduce overall energy dependence on the electrical grid by at least 50%, accomplished through implementation of energy efficiency, demand reduction measures and addition of renewable energy sources.

P2S Engineering was retained by Crafton Hills College to conduct an energy audit of the existing facilities and formulate a sustainable energy plan that addresses:

a) Energy saving opportunities in each of the buildings on campus to maximize efficiency and reduce associated operational and maintenance costs and carbon emissions

b) Demand shifting opportunities to reduce operating costs

c) Provision of available renewable energy technologies to reduce the overall dependence on utility grid and shield the campus against utility rate escalations and exposure to future carbon emissions charges in the future

Methodology

The following methodology was adopted in formulating the proposed Sustainable Energy Plan:

1. A critical aspect in the evaluation of existing systems currently serving each building on campus and the campus existing and projected energy consumption and associated utility rates. A survey of the existing systems currently serving Crafton Hills College (CHC) facilities was undertaken and existing systems information and operational schedules were noted. The surveyed information was verified through available record drawings and meetings with the campus facilities and management staff. Campus energy consumption and rates of current utilities were gathered from utility bills provided by the Program Management Team.

2. A list of applicable energy efficiency measures (EEM) were developed based on review of existing collected data on the various systems.

3. Costs and payback associated with implementation of these proposed energy efficiency measures were then developed and energy efficiency measures were prioritized and recommended based on payback.

4. Alternative energy technologies were explored along with placement locations on the campus were studied. Associated costs and paybacks were developed to recommend the most effective technologies.

Findings and Recommendations

The electrical consumption of the campus currently stands at approximately 3.4 million kWh per year with a peak electrical demand of 1.13 MW. The current average costs for electricity and gas for CHC are:

Electrical	$0.14/kWh
Gas	$0.72/therm

A review of the existing systems currently serving existing buildings on campus revealed:

- Some buildings have Roof Top Units with 10-11 SEER rating. There is a central plant with three chillers in LADM building and there are chillers in SSA and Gymnasium buildings, with hydronic boilers. Central Plant has 750 Tons capacity in LADM building and one out of three chillers operates year round. Two chillers operate at part load in summer. Hydronic boilers are set back for 72˚F outside air temperature.
- Most buildings have electric heaters for domestic hot water heating needs.
- Campus has Siemens APOGEE controllers in the buildings. Front end of the control system is located in Maintenance and Operations buildings. Implementation of exhaust fan set-backs are still work in progress and many features of the control system are not being used due to lack of training.
- Lighting systems are also controlled by setback controls of APOGEE controller and occupancy sensors with delay timers. Campus wide lighting system of T832W lamps was observed. Many spaces were measured for lower than required lighting intensity. Few classrooms were also metered for more then required lighting intensity also. There are few buildings which have potential for daylight harvesting. There is no as-build documentation of lighting systems for any of the buildings audited under the scope of this study.
- Air handlers and air transporting ducts are leaking at many buildings and the systems have exceeded their useful life. Most Air handling units have economizers, but there is no ventilation control for OSA (outside air).
- Based on information provided, current 220,722 ft^2 of space is scheduled to reach 487,384 ft^2, by virtue of additional buildings.

A review and application of the various renewable technologies currently existing in the market place revealed that photovoltaic and solar thermal systems could be effective technology for the campus to limit dependence on their fossil fuel sources, reduce greenhouse gas emissions and eliminate the impact of fluctuation of energy prices in the future. Various locations were studied for locating these PV systems to maximize their efficiency and output. In phase-1 Parking Structure-1 is recommended with 400 kW each. For phase-2, we are recommending a 400 kW system for CRF parking lot. PV system on rooftops of Student Center and Emergency Services #2 building are being recommended in phase-3. Phase-4 recommends installation of approximately 800 kW on campus available land.

Based on review and analysis of the existing systems and the various renewable technologies, the following are our recommendations for implementing the various energy efficiency and renewable energy projects to improve efficiency and reduce dependence on the utility grid. A detailed discussion on each of the proposed energy efficiency measures and renewable technologies along with corresponding paybacks is provided in the report.

The following table summarizes the energy savings from the various energy efficiency measures and the approximate total energy production from the proposed PV systems.

Phase	Description	Annual Energy Savings
1	Thermal Energy Storage (TES)	162,000 kWh
	Proposed PV Production 400kW Parking Structure	722,000 kWh
2	Proposed PV Production 400kW Parking Lot	722,000 kWh
	Energy Efficiency Measures	690,000 kWh
	Solar Collectors, Pool	30,000 therms
3	Proposed PV Production 400kW Building Rooftop	722,000 kWh
4	Proposed PV Production 800kW Campus Available Land	1,443,000 kWh

The following table summarizes the costs, potential rebates and annual energy cost reduction based on current electric rates ($0.14/kWh) for the various recommended energy efficiency measures and proposed PV systems.

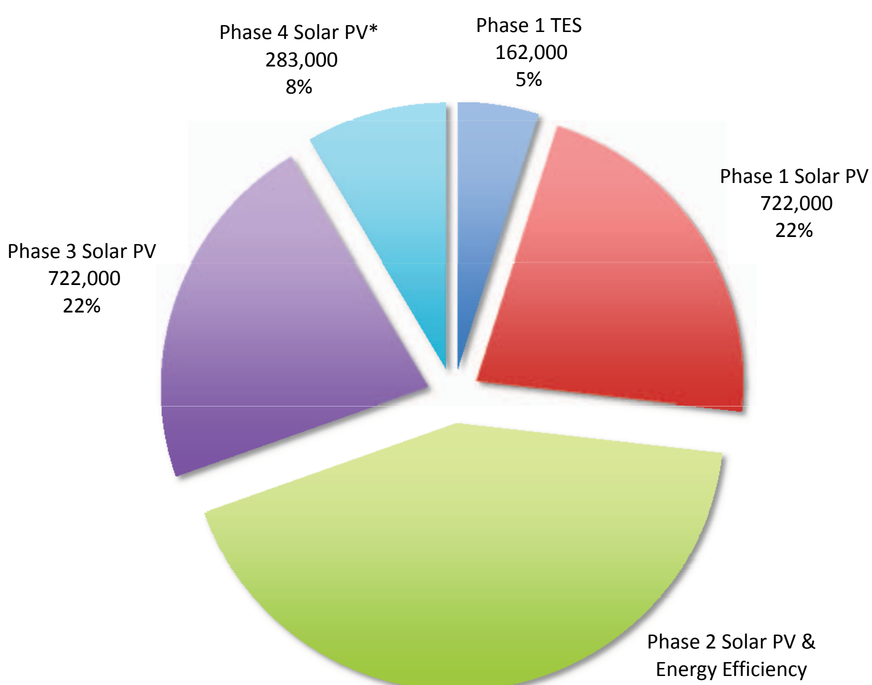
Phase	Description	Cost	Rebates	Annual Energy Cost Reduction	Payback (Years)
1	Thermal Energy Storage (TES)	*	$39,000	$94,000	15
	Proposed PV Production 400kW Parking Structure	**	$685,000	$101,000	22
2	Proposed PV Production 400kW Parking Lot	$3,200,000	$685,000	$101,000	22
	Energy Efficiency Measures 1-8, 10-14	$731,000	$169,000	$100,000	6
	Solar Collectors, Pool	$263,000	$30,000	$21,000	11
3	Proposed PV Production 400kW Building Rooftop	$2,000,000	$686,000	$101,000	13
4	Proposed PV Production 800kW Campus Available Land	$6,400,000	$1,371,000	$170,000	22

Notes:

* Included in Thermal Energy Storage Budget
** Included in Parking Structure Budget

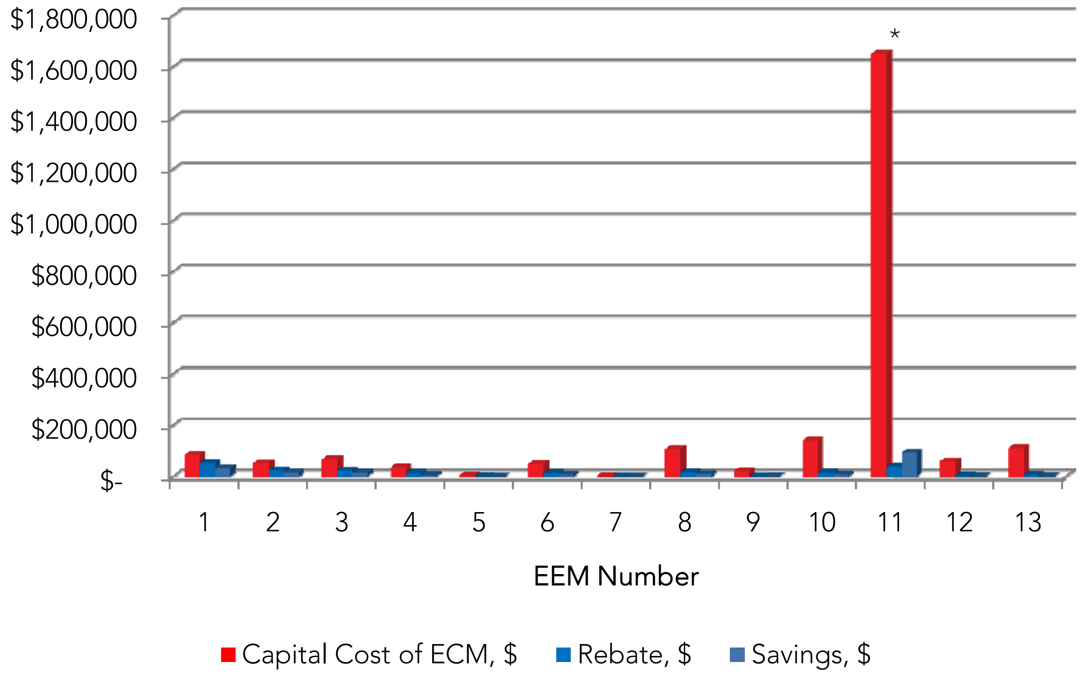
The following chart provides the annual electrical energy reduction in kWh per year associated with energy efficiency measures and implementation of all phases of solar PV systems.

ENERGY CONSUMPTION AT FULL BUILD-OUT



* Phase 4 Solar would produce 1,443,000 kWh/yr including the export of 1,160,000 kWh back to the electric grid to offset the other District electric meters

The following EEMs are recommended for implementation.



* Costs are included in Crafton Hills College Infrastructure master Plan.

Baseline Energy Usage

This section establishes current electricity and natural gas consumption at Crafton Hills College Campus buildings. Blended cost of electricity and natural gas are computed based on monthly bills at both facilities.

Electric utility is served to campus with SCE TOU-8-CPP service connection.

Natural gas is served to campus under GN-10 rate schedule from the gas company.. There are two gas connections as outlined in Table-4 of this section

Blended cost of electricity is calculated as $ 0.14/kWh and for natural gas as $ 0.72/Therm respectively.

Peak electrical demand is 1,114 kW. The billing demand usage statistic for electricity at CHC is summarized in the table below.

TABLE 1 BILLING DEMAND VARIATIONS

Parameter	On-Peak kW	Mid-Peak kW	Off-Peak kW
Min	1,114	1,018	902
Max	691	557	538
Mean	945	865	730
Median	979	883	749

After reviewing the electric consumption and natural gas consumption for twelve contiguous months, the EUI (Energy Utilization Index) of Crafton Hills College buildings is estimated at 119.32 $kBtu/ft^2$, as computed in Table-5 of this section. Electricity to buildings located south of E. Grant Street is served by Colton public Utilities. These buildings are not included in energy efficiency evaluation study. A review of utility bills of Colton Public Utility reveals higher cost of electricity then that of SCE TOU-08 service connection.

TABLE 2 SUMMARY OF MONTHLY ELECTRIC BILLS OF CHC

Service Connection: 3-000-0015-80												
Start Date	End Date	Charges	On-Peak kWh	Mid-Peak kWh	Off-Peak kWh	CPP kWh	Total kWh	On-Peak KW	Mid-Peak kW	Off-Peak kW	$/kWh
5/4/2009	6/3/2009	$33,287.27	6,101	7,651 146,338	4,714 103,454		268,258	691	557 902	538 691	$0.1241
6/3/2009	7/2/2009	$37,664.27	59,189	83,443	81,091	3,893	227,616	941	902	787	$0.1655
7/2/2009	8/3/2009	$77,291.52	59,534	108,835	121,095	24,576	289,464	979	1,018	883	$0.2670
8/3/2009	9/1/2009	$63,536.62	77,074	117,216	121,320	14,328	238,536	1,114	960	864	$0.2664
9/1/2009	10/1/2009	$57,895.35	86,246	124,699	131,496	10,325	352,766	998	902	902	$0.1641
10/1/2009	11/2/2009	$33,801.35		182,899	141,139		324,038		883	749	$0.1043
11/2/2009	12/3/2009	$33,219.73		175,368	128,362		303,730		960	787	$0.1094
12/3/2009	1/4/2010	$25,902.50		112,848	119,885		232,733		826	538	$0.1113
1/4/2010	2/2/2010	$26,808.07		143,453	109,656		253,109		864	634	$0.1059
2/2/2010	3/4/2010	$28,048.62		153,859	114,807		268,666		845	749	$0.1044
3/4/2010	4/2/2010	$28,635.79		151,301	104,971		256,272		826	653	$0.1117
4/2/2010	5/3/2010	$30,919.14		164,923	124,051		288,974		806	710	$0.1070
Totals		$477,010.23	288,144	1,672,833	1,406,041		3,304,162				$0.1444

*Indicates summer month.

TABLE 3 'TIME OF USE', MONTHLY ENERGY CONSUMPTIONS

Month #	On-Peak kWh	Mid-Peak kWh	Off-Peak kWh
1	-	143,453	109,656
2	-	153,859	114,807
3	-	151,301	104,971
4	-	164,923	124,051
5	6,101	153,989	108,168
6	59,189	83,443	81,091
7	59,534	108,835	121,095
8	77,074	117,216	121,320
9	86,246	124,699	131,496
10	-	182,899	141,139
11	-	175,368	128,362
12	-	112,848	119,885

TABLE 4 NATURAL GAS SERVICE CONNECTIONS

Mtr #		12775267		11706691	
Start Date	End Date	Therms	$/Month	Therms	$/Month
5/1/2009	6/2/2009	1,965	$1,194.13	42	$45.94
6/2/2009	7/1/2009	2777	$1,852.03	48	$57.93
7/1/2009	7/30/2009	451	$341.30	32	$43.89
7/30/2009	8/28/2009	129	$130.92	32	$45.07
8/28/2009	9/28/2009	401	$290.05	33	$44.70
9/28/2009	10/28/2009	5,055	$3,456.72	65	$76.87
10/28/2009	11/30/2009	8,453	$5,878.12	159	$165.56
11/30/2009	12/31/2009	12,835	$8,996.22	60	$79.33
12/31/2009	2/1/2009	13,409	$10,355.94	129	$163.05
2/1/2010	3/3/2010	13,615	$10,653.87	137	$173.13
3/3/2010	4/1/2010	9,554	$6,268.54	90	$104.69
4/1/2010	5/3/2010	11,060	$7,339.00	95	$112.97
Totals		79,704	$56,757	922	$1,113
Blended Cost of Natural Gas					0.72

BILLING DEMAND

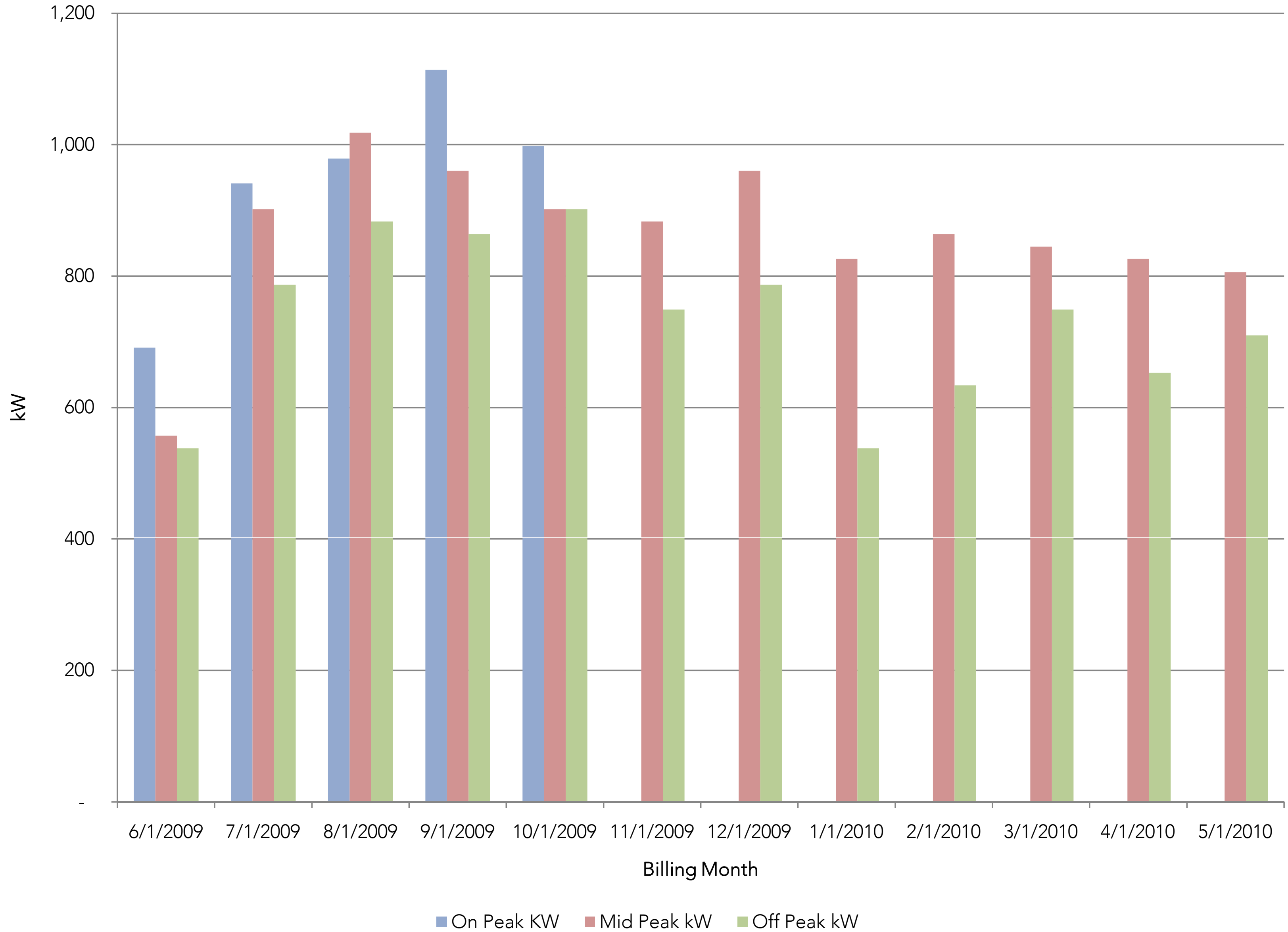


FIGURE 1 TIME OF USE, MONTHLY ENERGY CONSUMPTION

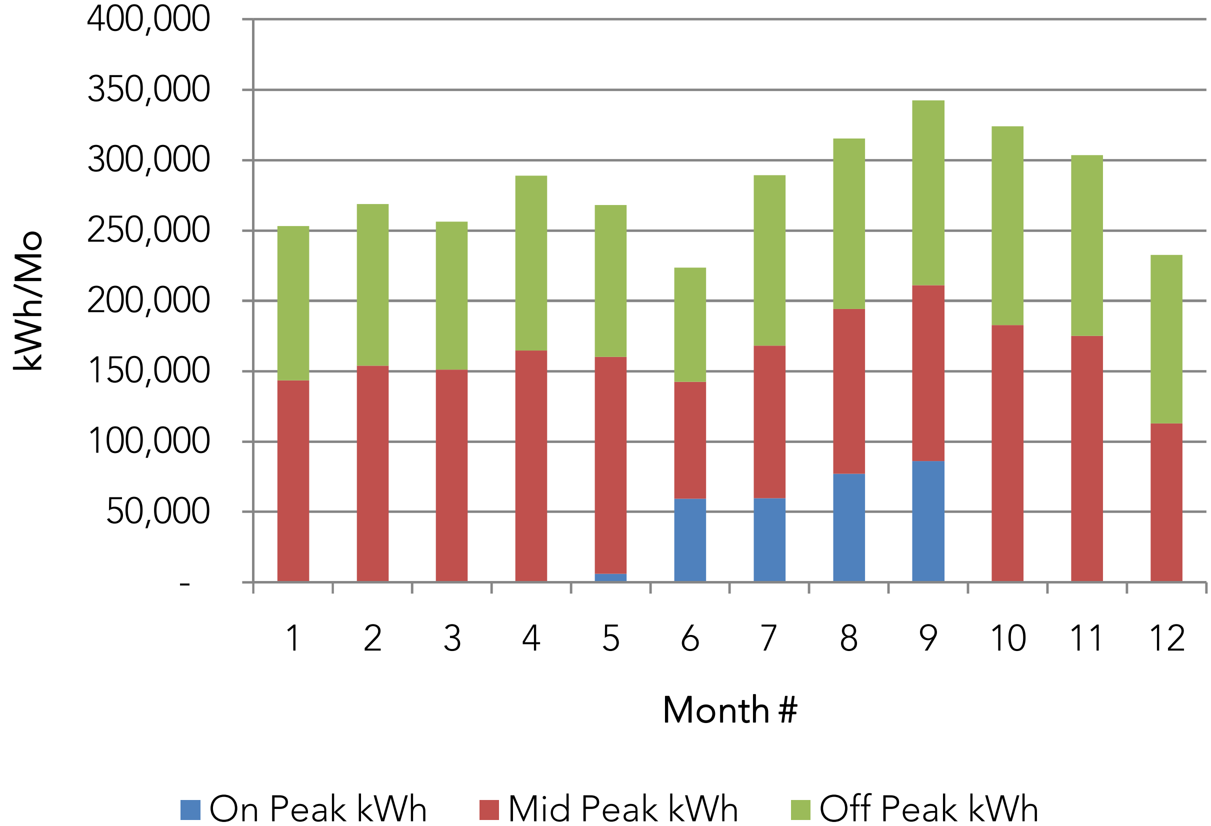


FIGURE 2 GAS CONSUMPTION BY MONTH IN THERMS

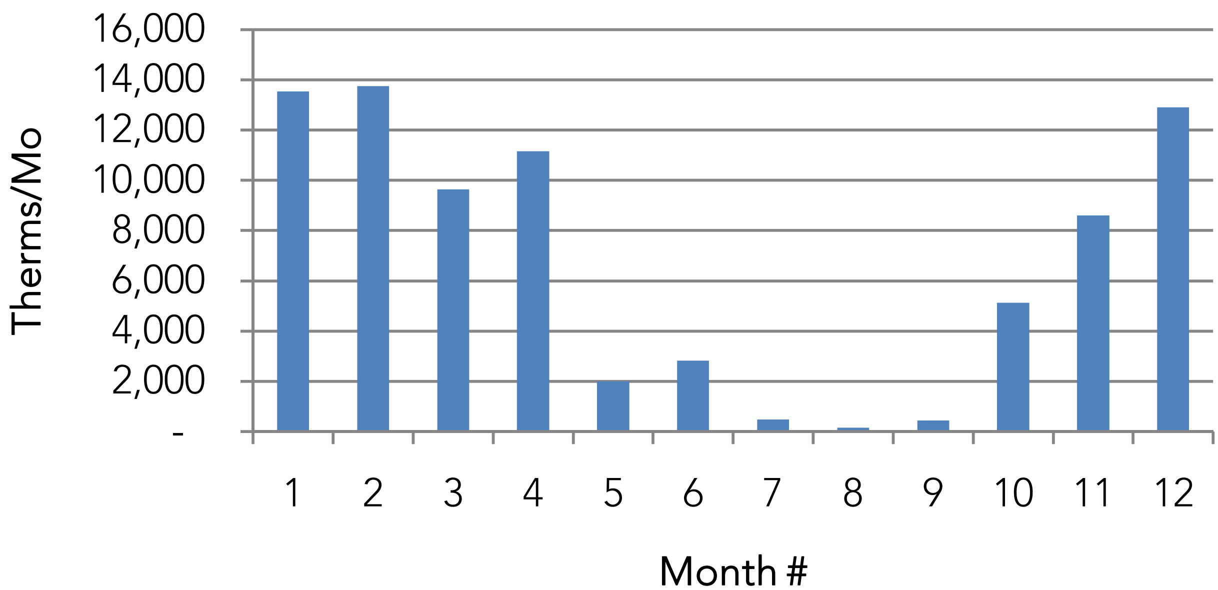


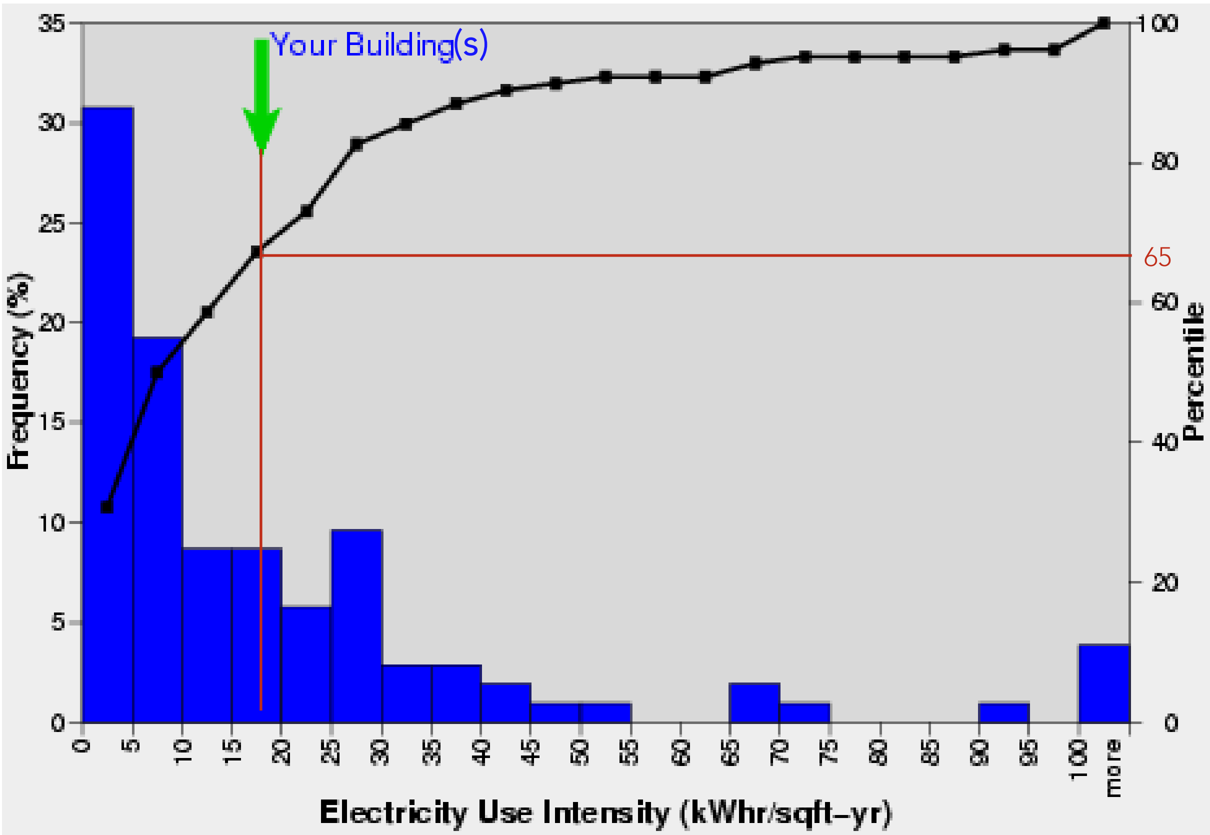
TABLE 5 EUI CALCULATION

Building No.	Building Name	GSF	Building Year
1	Lab/Administration	30,621	1970
2	Library (future Student Center)	36,900	1970
3	College Center	8,560	1970
4	Student Services A	9,970	1970
5	Classroom Bulilding (future Student Services C)	6,800	1970
6	Occupational Education 1	9,842	1975
7	Occupational Education 2 (future Emergency Services)	15,730	1975
8	Performing Arts Center	29,851	1975
9	Maintenance & Operations	6,400	1975
10	Gymnasium	27,250	1970
12	Chemistry	17,238	1978
13	Child Development Center 1	3,455	1999
14	Child Development Center 2	2,450	1999
16	Student Services B	5,575	1998
17	Bookstore	5,760	2000
18	Classrooms at Bookstore	4,320	2000
	Subtotal	**220,722**	

Total Conditioned Space of Existing Buildings	220,722	ft^2
Annual Electric consumption	3,304,162	kWh/Yr
	11,277,105	kBtu/Yr
Annual Gas Consumption	80,626	Therms/Yr
	8,062,600	kBtu/Yr
Total Energy Consumption of Campus	19,339,705	kBtu/Yr
Electric Consumption	14.97	kWh/Yr-ft^2
Gas Consumption	0.37	Therms/Yr-ft^2
EUI (Energy Utilization Index)	**87.62**	**kBtu/ft^2·Yr**

CHC buildings EUI of 88 kBtu/ft^2-yr is higher than 100% of comparison buildings in the climate zone, per database of California Building Energy Reference Tool.

FIGURE 2 ELECTRIC USE INTENSITY COMPARISON



CHC electric EUI is 15 kWhr/ft^2-yr which is higher than 59% of comparison buildings shown in the climate zone, per database of California Building Energy Reference Tool.

Energy Efficiency Measures

After reviewing existing drawings and conducting site surveys to observe existing conditions, the following EEMs are recommended for implementation:

1. Controls and Post Monitoring-Based Commissioning (MBCx) Measures
2. Thermal Energy Storage (TES)
3. Fan Wheels Retrofit
4. Plug Load Control
5. Lighting Retrofits
6. Roof Top Unit (RTU) Upgrades
7. Tankless Domestic Hot Water (DHW) Heaters
8. Premium Efficiency Motors
9. Not Used
10. Decommission Gym Chiller
11. Return Air Heat Recovery
12. Student Services A Air Handler Unit (AHU) Veriable Frequency Drives (VFDs)
13. High SEER Split Condensing Units
14. Low Flush Urinals

The following buildings were part of the Energy Efficiency Measures evaluations:

1. Laboratory / Administration Building
2. Library
3. College Center
4. Student Center A
5. Student Center C (Classroom Building)
6. Student Services B (Health and Wellness Center)
7. Occupational Education 1
8. Occupational Education 2
9. Bookstore
10. Classroom at Bookstore
11. Performing Arts Center
12. Maintenance and Operations
13. Gymnasium
14. Chemistry Building
15. Child Development Center 1
16. Child Development Center 2

Individual ECMs and their descriptions are outlined in this section. Executive summary of individual EEMs is narrated in this section. Detailed description of EEMs is appended in Appendix-B

Implementation of these fourteen EEMs will result in reduction of electrical energy consumption by 27% at CHC and 7% reduction in gas. The gas reduction is due to EEMS and it does not include the savings of 30,000 therms/yr, which will be realized after installation of solar collectors on pools.

#	Parameter	Value	Units
1	Σ Savings	892,369	kWh/Yr
2	Baseline Energy Consumption	3,304,162	kWh/Yr
3	% Savings (Electrical)	27.0%	%
4	Existing Gas Consumption	80626	Therms/Yr
5	Gas Savings	5,393	Therms/Yr
6	% Savings (Gas)	6.7%	%

TABLE 1 LIST OF EEMS

Priority	EEM #	EEM Description	Energy Savings (kWh/Yr)	Demand Savings (kW)	Energy Savings (Therms/Yr)	Construction Cost of EEM	Rebate	Savings	Simple Payback (Yrs)
1	1	Controls and Post MBCx Measures	219,982	55.0	390	$83,980	$53,186	$32,047	1.0
2	3	Fan Wheels Retrofit	102,844	25.7		$52,000	$24,683	$14,810	1.8
3	4	Plug Load Control	100,521	25.1		$67,500	$24,125	$14,512	3.0
4	7	Tankless DHW Heaters	54,760	13.7	-	$35,600	$13,142	$6,321	3.6
5	12	SSA Bldg VFD	4,226	1.4		$4,050	$1,014	$610	5.0
6	8	Premium Efficiency Motors	50,817	14.5		$48,963	$12,196	$7,374	5.0
7	13	High SEER Split Condensing Units	1,280	1.3		$1,875	$307	$179	8.7
8	5	Lighting Retrofits	65,422	22.5		$106,665	$15,701	$9,493	9.6
9	14	Low Flush Urinals				$21,000	$ -	$2,008	10.5
10	6	RTUS Upgrade	57,513	35.9		$140,000	$13,803	$8,052	15.7
11	2	TES (Thermal Energy Storage)	162,461	101.5		*	$38,991	$93,716	17.2
12	10	Decommission Gym Chiller	18,200	14.6		$58,966	$4,368	$2,627	20.8
13	11	Return Air Heat Recovery	14,223	4.7	3,048	$110,475	$6,461	$2,476	42.0
Totals			852,249	311	390	$731,074	$207,978	$194,225	

* Cost is included in Crafton Hills Infrastructure Master Plan.

EEM 01—Controls and Post Monitoring-Based Commissioning (MBCx) Measures

Construction Cost	$89,980
Estimated Savings	$32,047
Potential Rebates	$53,186
Payback	1.0 years

Annual Utility Savings	
Electricity	219,982 kWh
Gas	N/A
Water	N/A

Description

This EEM is included to calculate the savings and potential rebate associated with the installation of a demand ventilation system, static pressure reset on multizone systems, Exhaust Fan Set-backs and Occupancy sensor based Heating/Cooling set-backs-on the CHC campus. The EEM includes the installation of a instrumentation and controls for the following buildings:

- Laboratory and Administration (LADM)
- College Center (CC)
- Student Services - A (SSA)
- Business (B)
- Classroom Building (SSC)
- Occupational Education-1 (OE-1)
- Occupational Education-2 (OE-2)
- Performing Arts Center (PAC)
- Gymnasium (GYM)
- Chemistry

This EEM provides an efficient means to reduce ventilation and heating/cooling related energy usage by providing the required amount of conditioned air.

We recommend this EEM be implemented to capture these savings.

EEM 02—Thermal Energy Storage (TES)

Construction Cost	$1,650,000*
Estimated Savings	$202,834
Potential Rebates	$219,561
Payback	17.2 years

Annual Utility Savings	
Electricity	162,461 kWh
Gas	N/A
Water	N/A

Description

This EEM is included to calculate the savings and potential rebate associated with the installation of a new 8000 Ton-Hrs TES (Thermal Energy Storage at CHC campus, using existing chillers. The EEM includes the installation of TES with instruments, controls and civil construction costs, with provision for commissioning.

By installing TES, CHC will be able to shift the demand charges from peak and mid-peak consumption to zero charges of off-peak consumption. Chillers operate more efficiently at lower condenser temperatures. The chillers are expected to operate at 0.5 kW/ton at night, which will save energy (kWh/Yr), when compared to day operations similar to existing operations.

Chilled water will be stored in approximately 720,000 gallons of storage tank and chillers, cooling towers, cooling tower circulation pumps will be turned off during peak hours in summer.

TES has most cost savings from load shifting then from increased efficiency of night operations.

Recommendation

This EEM provides an efficient means to provide chilled water to the campus during day times (12 PM to 6 PM) by storing it in chilled water tank. TES also provides additional capacity, if the campus decides to not install new chillers for the proposed expansion.

We recommend this EEM be implemented to capture these savings.

* Cost is included in Crafton Hills Infrastructure Master Plan.

EEM 03—Fan Wheels Replacement

Construction Cost	$52,000
Estimated Savings	$14,810
Potential Rebates	$24,683
Payback	1.8 years

Annual Utility Savings	
Electricity	102,844 kWh
Gas	N/A
Water	N/A

Description

This EEM evaluates the feasibility of installing an efficient fan wheel on the existing air handler sized for the proper airflow in the building. Existing fans wheels were installed with AHU during original construction over 30 years ago. Air-foil blades on fan wheels can provide 15 % efficiency gains compared to forward curved fans.

This EEM has labor element involved in it. If campus decides to replace all the air handlers, this measure should be included and the paybacks will get even shorter because the shop costs of installing fan wheels will be much less then field retrofit.

No information about fan wheels is available at the campus.

Recommendation

We recommend installing energy efficient fan wheels on all fans of all air handling units throughout CHC.

EEM 04—Plug Load Reduction

Construction Cost	$67,500
Estimated Savings	$14,512
Potential Rebates	$24,125
Payback	3.0 years

Annual Utility Savings	
Electricity	100,521
Gas	N/A
Water	N/A

Description

This EEM evaluates the opportunity to reduce plug load across the campus.

Single largest plug load observed during site visits was computers not being turned off. Currently CHC does not have any Watt-stoppers or Power management system to turn the computers off at night and during weekends. CHC relies on instructors and custodians to turn the plug loads off.

It is recommended that all the computers have Power Management Software, which turns the computer off or on sleep mode when it is inactive for more predetermined time. CHC has over 1000 computers and some of them are turned off at night while some stay on all the times. Settings of Power Management cannot be changed by users and can be changed by network administrators.

CHC has 538 kW of minimum billing demand, which mostly occurs at nights and week-ends. It is recommended that computers be scheduled to be turned off during weekends to take further advantage of energy savings. A significant fraction of this demand is attributable to plug loads.

Recommendation

We recommend to install Watt stoppers and/or Power Management software to be installed on CHC.

EEM 05—Lighting Retrofits

Construction Cost	$106,665
Estimated Savings	$9,4934
Potential Rebates	$15,701
Payback	9.6 years

Annual Utility Savings	
Electricity	65,422
Gas	N/A
Water	N/A

Description

This EEM analyzes the lighting in the subject sixteen buildings being analyzed for energy efficiency measures. Some construction drawings were not current as "as-builts". Retrofit opportunities for the most part did not consider fixture replacement because of the larger investment and subsequent longer paybacks.

The detailed lighting EEMs listed in the table (refer to Appendix B) are defined in this section for their definition of scope. This will provide general understanding equipment involved and the purpose of the measure. Some efficiency measures are described below even if not all were identified in the Lighting Audit.

The following lighting energy efficiency measures (LEEM) were considered in the various buildings:

ECM 1 Replace ballast and lamps with daylight harvesting ballast (photocell and ballast factor adjustable by dip switch on ballast)

ECM 2 Replace lamp and ballast of a T8 - 32 W to T8 -25W

Recommendation

We recommend implementing the lighting efficiency measures shown in EEM-05 shown in Appendix B.

EEM 06—Roof Top Units Upgrades

Construction Cost	$57,513
Estimated Savings	$8,052
Potential Rebates	$13,803
Payback	15.7 years

Annual Utility Savings	
Electricity	960,038 kWh
Gas	N/A
Water	N/A

Description

This EEM evaluates the feasibility of replacing existing RTUs (Roof top Units) with new energy efficient RTUs.

There are about 21 RTUS with 10-11 SEER ratings on roofs of Occupational Education-2, Bookstore, Classrooms at Bookstore, Maintenance and operations, and Child Development Center buildings. Capacity of the units ranges from 3-6 tons.

The vintage of majority of the equipment is 2003, except for Maintenance and Operations and Occupational Education-2 buildings.

These buildings are not proposed to be connected to central plant. Bookstore, Classrooms at Bookstore and OE2 may be torn down. Maintenance and Operations is scheduled to be renovated.

Current replacement efficiency is 15 SEER (Seasonally adjusted Energy Efficiency Ratio) available commercially and for smaller units, the efficiency ratings go as high as 21 SEER.

Recommendation

We recommend replacing the RTUs with newer units towards the end of their useful life, if these buildings are not torn down. We recommend Energy Star replacement for rebates and reliable savings.

If the buildings are remodeled, we recommend the RTU technology be replaced and the cooling/heating load be connected to the central plant.

EEM 07—Tankless Domestic Hot Water Heaters

Construction Cost	$35,600
Estimated Savings	$7,374
Potential Rebates	$13,142
Payback	3.6 years

Annual Utility Savings	
Electricity	54,760 kWh
Gas	N/A
Water	N/A

Description

This EEM recommends the conversion of existing electric and gas water heaters to high efficiency tankless water heaters in various buildings at the College. Domestic hot water needs are currently met by electric and gas heaters and are an expensive way of providing domestic water heating in facilities as compared to the tankless water heaters. Tankless water heaters are cheaper to operate and their service life is more than twice that of a tank-based system. On an operational basis, tankless water heaters heat water much more efficiently than the traditional tank-based water heaters. The standard measure of energy efficiency for water heaters is a metric called the Energy Factor or "EF". EFs for tank-based natural gas water heaters are usually in the low 60s, while EFs for natural gas fueled tankless water heaters are usually in the mid 80s. Therefore, when doing the basic job of heating cold water to hot water, tankless water heaters are about 20 to 25 percent more efficient than tank-based systems. In addition, traditional tank- based systems consume energy in their "stand-by" mode, i.e. when they are maintaining the temperature of an already heated but idle tank of hot water. Energy used during stand-by mode can range from 15 to 30 percent of the total energy that a tank-based system uses. Taken together, these two sources of operational efficiency result in tankless water heaters being 20 to 40 percent more economical to operate.

A list of buildings recommended for this Energy Efficiency Measure along with associated construction costs and payback is included in Appendix B.

Recommendation

We recommend replacing the existing electric domestic hot water heaters in the following buildings:

- Laboratory and Administration (LADM)
- Student Services – B (SSB)
- Occupational Education -1 (OE-1)
- Bookstore
- Performing Arts Center (PAC)
- Chemistry

EEM 08—Premium Efficiency Motors

Construction Cost	$48,968
Estimated Savings	$7,347
Potential Rebates	$12,196
Payback	5.0 years

Annual Utility Savings	
Electricity	50,817 kWh
Gas	N/A
Water	N/A

Description

This EEM evaluates the feasibility of replacing the standard efficiency motors in LADM, Chemistry, SSA, OE1, OE2, PAC and GYM Buildings to premium efficiency motors.

CHC has over 100 motors in sixteen buildings being analyzed. It is recommended that CHC maintain the inventory of motors with the appropriate data, using a DOE (Department of Energy) tool called MotorMaster+. We observed that many building with large motors (HP>3) had been retrofitted with premium efficiency motors. Premium efficiency motors are a right replacement for any motor that operates more than 1000 hours/yr. CHC should mandate the use of premium efficiency motors for all future retrofits and new buildings.

If the air handlers are replaced, the installation costs will be have further savings for not retrofitting the motors in field.

Recommendation

We recommend replacing the all the 50 (fifty) motors to premium efficiency motors.

EEM 09—Not Used

Construction Cost	
Estimated Savings	
Potential Rebates	
Payback	

Annual Utility Savings	
Electricity	
Gas	
Water	

EEM 10—Decommission Gymnasium Chiller

Construction Cost	$58,966
Estimated Savings	$2,627
Potential Rebates	$4,368
Payback	20.8 years

Annual Utility Savings	
Electricity	18,200 kWh
Gas	N/A
Water	N/A

Description

This EEM evaluates the energy savings by switching the Gymnasium cooling load to central plant chillers.

This EEM is included to calculate the savings and potential rebate associated with decommissioning of existing Gymnasium Chillers and leaving them in place as back-up Chillers.

The central plant chiller is more efficient then Gymnasium Chillers. There will be reduced maintenance costs, which are not taken in to consideration as energy savings under analysis of this ECM.

Central plant chillers are also proposed to be operated at night, which will provide additional savings to Gymnasium and CHC operations. Savings for Gymnasium is analyzed in EEM-2 and is not double dipped here.

Recommendation

We recommend capturing these savings by converting the electric reheat to hot water reheat.

EEM 11—Return Air Heat Recovery

Construction Cost	$110,475
Estimated Savings	$2,476
Potential Rebates	$6,461
Payback	42.0 years

Annual Utility Savings	
Electricity	14,2230 kWh
Gas	3,048 Therms/Yr
Water	N/A

Description

This EEM evaluates the energy savings by installing return air heat recovery devices on air handlers.

This EEM is included to calculate the savings and potential rebate associated for larger air handling units, where smallest energy wheel can be installed as outlined in Appendix-B.

Energy from exhaust air is imparted to fresh outside air via the heat transfer in the energy wheel. If new air handlers are installed, the cost of modifying ductwork and existing air handlers in field can be further reduced.

Recommendation

We recommend capturing these savings by installing the energy wheels on the air handlers identified in Appendix-B.

If campus wide air handlers are .replaced, they should have energy recovery devices and provision for economizer. Exhaust air should be brought back to air handlers and it is recommended that a district wide policy be implemented to recover heat from all exhaust air, except for Rest rooms and Kitchens.

EEM 12—SSA Air Handler VFD

Construction Cost	$4,050
Estimated Savings	$610
Potential Rebates	$1,014
Payback	5.0 years

Annual Utility Savings	
Electricity	4,226 kWh
Gas	N/A
Water	N/A

Description

This EEM evaluates the feasibility of installing a variable frequency drive (VFD) on the air handlers of SSA building. SSA building has two air handlers of 5138 cfm and 7420 cfm capacity with ESP of 1.75". Motors are belt driven and operate at fixed speed.

The building has varying ventilation demand due to different number of occupants at different times of day in different occupancies.

E-Quest was used to model the performance of the baseline and savings.

Recommendation

We recommend installing a variable frequency drive (VFD) on the SSA air handlers.

EEM 13—High SEER Split Condensing Units

Construction Cost	$1,875
Estimated Savings	$179
Potential Rebates	$307
Payback	8.7 years

Annual Utility Savings	
Electricity	1,280 kWh
Gas	N/A
Water	N/A

Description

This EEM evaluates the feasibility of replacing small split system condensing units only in College Center building.

A split system of 2 Tons with 10 EER (Energy Efficiency Ratio) is proposed to be replaced with 15 EER or higher. Use of Energy Star systems is recommended for rebates and reliable savings.

Implementation of this EEM will also allow CHC to eliminate CFC based refrigerants from the subject building.

Recommendation

We recommend replacing the small split system condensing unit in College Center Office.

EEM 14—Low Flush Urinals

Construction Cost	$21,000
Estimated Savings	$2,008
Potential Rebates	N/A
Payback	10.46 years

Annual Utility Savings	
Electricity	N/A
Gas	N/A
Water	591 kGal/Yr

Description

CHC has opportunity to retrofit 21 urinals in Buildings LADM, SSA, SSB, OE1, OE-, Bookstore, PAC, M&O and GYM. This EEM includes the replacement of 21 urinals on the campus. This EEM analyzes and reports costs, savings and paybacks for both "no flush" and "low flush" technologies available in market for water conservation.

The existing urinals use 1.0 gpf. Low flow models use 0.125 gpf while "no flush" urinals use no water.

Water costs are expected to continue to increase in Southern California.

Recommendation

We recommend replacing the existing urinals with "low flush" urinals.

Alternative Energy Sources

The majority of our nation's electrical energy requirements are currently met by fossil fuels such as coal and natural gas. These fossil fuels are non renewable sources, that is, they draw on finite resources that will eventually dwindle or disappear, become too expensive or too environmentally damaging to retrieve in the future. In contrast, renewable energy resources—such as wind and solar energy—are constantly replenished and will never run out. It is thus important for us to not only conserve energy but also promote the use of these renewable energy sources to deliver clean energy that improves our lives and minimizes our impact on the environment.

The State of California has committed to reduce its global warming emissions to 2000 levels by 2010 (11% below business as usual), to 1990 levels by 2020 (25% below business as usual), and 80% below 1990 levels by 2050. California passed the AB 32 that requires that the state's global warming emissions be reduced to 1990 levels by 2020. This reduction will be accomplished through an enforceable statewide cap on global warming emissions that will be phased in starting in 2012.

The State of California predicts that electrical rates will continue to escalate at approximately 2.5% per year. Carbon costs will also be added to future energy production costs once AB32 becomes effective in 2012.

The California Community Colleges Energy and Sustainability Policy recommends that colleges should consider procuring 20% of their electricity needs form renewable sources by 2010, and 40% by 2014.

There are a variety of renewable power technologies that have been developed to take advantage of solar and wind energy. These include concentrating solar power systems, solar water heating, photovoltaic systems, wind mills and turbines. These renewable power technologies help in:

- Minimizing the use of natural resources,
- Provide a constant electrical energy price for renewable supplied energy that will hedge against fuel price increases, carbon pricing/trading and rising electrical rates
- Reduce peak demand and thus operating costs at each of the campuses;
- Provide environmental benefits by reducing greenhouse gas emissions consistent with current AB 32 and help reduce the District's exposure to future carbon emission charges;
- Viewed as environmentally responsible in community.

The following sections include a description of each of the alternative power sources considered and our recommendations for each of the systems.

Fuel Cells

Fuel cells can deliver electrical conversion efficiencies in the range of 40 to 60%. Even higher total energy conversion efficiencies (approaching 60 to 70%) are possible when used in co-generation applications, where both electricity and the heat of reaction are effectively utilized. Another promising feature of fuel cells is low emissions. Since they produce electricity without combustion, the usual products of combustion are not present. Fuel cells also operate quietly and reliably.

The legacy fuel cell technologies like proton exchange membranes (PEMs), phosphoric acid fuel cells (PAFCs), and molten carbonate fuel cells (MCFCs), have all required expensive precious metals, corrosive acids, or hard to contain molten materials. Combined with performance that has been only marginally better than alternatives, they have not been able to deliver a product that offers attractive economics.

Some makers of these legacy fuel cell technologies have tried to overcome these limitations by offering combined heat and power (CHP) schemes to take advantage of their wasted heat. While CHP does improve the overall economics, it only really does so in environments with exactly the right ratios of heat and power requirements on a 24/7/365 basis. Everywhere else the cost, complexity, and customization of CHP tends to outweigh the benefits. Our experience has shown it to be extremely difficult to utilize enough waste heat in Southern California community colleges.

Fuel cells are being developed in the size range of a few kilowatts up to a few megawatts. The costs of fuel cells currently vary between $5500-$6500 per kW. Like most new technologies, as more units are installed and new manufacturers join the market, prices are likely to fall. At the current price, units are only used in high value, “niche” markets where reliability is premium, and in areas where electricity prices are very high and natural gas prices are low.

While this technology can reduce overall greenhouse gas emissions when the waste heat can be utilized, this is not a renewable energy technology. This would be considered a clean energy technology.

Maintenance costs of the legacy fuel cells are extremely high due to replacement of stacks every 3-4 years. The costs of stacks are roughly 40-50% of the total fuel cell costs and thus do not render this technology economically feasible for the district.

Various manufacturers over the years have been looking at reducing the overall costs and increasing the efficiency of the fuel cell system. One such promising manufacturer is Bloom Energy that is currently manufacturing fuel cells from solid oxide. With low cost ceramic materials, and extremely high electrical efficiencies, Solid Oxide Fuel Cells (SOFC) can deliver attractive economics. Bloom Energy currently offers a 100 kW unit and has trial installations currently at few of the Silicon Valley companies. The product is promising and needs to stand the test of time to confirm the product can meet their objectives. We recommend the District evaluate similar technologies in the future once the same stand the test of time and become cost effective.

Microturbines

Microturbines are small combustion turbines that produce between 25 kW and 500 kW of power. Most microturbines are single-stage, radial flow devices with high rotating speeds of 90,000 to 120,000 revolutions per minute (RPM). However, a few manufacturers have developed alternative systems with multiple stages and/or lower rotation speeds.

MICROTURBINE OVERVIEW

Size Range	25 – 500 kW
Fuel	Natural gas, hydrogen, propane, diesel
Efficiency	20 – 30% (Recuperated)
Environmental	Low (< 9 – 50 ppm) NOx
Other Features	Cogeneration (50 – 80°C water)

Microturbine capital costs range from $2000/kW for larger units to approximately $1,500/kW for smaller ones. These costs include all hardware, associated manuals, software, and initial training. The addition of a heat recovery system adds between $150 - $350/kW. Site preparation and installation costs vary significantly from location-to-location but generally add 30-70% to the total capital cost.

With fewer moving parts, microturbine can provide higher reliability and require less maintenance than conventional reciprocating engine generators. Typical maintenance intervals for Microturbines are in the range of 5,000-8,000 hours. Estimated maintenance forecasts range from $0.015-$0.025 per kWh, which would be comparable to costs for small reciprocating engine systems.

MICROTURBINE COST

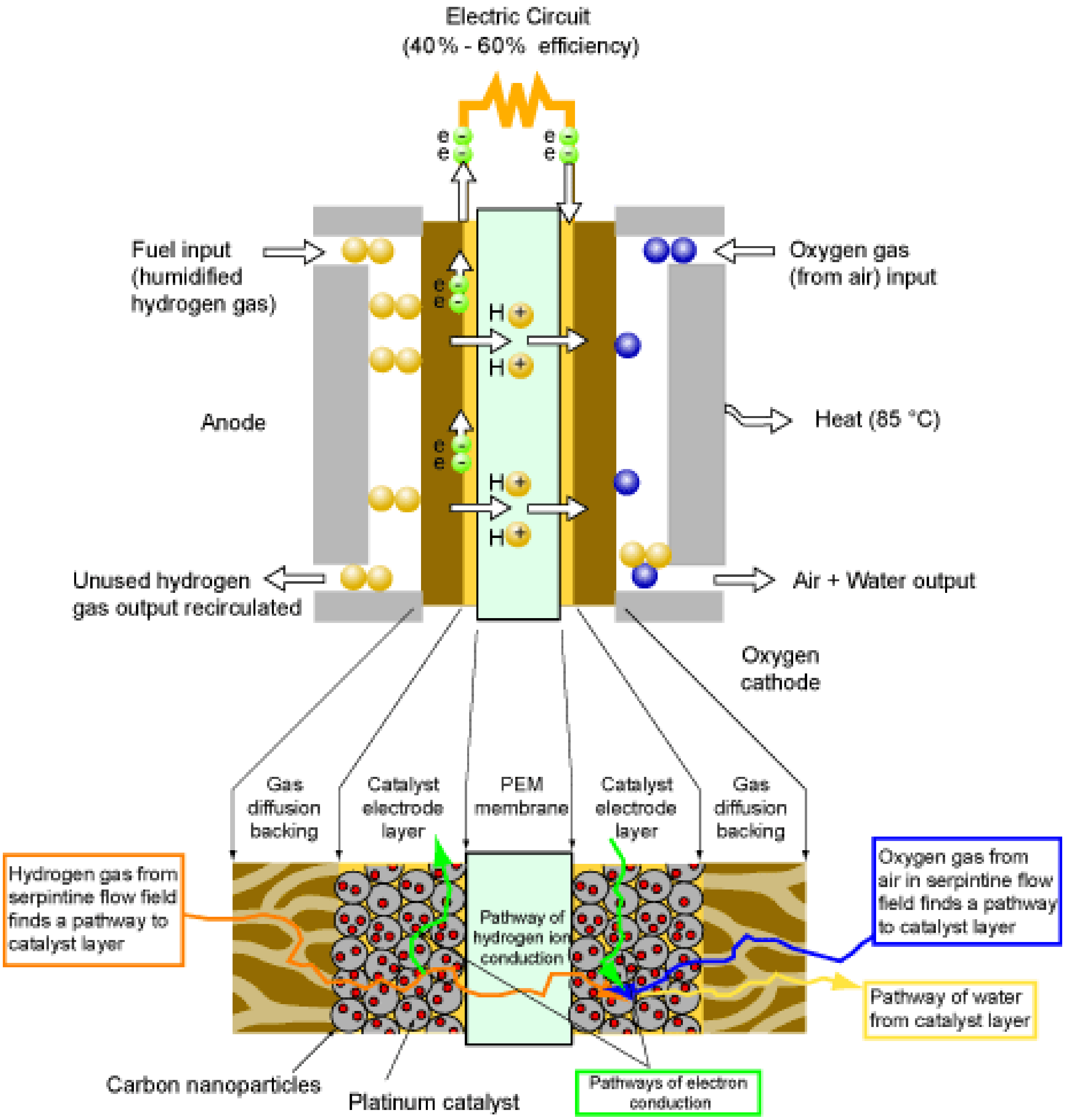
Capital Cost	$1500-$2000 per kW
O&M Cost	$0.015-0.025 per kW
Maintenance Interval	5,000-8,000 hrs

While this technology can reduce overall greenhouse gas emissions when the waste heat can be utilized, this is not a renewable energy technology. This would be considered a clean energy technology.

The primary challenge with cogeneration is to utilize enough of the waste heat throughout the year to provide adequate return on the investment. Our experience has shown it to be extremely difficult to utilize enough waste heat in Southern California community colleges. This technology would provide a payback beyond 15 years based on current utility rates.

Cogeneration systems require periodic maintenance to keep them functional. Since these systems are difficult to maintain and require expertise that is not available with College facility people, we currently do not recommend cogeneration systems on either of the campuses.

FIGURE 1



Electric Circuit
(40% - 60% efficiency)
Fuel input
(humidified
hydrogen gas)
Oxygen gas
(from air) input
Anode
Heat (85 °C)
Unused hydrogen
gas output recirculated
Air + Water output
Oxygen
cathode
Gas
diffusion
backing
Catalyst
electrode
layer
PEM
membrane
Catalyst
electrode
layer
Gas
diffusion
backing
Hydrogen gas from
serpintine flow field
finds a pathway to
catalyst layer
Pathway of
hydrogen ion
conduction
Oxygen gas from
air in serpintine flow
field finds a pathway
to catalyst layer
Pathway of water
from catalyst layer
Carbon nanoparticles
Platinum catalyst
Pathways of electron
conduction

FIGURE 2—MICROTURBINES

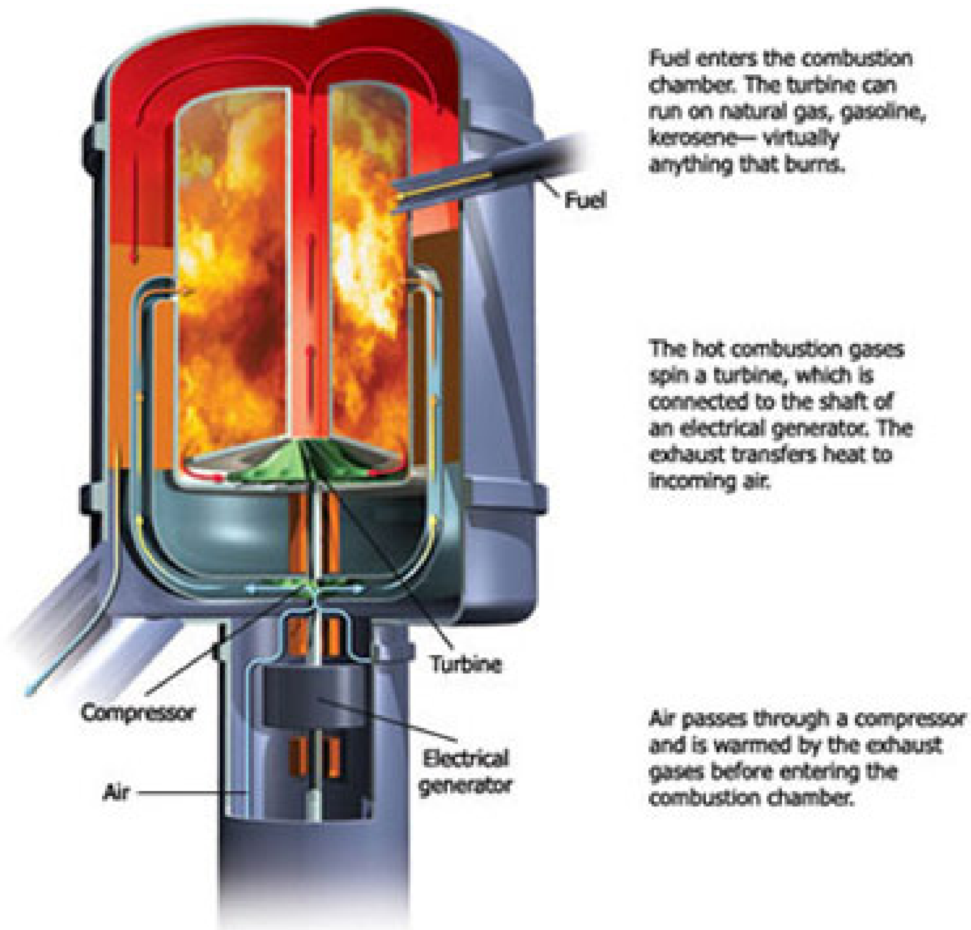


FIGURE 3—SERVICING MICROTURBINES

Solar Photovoltaic Systems

Solar photovoltaic systems use solar energy to produce electricity. The term photovoltaic is composed of "photo", the Greek root for "light", and "volt", a common measurement of electricity named after Alessandro Volta, a scientist renowned for his research on electricity. Together, these terms literally mean "light electricity". Photovoltaic technology can be referred to in short as photovoltaic or PV.

Photovoltaic technology relies on the electrical properties of certain materials known as semiconductors. When hit by sunlight, a semiconductor material responds by creating an electrical charge which can then be transferred to anything that uses electricity.

In connecting a photovoltaic system to an end use, several additional structures and technologies are needed. While photovoltaic panels can be mounted on roofs, it is important to consider the angle at which they face the sun. To transfer electricity to its end use, photovoltaic panels are connected through intermediary technologies that condition and modify the electricity they produce. These considerations are known as balance of system components, as they maximize the system's efficiency and allow higher amounts of electricity to reach its end use.

Some photovoltaic systems are called "stand-alone" or "off-grid" systems, which mean they are the sole source of power to a, water pump or other load. Stand-alone systems can be designed to run with or without battery backup. Remote water pumps are often designed to run without battery backup, since water pumped out of the ground during daylight hours can be stored in a holding tank for use any time. In contrast, stand-alone home power systems store energy generated during the day in a battery bank for use at night. Stand-alone systems are often cost-effective when compared to alternatives, such as lengthy utility line extensions. Other PV systems are called "grid-connected" systems. These work to supplement existing electric service from a utility company. When the amount of energy generated by a grid-connected PV system exceeds the customer's loads, excess energy is exported to the utility, crediting the customer's electric meter. Conversely, the customer can draw needed power from the utility when energy from the PV system is insufficient to power.

All of the power ratings of the PV arrays are presented in direct-current (DC) kW at Standard Test Conditions (STC). These test conditions are defined as 1,000W/m2 irradiance, 25°C cell temperature, and spectral distribution of Air Mass 1.5. Estimated electrical energy harvest is calculated with PV Watts software and estimates the annual net expected AC output of the system after overall power conversion efficiency and local weather data is taken into account. Since these Standard Test Conditions are not usually typical of how PV modules and arrays operate in the field, actual performance is usually 85 to 90 percent of the STC rating.

It is standard practice to size the photovoltaic array DC power rating to be larger than the AC output power rating of the inverter that is specified for the array. This is done because it is uncommon that PV modules will operate at the standard test conditions described above. The typical environmental conditions are often less than this ideal. In particular, as the modules increase in temperature, their power output decreases. This is most pronounced during the summer months when ambient temperatures are highest and the strongest sun is available. This sizing approach also compensates for the small amount of power that is lost when the DC electricity from the array is converted to AC electricity.

On College or University campuses, these systems are typically installed on roof of buildings or parking structures or on top of carports provided on parking lots.

Rooftop deployment of PV modules is one of the most common and cost-effective methods for adding solar electrical generating capabilities to a campus building.

Following is a description of two major types of photovoltaic systems:

Types of Photovoltaic Systems

Following is a description of two major types of photovoltaic systems:

Stand-Alone Systems

Stand-alone systems are not connected to the electrical grid and generally include storage batteries that store energy to provide power when solar energy is not available. Stand-alone systems are particularly suited for remote locations for powering a single piece of equipment where normal power is either difficult to distribute or is not available.

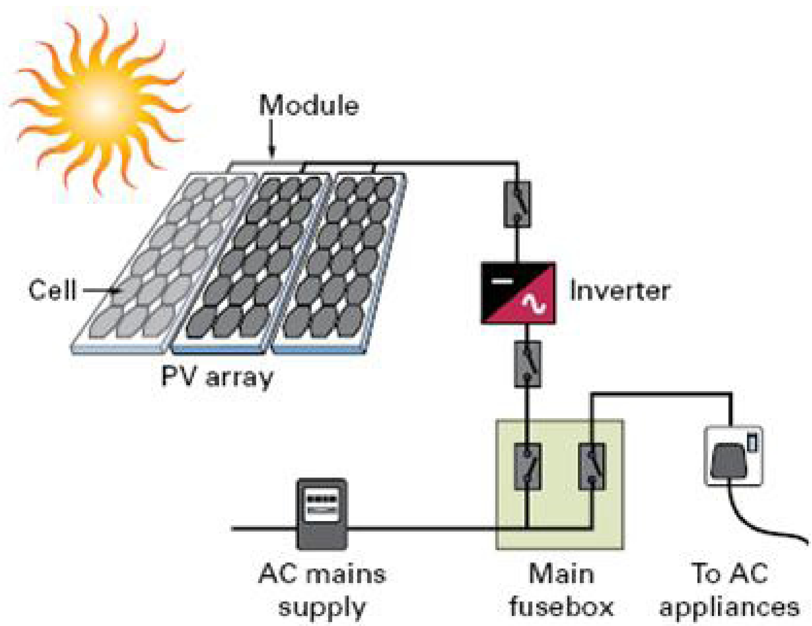
Grid-Connected Systems

Grid connected systems are the most preferred method for installing photovoltaic power generation on University/College campuses. Grid connected systems put the power they make onto the electrical grid. The serving electric utility company provides the balance of electric power when the campus uses more power than the PV system is generating. If the campus demand is below the amount made by the PV system the excess power credits the electric meter. The electric utility company will not buy power from the campus, but the electric bill will be reduced by the amount created by the PV system. This scheme is known as "Net Metering".

A grid connected system has few major components, requires very little maintenance, and has a long life span. The solar panels are available with a 25-year performance warranty and the inverters have warranties up to 10-years long or longer. The support structure, wiring, and other electrical components will last much longer than the PV panels. It is conceivable that a system could be built so that once the first 25-years was up it could be fitted with new panels and continue to operate for another 25-years.

A grid-connected photovoltaic system is also eligible for utility incentives. In the case of University or Colleges, this would be through their local utility company. There are no self-generation penalties for making electricity with photovoltaic systems.

FIGURE 4—GRID CONNECTED PV SYSTEM



Photovoltaic Panel Types

Although photovoltaic panels are based on a similar structure of cells and enabling components, there are many variations on the standard solar panel, differing primarily in the types of photovoltaic cell that they use. Each panel type is manufactured in a different way and has its own advantages and disadvantages.

The vast majority of solar panels produced today depend on the use of crystalline silicon as the material in their cells. It is used in moncrystalline (or single-crystalline), polycrystalline (or multicrystalline), and ribbon (or thin-layer) silicon panels.

Other panels, like thin-film technologies, depend on amorphous silicon, and still others use completely different semiconductors known as Group III-IV materials. Panels can also be enhanced in a number of ways to increase their efficiency or improve their versatility through the use of multi junction devices, concentrator systems, or building integrated systems.

The following is a description of each of the following panel types available in the market today with their advantages and disadvantages.

Monocrystalline Silicon Panels

15-18% efficiency

Monocrystalline panels use crystalline silicon produced in large sheets which can be cut to the size of a panel and integrated into the panel as a single large cell. Conducting metal strips are laid over the entire cell to capture electrons in an electrical current.

These panels are more expensive to produce than other crystalline panels but have higher efficiency levels and, as a result, are sometimes more cost-effective in the long run.

Polycrystalline Silicon Panels

12-14% efficiency

Polycrystalline, or multicrystalline, photovoltaics use a series of cells instead of one large cell. These panels are one of the most inexpensive forms of photovoltaics available today, though the costs of sawing and producing wafers can be high. At the same time, they have lower conversion efficiencies than monocrystalline panels.

For this technology, several techniques are used:

Polysilicon

In this process, molten silicon is first cast in a large block which, when cooled, is in the form of crystalline silicon and can be sawn across its width to create thin wafers to be used in photovoltaic cells. These cells are then assembled in a panel. Conducting metal strips are then laid over the cells, connecting them to each other and forming a continuous electrical current throughout the panel.

String Ribbon Silicon

String ribbon photovoltaics use a variation on the polycrystalline production process, using the same molten silicon but slowly drawing a thin strip of crystalline silicon out of the molten form. These strips of photovoltaic material are then assembled in a panel with the same metal conductor strips attaching each strip to the electrical current. This technology saves on costs over standard polycrystalline panels as it eliminates the sawing process for producing wafers. Some string ribbon technologies also have higher efficiency levels than other polycrystalline technologies.

Amorphous Silicon or Thin Film Panels

5-6% efficiency

Thin-film panels are produced very differently from crystalline panels. Instead of molding, drawing or slicing crystalline silicon, the silicon material in these panels has no crystalline structure and can be applied as a film directly on different materials. Variations on this technology use other semiconductor materials like copper indium diselenide (CIS) and cadmium telluride (CdTe). These materials are then connected to the same metal conductor strips used in other technologies, but do not necessarily use the other components typical in photovoltaic panels as they do not require the same level of protection needed for more fragile crystalline cells.

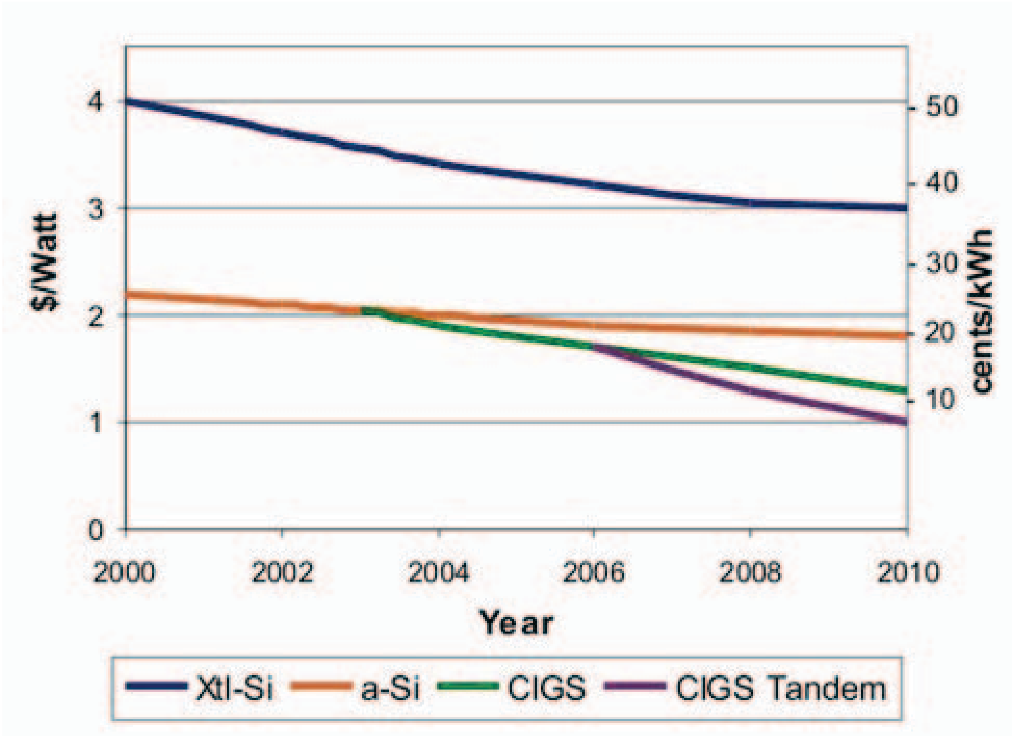
The primary advantages of thin-film panels lie in their low manufacturing costs and versatility. Because amorphous silicon and similar semiconductors do not depend on the long, expensive process of creating silicon crystals, they can be produced much more quickly and efficiently. As they do not need the additional components used in crystalline cells, costs can be reduced further. Because they can be applied in thin layers to different materials, it is also possible to make flexible solar cells.

However, thin-film panels have several significant drawbacks. What they gain in cost savings, they lose in efficiency, resulting in the lowest efficiency of any current photovoltaic technology. Thin-film technologies also depend on silicon with high levels of impurities. This can cause a drop in efficiency within a short period of use.

Thin-film panels have the potential to grow in use, and already figure in some of the most exciting enhanced photovoltaic systems, including high-efficiency multi-junction devices and building integrated photovoltaics.

Below is a graph showing the $/watt and production costs in cents/kWh of various thin film panel types (Xtl-Si: crystallline silicon, a-Si = amorphous silicon thin film, CIGS = copper indium gallium diselenide thin film, CIGS tandem = tandem a-Si/CIGS thin film). Presently, thin-film PV modules are one-third the cost of crystalline PV modules.

FIGURE 5—COST EVOLUTION IN $/WATT FOR DIFFERENT PV MODULES



Group III-V Technologies

25% efficiency

These technologies use a variety of materials with very high conversion efficiencies. These materials are categorized as Group III and Group V elements in the Periodic Table. A typical material used in this technology is gallium arsenide, which can be combined with other materials to create semiconductors that can respond to different types of solar energy.

Though these technologies are very effective, their current use is limited due to their costs. They are currently employed in space applications and continue to be researched for new applications.

Enhanced Systems

Building-Integrated Photovoltaics (BIPV)

BIPV technologies are designed to serve the dual purpose of producing electricity and acting as a construction material. There are many forms that this technology can take. One common structure is the integration of a semi-translucent layer of amorphous silicon into glass, which can then be used as window panes that let controlled amounts of light into a building while producing electricity. Another common structure is the use of shingle-sized panel of amorphous silicon as a roofing material.

Currently, BIPV technologies have very low efficiency levels due to their use of amorphous silicon, but present the advantage of replacing other construction materials and offering a wide variety of aesthetic choices for the integration of photovoltaics into buildings.

Concentrator Systems

Concentrating photovoltaic systems use lenses or mirrors to concentrate sunlight onto high-efficiency solar cells. These solar cells are typically more expensive than conventional cells used for flat-plate photovoltaic systems. However, the concentration decreases the required cell area while also increasing the cell efficiency.

Their main disadvantage for SBVC is that there is no available land due to the density of the campus to install these ground-based collector arrays.

FIGURE 6—8.4 KW GROUND-BASED CONCENTRATOR ARRAY

High-Efficiency Multi-junction Devices

Multi-junction devices receive their name from their use of multiple layers of cells, each layer acting as a junction where certain amounts of solar energy are absorbed. Each layer in a multi-junction device is made from a different material with its own receptivity to certain types of solar energy.

In a typical device, the top photovoltaic layer responds to solar waves that travel in short wavelengths and carry the highest energy, absorbing this energy and creating an electrical charge. As other solar waves pass through this layer, they are absorbed and translated into electricity by the lower layers. Typical materials used in this device include gallium arsenide and amorphous silicon.

Though some two-junction devices have successfully been built, these devices are still largely in the research and development stage, with most research focused on three- and four-junction devices.

Installation Considerations

Of the various technologies discussed above, PV panels should be selected based on various factors for each specific project. These factors include overall efficiency, available space for installation and installed $/watt.
In addition, consideration of the panel's output over their lifetime is also critical. The cells made from mono-crystalline silicon have the highest performance in terms of efficiency, and lifespan. These cells are available with performance warranties as long as 25-years, and are made by manufactures that are well established in the solar industry.

To work its best, a complete photovoltaic system depends on several considerations and intermediary technologies to efficiently generate electricity and transfer it to an end use. These elements include mounting structures that help an array gain the best tilt towards the sun, and technologies that both condition the electricity produced and connect it in a variety of ways to one or more end uses. In the photovoltaic industry, these elements are called balance of system components because they help in matching a photovoltaic panel or array to its site and use.

Following are areas of consideration in installing photovoltaics.

Installing an Array to Maximize Efficiency

A primary consideration in installing a photovoltaic array on a building is the availability of solar energy in the space where the system will be mounted. As solar cells are connected within panels and as panels are connected to each other in the array, any shade from a tree, building or other structure that falls on a cell or panel can reduce the efficiency of the entire system. For this reason the majority of arrays are installed on roofs where they can receive unimpeded solar energy throughout the day.

A second consideration is the angle at which the array is mounted. Solar energy does not reach the earth at the same angle throughout the day and year or in different parts of the country. In the Northern Hemisphere, the summer sun is almost directly overhead, but, as the earth tilts away from the sun in the winter, the sun follows a path lower in the sky and towards the south, causing solar energy to reach the earth's surface at a much more acute angle.

While the sun's angle changes throughout the year, our need for electricity does not change very much. To allow for the breadth of angles of solar energy, photovoltaic systems are typically mounted at an angle that accommodates both the high summer sun and the low winter sun, maximizing its efficiency at all times of year.

As a rule of thumb, photovoltaic panels that best accommodate the range of solar angles in a particular location are facing south tilted at an angle equal to the latitude of the location.

While a photovoltaic system can operate without directly facing the path of solar energy, the closer it comes to meeting this path, the more efficiently it works. However, this efficiency is often traded off with the additional cost of certain mounting structures and need to be evaluated on a case-by-case basis.

Mounting Structures

The following are various methods utilized to install photovoltaics panels:

Flat Mounting: Flat mounting is the simplest way to install photovoltaics on a roof. In this situation, photovoltaic panels are simply arranged in an array and mounted to the roof using direct attachments or a weighted framework to make the system resistant to the wind.

While efficiency is diminished, the system is still relatively effective and can be an attractive choice for buildings that want to install large arrays at minimal cost.

Flat mounted systems can also be installed on slanted roofs, which keep installation costs down while gaining a tilt closer to the region's ideal angle.

Rack Structures: Rack mounting systems allow more control over the array's angle. These systems rely on a simple metal frame that supports the array at the desired angle toward the south. Rack systems are best used on buildings with flat roofs or on the ground, as even a slightly tilted roof can sometimes make installation difficult.

Pole Mounting: Pole mounting is used similarly to rack mounting but supports the photovoltaic array on a pole mounted in the ground. These systems are most often used in rural locations or locations where the best sunlight is not near a building.

Tracking Structures: Tracking structures literally track the sun's angle as it changes throughout the day and year. Two types of tracking structures are available: one-axis and two-axis. One-axis trackers follow the sun from east to west as it passes through the sky and still need to be mounted at a 34-degree angle facing the south. Two-axis trackers can track both the sun's daily course and its changing path throughout the year. While these systems are the most effective in capturing direct sunlight as its angle changes, they also require more expensive, high-maintenance components than other mounting structures. They are typically reserved for technologies like photovoltaic concentrator systems that depend solely on direct sunlight to function.

Connecting an Array to a Load

Because photovoltaic technologies rely on the sun, their energy production changes with the availability of solar energy. To ensure that a photovoltaic system can provide electricity when it is needed, additional components are needed to either temporarily store electricity for later use, or to connect the array to a building that has an alternate power source, like the local utility, available when electricity from the array is not.

Another factor complicating connection of an array to a building is that buildings use electricity in a different form than the electricity provided by a photovoltaic array. The electricity from photovoltaic arrays travels in a direct current (DC current) while buildings are structured to rely on alternating current (AC current). To make photovoltaic electricity usable, it needs to be transformed from direct current to alternating current and its flow needs to be controlled as it joins the currents used in different buildings.

There are several different ways to structure a photovoltaic array in relation to its load. The most straightforward is a direct connection, or direct-coupled system which connects the direct current to an end use. These systems are useful for small-scale daytime applications like water pumps and ventilation fans, but because of the complicating factors mentioned above, most applications require several additional components.

Balance of System Components

All PV modules generate direct-current (DC) electricity and will require additional equipment beyond the PV array to interface with the building's electrical distribution system. This equipment is often referred to as the 'balance-of-system' (BOS) equipment. The components consist of structures, enclosures, wiring, switchgear, fuses, ground fault detectors, charge controllers, and inverters.

Inverter Technology

Inverters are used to convert DC power, which is not compatible with the AC power used on the grid into AC power. The power and voltage output of the panels changes with the intensity of the sunlight striking them. The inverters convert the power to AC, and keep the output voltage constant. The inverter will match its output power to the frequency, phasing, and voltage of the grid power. Inverter technology is based on insulated-gate bipolar transistors (IGBT).

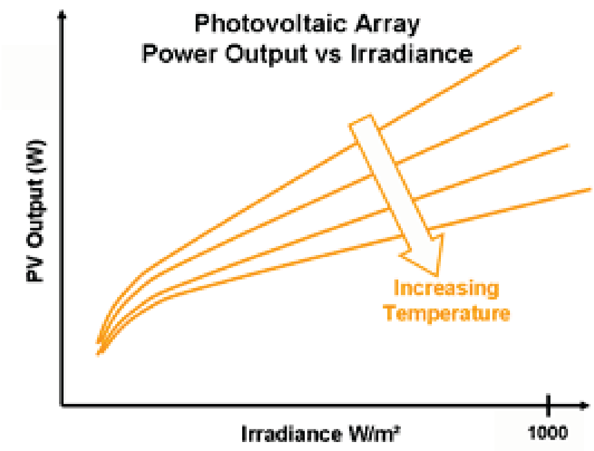
FIGURE 7—TYPICAL 250 KW PV INVERTER

PV Panels Installation

The solar cells convert sunlight into DC electricity. Groups of 5-12 panels are wired in series arrays. This develops the desired output voltage of approximately 400VDC. The actual number of PV panels in an array is dependent on the actual installation, since the output voltage will varies between models, and brands of panels.

The arrays are wired in parallel to develop the desired system capacity (kW). A typical system will use a large number of panels. As an example a 225kW system will use approximately 1700 each of 175W panels. The overall system capacity equates typically to a 300kW system, since it is common to install 30% or more in panel rated capacity than the system size. There are two main reasons to do this. First the panel rating is based on ideal conditions; the actual operating conditions will differ. Secondly, the panels do not produce full power most of the day (power is a function of the position of the sun).

FIGURE 8—TEMPERATURE VS. PV OUTPUT



The power from the arrays is collected in junction boxes. The junction boxes are located outside with the PV panels. Inside these boxes the arrays are tied together in parallel connections. The feeders from the junction boxes are routed to the inverter, which is typically located in an electrical room near the grid connection point.

The DC current from the cells is connected to an inverter. The inverter converts the DC power into 480VAC or 208V and matches the incoming phase, voltage and frequency of the grid power. The inverters for grid connected PV plants are pre-approved by the utilities for this purpose. The inverter has disconnect switches on both PV and utility sides.

The electricity leaving the inverter travels through a meter section and switch-gear before entering the power grid. A specialized meter and switch-gear design is required for a PV system. During the day when the PV system is creating power the unusual situation exist of having live power on both sides of the meter, and the design has to allow for this.

Weather conditions play an important role in determining the amount of power generated from a PV plant. Obviously cloud cover will greatly degrade performance. The outside air temperature also plays an important role in generated output. The solar panels output is also reduced with an increase of temperature of the cell. Figure below represents the decrease in the cell's performance with the increased temperature of the cell. This is not the ambient temperature, but the actual cell's temperature. It is not advisable to put a PV panel right against another surface, such as a roof. It is a better design that allows for airflow all round the cell. Most roof top systems have an air gap on the underside to allow natural convection to take place. The carport style of construction also does not have this problem.

The figures below provides the sun path for both winter and summer seasons and the associated solar radiation in kWh/m²/day at the campus.

FIGURE 9—SAN BERNARDINO SUN PATH

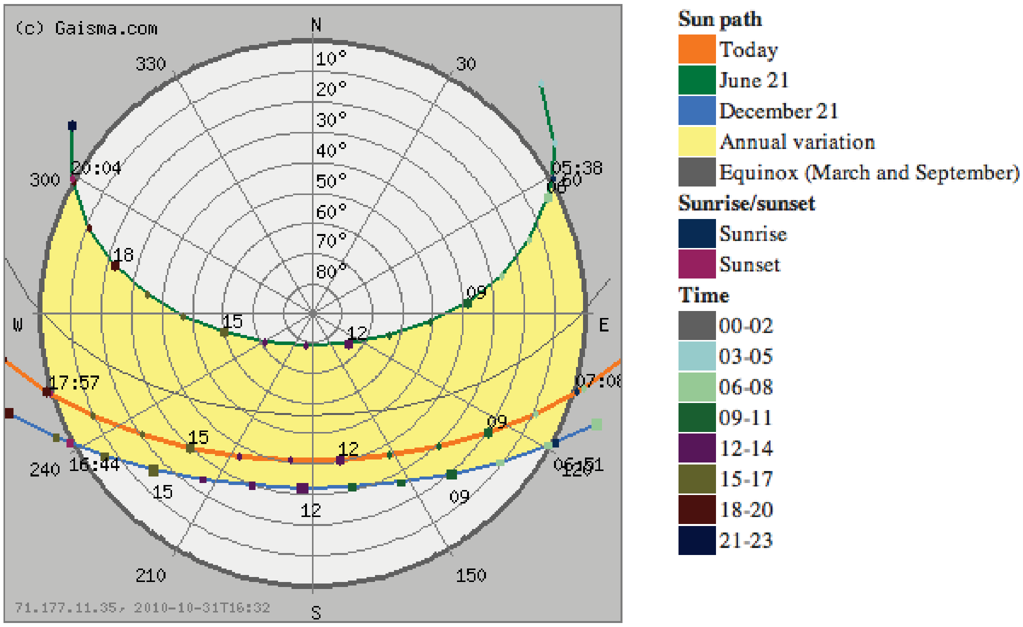
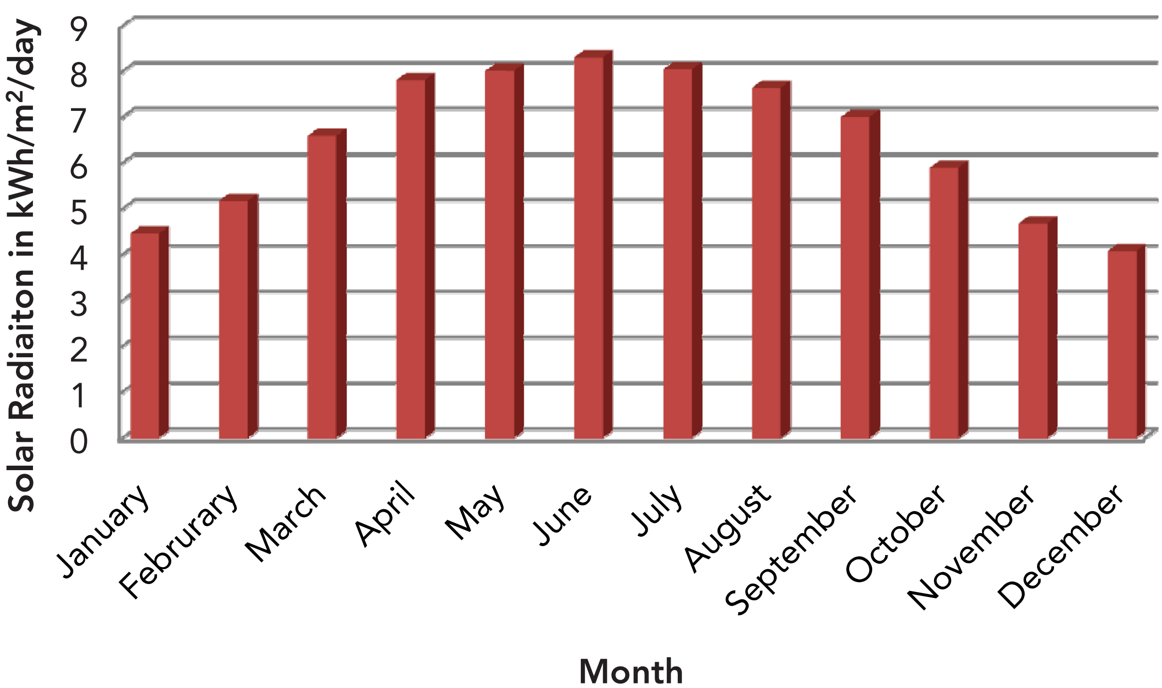


FIGURE 10—SAN BERNARDINO AVAILABLE AVERAGE SOLAR RADIATION IN KWH/M²/DAY



Incentives

The California Public Utilities Commission, through its California Solar Initiative, provides incentives for existing and new commercial properties that install photovoltaic systems.

The California Solar Initiative provides two types of incentives to solar customers:

- Performance-based incentives (PBI), As of January 1, 2010, all systems over 30 kW must take the PBI. Any sized system can elect to take PBI. The PBI pays out an incentive, based on actual kWh production, over a period of five years. PBI payments are provided on a $ per kilowatt-hour basis.
- Expected performance-based buy down (EPBB) As of January 2010, systems smaller than 30 kW in capacity will receive a one-time, up-front incentive based on expected performance, and calculated by equipment ratings and installation factors (geographic location, tilt and shading). EPBB payments are provided on a $ per watt basis. Systems eligible for EPBB can choose to opt-in to the PBI system described below.

Incentives for both types are provided below for reference.

TABLE 1—INCENTIVE PAYMENT AMOUNTS

Step	MW in Step	EPBB Payments (per Watt)			PBI Payments (per kWh)		
			Non-Residential			Non-Residential	
		Residential	Commercial	Governmental / Non-Profit	Residential	Commercial	Governmental / Non-Profit
1-6	190	n/a	n/a	n/a	n/a	n/a	n/a
7	215	$0.65	$0.65	$1.40	$0.09	$0.09	$0.19
8	250	$0.35	$0.35	$1.10	$0.05	$0.05	$0.15
9	285	$0.25	$0.25	$0.90	$0.03	$0.03	$0.12
10	350	$0.20	$0.20	$0.70	$0.03	$0.03	$0.10

The first two columns represent the amount of megawatts that have approved applications submitted. As of October 2010, the non-residential program had reached Step 7.

The EPBB column represents the single payment amount the owner will receive once the PV system is completed. The PBI is a monthly payment that will be provided to the owner for a period of 5-years. The amount of each month's payment will be based on the PV system's meter reading. Once the application is accepted the rate of payment is locked in for the 5-years. Currently the rate is at $0.19/kWh.

Assembly Bills Affecting PV Generation Capacity

The following two bills have recently been passed by the state and affect the proposed generation capacities of PV systems at the campus:

Assembly Bill 2466

Assembly Bill 2466 was passed by the State last year allowing a facility to apply excess renewable power produced from a customer account as energy credits against charges for power delivered to one or more of its other accounts provided:

a) The net power delivered to the grid from a generating facility consists of generators whose nameplate ratings do not collectively exceed 1 MW.

b) The generating facility is located within the geographical boundary of, and is owned, operated, or on property under the control of, the customer.

c) The generating facility is sized to offset all or part of the electrical load of the Benefiting Account(s).

d). The generating facility is an eligible renewable resource under the Renewables Portfolio Standard Program

Although this bill became effective last year, the same is still being discussed with the PUC and the utility companies and no formal arrangement or agreement of sharing the additional energy generated among the various sits of the customer has been reached.

Assembly Bill 920

Assembly Bill was passed by the state this year and requires the ratemaking authority by January 1, 2011, to compensate a net surplus eligible customer-generator for delivering electricity to grid that is in excess of the amount of electricity delivered from the grid to the eligible customer-generator. The bill requires the electric utility to offer a standard contract or tariff to eligible customer-generators that includes compensation for the value of net surplus electricity. The bill would require the electric utility, upon an affirmative election by the eligible customer-generator to receive service pursuant to this contract or tariff, to either:

a) provide net surplus electricity compensation for any net surplus electricity generated in the 12-month period, or

b) allow the eligible customer-generator to apply the net surplus electricity as a credit for kilowatt hours subsequently supplied by the electric utility to the surplus customer-generator.

Again, although this bill became effective this year, the same is still being discussed with the PUC and the utility companies and no formal arrangement or agreement of rates that would be offered to the eligible customer generators has been reached.

Solar Water Heating

Solar water heating systems for pools can provide an efficient and cost-effective means of heating pools if pools are heated throughout the year. The most common collector used in solar hot water systems is the flat plate collector.

Solar water heaters use the sun to heat the pool water in the collector.

Types of Solar Collectors

Two types of solar collectors currently exist in the market: : flat plate collectors and evacuated tube collectors.

Flat Plate Collectors

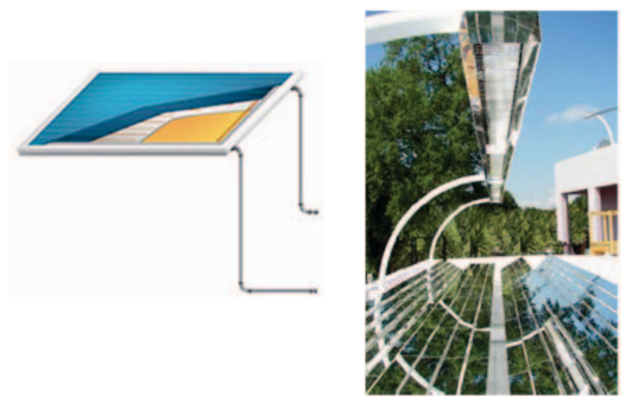
Flat plate collectors typically consist of copper tubes fitted to flat absorber plates. The most common configuration is a series of parallel tubes connected at each end by two pipes (the inlet and outlet manifolds). The flat plate assembly is contained within an insulated box and covered with tempered glass.

Passive Solar

Passive solar water heaters rely on gravity and the tendency for water to naturally circulate as it is heated. Because they contain no electrical components, passive systems are generally more reliable, easier to maintain, and possibly have a longer work life than active systems.

No incentives are currently offered by the state for this technology. The building solar water heating system costs are high and the technology is not cost effective due to the intermittent service water heating loads. This technology is currently not recommended.

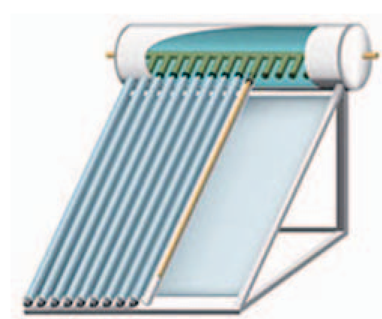
FIGURE 3—FLAT PLATE AND COMPOUNDED PARABOLIC COLLECTORS



Evacuated Tube Collectors

Evacuated tube collectors are the most efficient collectors available and similar to a thermos in principle. A glass or metal tube containing the water or heat transfer fluid is surrounded by a larger glass tube. The space between them is a vacuum, so very little heat is lost from the circulating fluid. These collectors also work well in overcast conditions and operate in temperatures as low as -40°F. Individual tubes have a life expectancy of 25-30 years and can be replaced as needed.

FIGURE 4—EVACUATED TUBE TYPE COLLECTORS

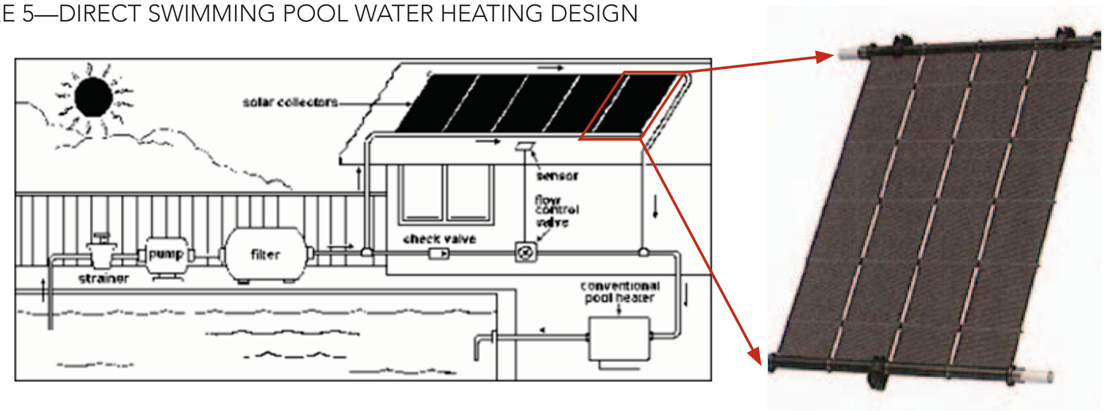


Circulation Systems

Direct Circulation Systems

Direct systems circulate water through solar collectors where it is heated by the sun. The heated water is then used directly in the pool. These systems are preferable in climates where it rarely freezes. Freeze protection is necessary in cold climates. Scaling can be an issue due to water hardness and can add a performance barrier to the heat transfer over time. A typical direct solar collector is specified in Attachment E.

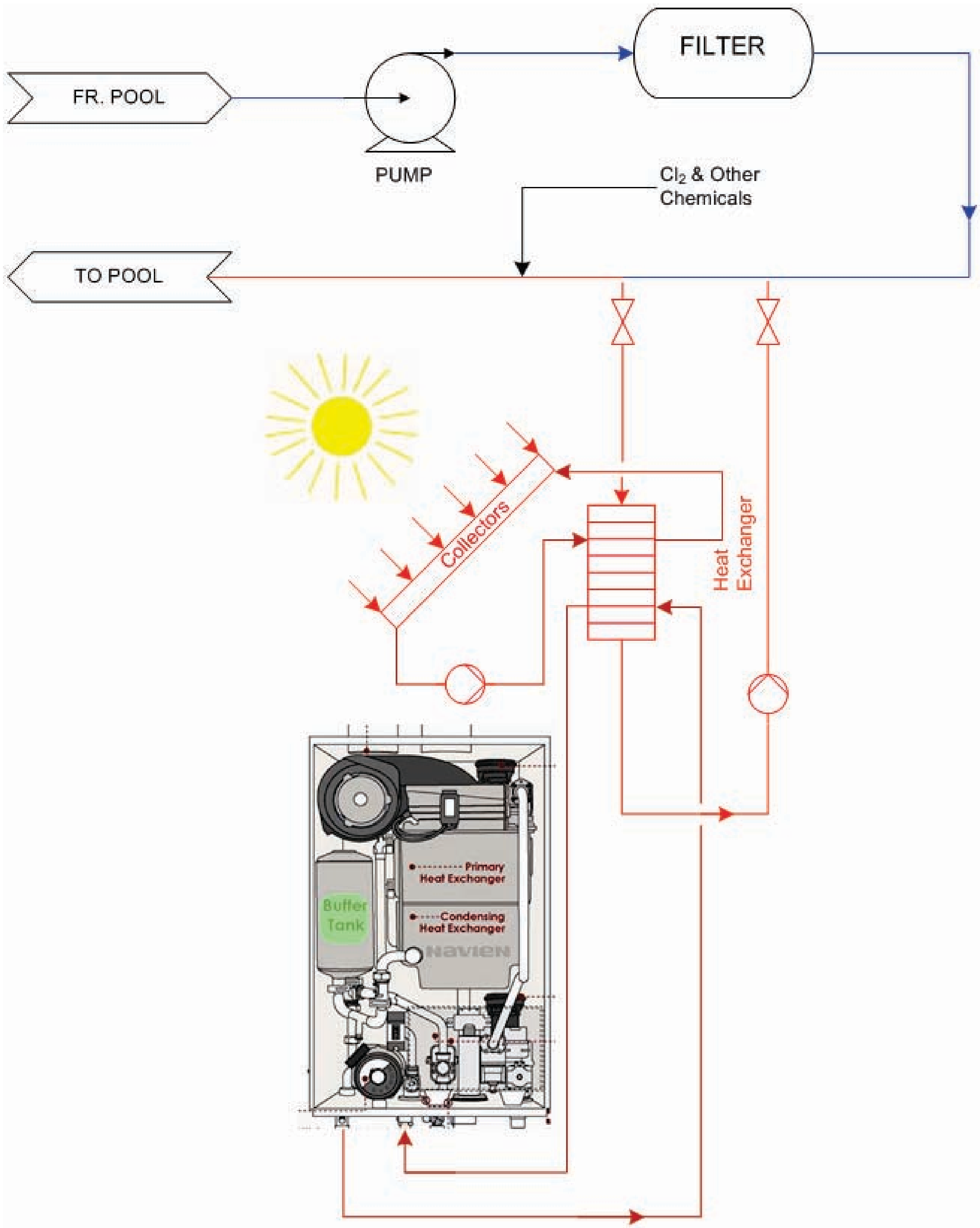
FIGURE 5—DIRECT SWIMMING POOL WATER HEATING DESIGN



Indirect Circulation Systems

Closed-loop, or indirect, systems use a non-freezing liquid to transfer heat from the sun to water in a storage tank. The sun's thermal energy heats the fluid in the solar collectors. Then this fluid passes through a heat exchanger in the storage tank, transferring the heat to the water. The non-freezing fluid then cycles back to the collectors. Glycol is typically to fluid of choice, but brings with it special handling and disposal requirements due to its classification. Good alternatives to glycol, especially in non-freezing climates, are deionized water and the use of biodegradable water softeners. These systems are appropriate where high hardness of domestic water is encountered. The clean design of the indirect system (i.e. not circulating the pool water through the collectors) results in a very low degradation rate for the fluid. An example of an indirect system with high-efficiency tankless water heaters is shown in Figure 6.

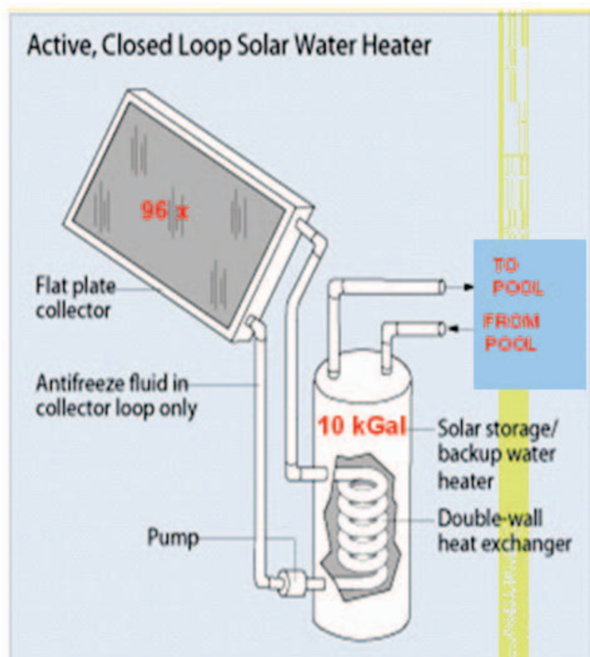
FIGURE 6—INDIRECT SWIMMING POOL WATER HEATING DESIGN



Active (Forced-Circulation) Systems

Active - or forced-circulation - systems use electric pumps, valves and controllers to move water from the collectors to the storage tank. This type of system is needed for storing solar thermal energy to be supplied during off sun hours of pool use. An example of an active system is shown in Figure 7.

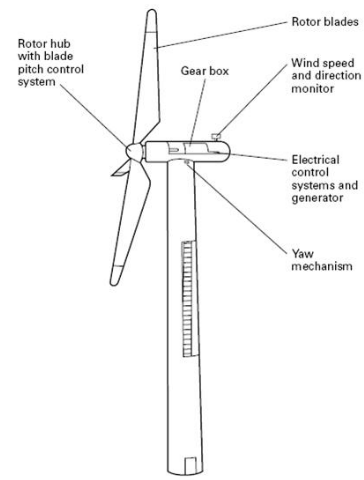
FIGURE 7—ACTIVE SWIMMING POOL WATER HEATING DESIGN



Wind Power

Wind power is a viable energy source with wide-ranging applications for distributed generation. Wind farms can be sized for small- or large-scale power generation. Wind power is becoming popular due to the fast and simple installation and low maintenance requirements once installed.

FIGURE 12—WIND TURBINE

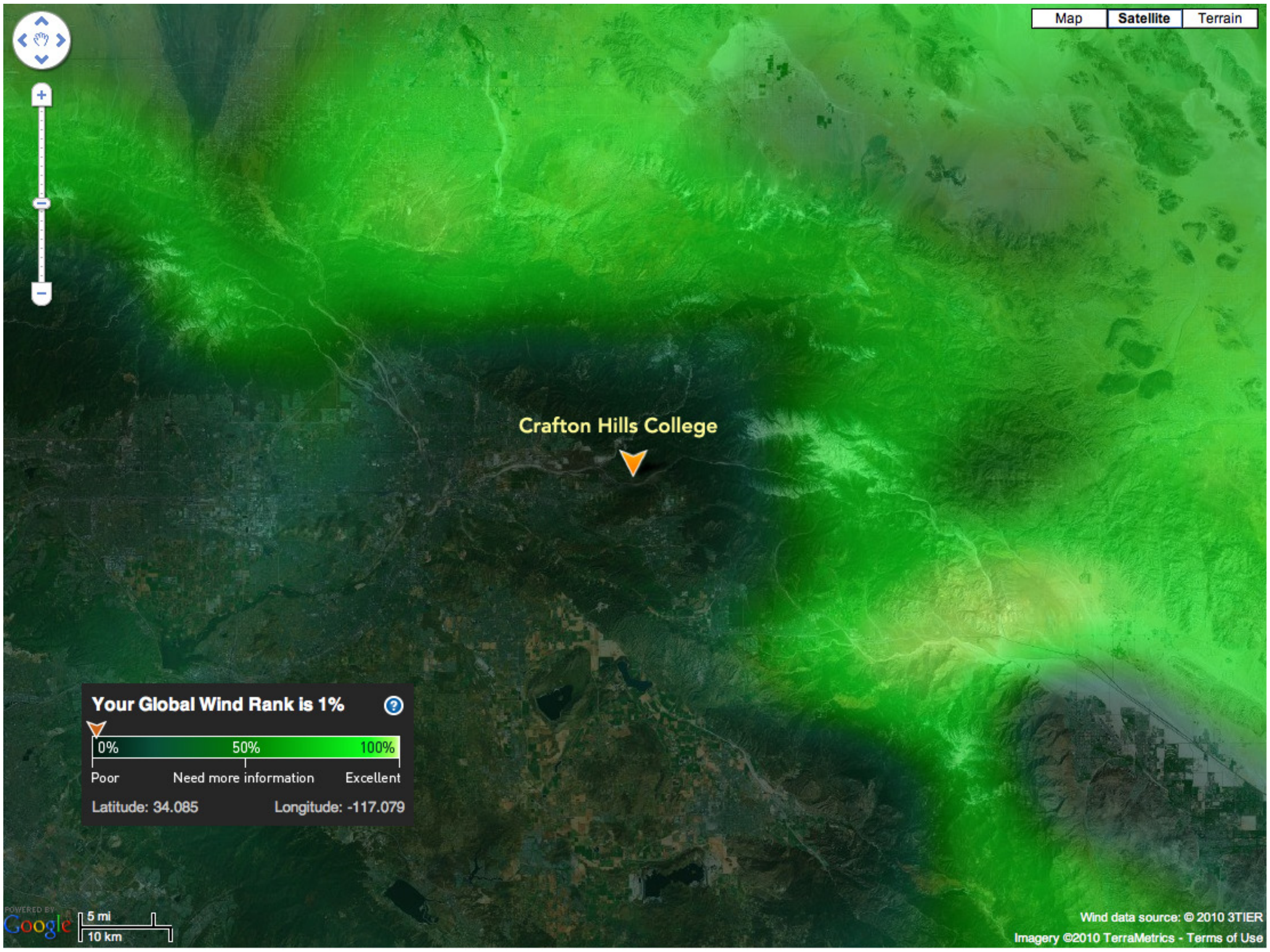


Generally, wind farms are located in areas with good winds and typically have annual capacity factors ranging from 20% to over 40%. A typical life of a wind turbine is 20 years. Maintenance is required at 6-month intervals.

Large-scale wind farms can be installed for about $3,000-$3,500/kW. The cost of electricity produced from wind farms depends on the annual capacity factor, location/wind quality, maintenance costs, and installation costs; but typically ranges from 5 to 8 cents/kWh. The cost for small-scale wind turbines is higher. Wind turbines do not produce any harmful emissions or require any fuel product for operation. Minimal space is required for a turbine farm.

The class of winds required to provide adequate power where it becomes economically attractive are Class 3 (6meters/sec) and above (Class 1 is Poor and Class 7 is Superb). A review of the Crafton Hills campus wind map below indicates that the wind speeds at the campus location fall below the required wind class required for generating power and falls in the poor class having 1% out of 100% wind potential. Thus a wind turbine in a poor wind speed (Class 2 and below) will produce 25-30% less power than in a class 3 and above winds. In addition, the capacity factor of the system will be reduced by the same factor and thus increase the cost of production. Based on a comparison of costs of this technology versus the PV technology at the campus, this technology would cost approximately 2-3 cents/kWh more compared to the PV technology. Thus based on the availability of class of wind at the campus, this technology proves to be expensive and is not recommended for the campus.

FIGURE 11—ANNUAL AVERAGE WIND SPEED



Recommendations and Costs

The total electrical consumption of the campus currently stands at 3.4 million kWh per year with a peak demand of 1.3 MW.

A review of the various technologies revealed that PV and Solar Thermal systems would be the most techno economical solutions for the campus.

Photo Voltaic Systems

A review of the campus landscape reveals that the campus has a number of open areas available to provide ground mount PV systems at the campus. In addition, proposed parking structures and new buildings provide sufficient roof areas to install PV systems. Based on a review of the various PV technologies, we recommend that the campus install photovoltaic power systems on the roofs of new buildings and proposed parking structures/parking lots to limit dependence on non-renewable power sources, reduce greenhouse gas emissions and eliminate the impact of fluctuation of energy prices in the future. Alternate locations of providing ground mount concentric PV systems have also been provided in Appendix 'C'. These locations can be used in lieu of parking lots and parking structure 2 if the prices of the ground mount concentrator PV systems become attractive in the coming years. Although the campus has a lot more open area compared to Valley campus and can accommodate a sizeable PV system, we would recommend limiting the size of the proposed PV system in phase 1 to under 1MW until an agreement is reached on the above assembly bills AB2466 and AB920. The proposed PV systems referenced should be installed in phases as follows. Phase 1 would include 800 kW (DC) of PV power. Phase 2 would include an additional 600 kW (DC) of PV power.

Phase 1	Parking Structure 1	400 kW (DC)
	Total	400 kW (DC)
Phase 2	CRF Parking Lot	400 kW (DC)
	Total	400 kW (DC)
Phase 3	Student Center	200 kW (DC)
	Emergency Services #2	200 kW (DC)
	Total	400 kW (DC)
Phase 4	Campus Available Land	800 kW (DC)
	Total	800 kW (DC)

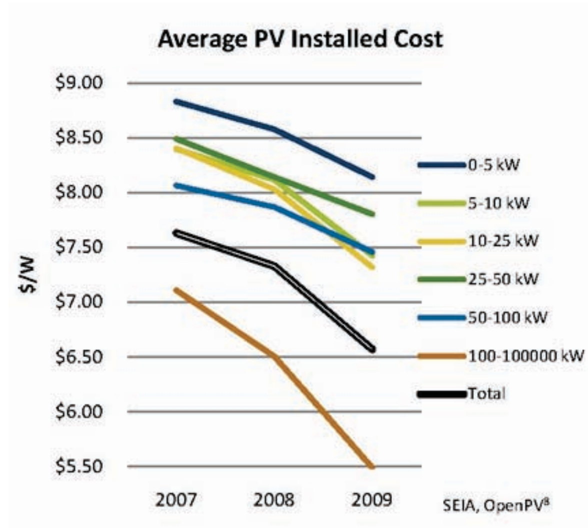
The proposed kWh generated by each phase of PV system is depicted in Figure 13.

A photovoltaic system requires approximately 90 -115 ft^2 of footprint area per installed kW DC. In addition, this area should be free from solar shading from other buildings, trees, light poles, or other structures. Thus rooftops and parking lots are the preferred PV locations.

Maintenance typically involves replacing DC-AC power inverters every 10 years. Current inverter replacement cost is approximately $0.50 per watt (DC). Replacement costs are projected to be $0.20-0.30 per watt (DC).

These PV systems could either be purchased and owned by the District or procured using a 3rd party under the Power Purchase Agreement (PPA). Using a PPA, the owner of the PV system will own the renewable energy credits and will offer the same to the District at a specified rate/kWh. The cost of these REC's currently vary from $0.01-$0.015 per kWh. The cost for electricity under these agreements are typically structured to ensure the owner of the PV system will recover their investment with profit by providing escalation rates (typically 3% per year) to the power purchase costs. The District should consider the possible rewards and risks of both options during the early phases of implementation.

Costs



The solar energy industry typically uses price per watt as its primary unit of measurement.

As a rule of thumb, the solar module represents 40-50% of the total installed cost of a Solar System. This percentage will vary according to the nature of the application. A complete solar system includes all the other components (called the balance of systems) required to create a functioning system, whether it be to feed energy in to the grid or to be used in stand-alone off-grid applications.

Last year saw a second year of major price declines for PV modules. Prices have fallen to $1.85-$2.25 per watt from $3.50-$4.00 per watt in mid-2008, a drop of over 40 percent. With module prices accounting for up to half of the installed cost of a PV system, these prices are beginning to put downward pressure on system prices. Average installed cost fell roughly 10 percent from 2008 to 2009. This is despite the large shift to the more labor-intensive (and expensive) residential installations. With new innovations in the installation process, increasing economies of scale and innovative equipment increasing energy yields, the cost reductions are expected to continue.

The graph below shows PV installed costs for various kW capacities. These costs continue to decline this year thus making PV's more attractive in the commercial market.

The cost of a rooftop PV installation is currently projected to be about $5/watt. A payback analysis of this system revealed a positive cash flow after 13 years. Payback calculations are included in Appendix 'C'.

Costs of car port structures on parking lots and on parking structures are currently projected to be approximately $8/watt due to the costs of additional steel structure required to elevate and support the panels.

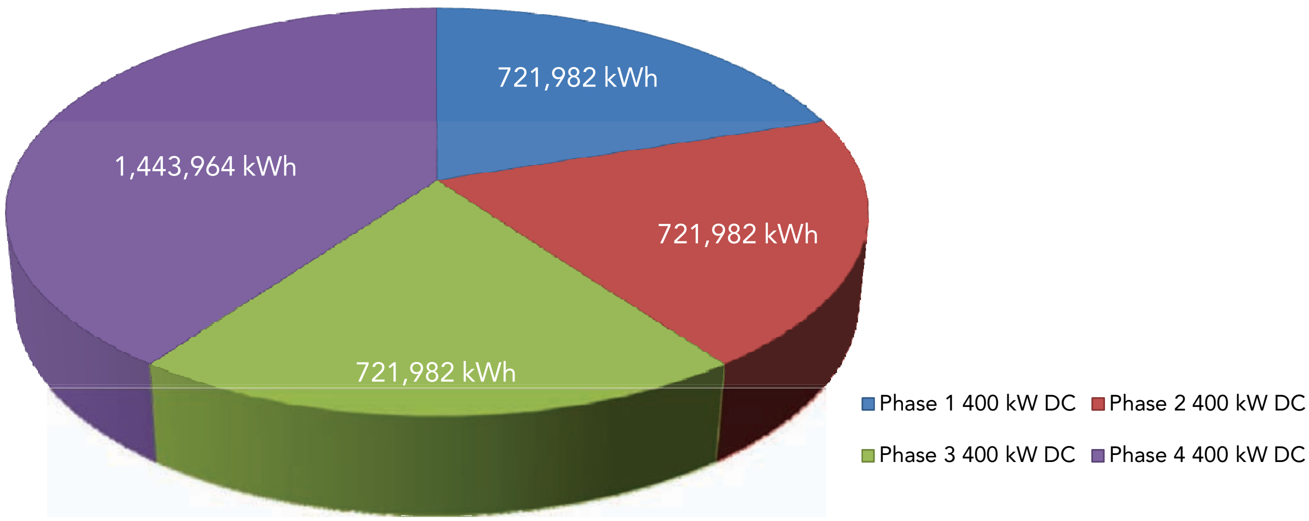
Based on our above projected costs/watt, below are costs projected for Phase 1 and Phase 2 PV systems recommended in our report.

COSTS

Phase	Proposed Location	PV Capacity in kW	Unit Cost in $/watt	Total Costs
1	Parking Structure 1	400 kW	$8/watt	$3,200,000*
2	CRF Parking Lot	400 kW	$8/watt	$3,200,000
3	Student Center	200 kW	$5/watt	$1,000,000
	Emergency Services #2	200 kW	$5/watt	$1,000,000
4	Campus Available Land	800 kW	$8/watt	$6,400,000
	Total Costs			$14,800,000

* Cost included in Parking Structure budget.

FIGURE 13—PV ENERGY PRODUCTION BY LOCATION



The California Solar Initiative incentives were calculated based on the Step 7 EPBB incentive available today. Phase 2 incentives may be lower but we have assumed that the cost/watt of PV will also be lower in the future.

PHASE 1 INCENTIVES

Proposed Location	kWh for First 5 Yrs	Incentive $/kWh	Total Incentive
Parking Structure 1	3,609,910	$0.19	$685,880
Total Incentives			$685,880

PHASE 2 INCENTIVES

Proposed Location	kWh for First 5 Yrs	Incentive $/kWh	Total Incentive
CRF Parking Lot	3,609,910	$0.19	$685,880
Total Incentives			$685,880

PHASE 3 INCENTIVES

Proposed Location	kWh for First 5 Yrs	Incentive $/kWh	Total Incentive
Student Center	1,804,955	$0.19	$342,940
Emergency Services #2	1,804,955	$0.19	$342,940
Total Incentives			$685,880

PHASE 4 INCENTIVES

Proposed Location	kWh for First 5 Yrs	Incentive $/kWh	Total Incentive
Campus Available Land	7,219,820	$0.19	$1,371,760
Total Incentives	7,219,820	$0.19	$1,371,760

Refer to Appendix C for associated payback calculations, approximate kWh output and a map showing locations of the proposed PV installations.

Life cycle cost calculations using a 2.5% electric rate escalation factor and inverter replacement costs revealed the following payback periods for the PV systems if the campus chose to install the systems. A Power Purchase Agreement (PPA) with an outside entity can produce different results since they can take advantage of the 30% renewable energy federal tax credits.

Phase 1 PV resulted in a payback of 22 years

Phase 2 PV resulted in a payback of 13 years for building and 22 years for the parking structure.

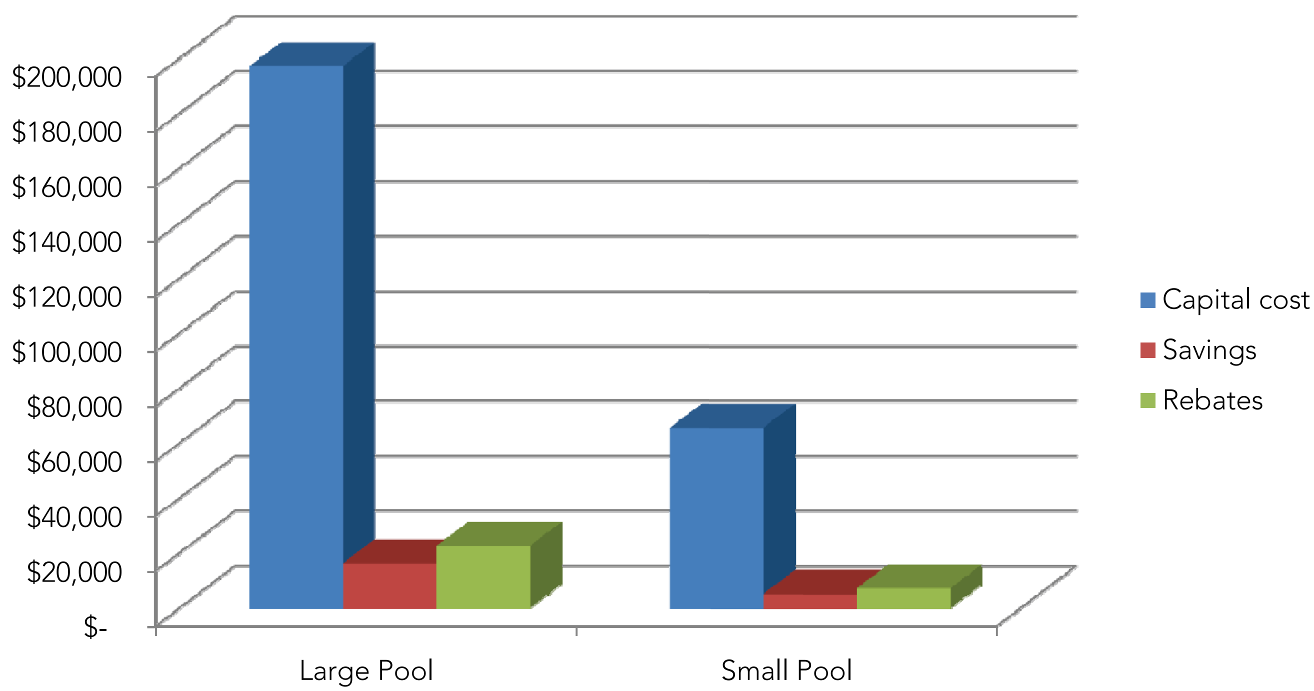
Solar Thermal Systems

P2S recommends heating of competition pool (Large Pool) and Wellness Pool (Small Pool) with direct circulation Heliocol Solar collectors. This will allow 50% of the thermal load transferred to Sun from Natural gas to keep the pools at 78° temperature. Approximately 30,000 therms of load is shifted to solar heating by installing these systems. The figure below and the table below summarizes the Costs, Rebates and Benefits (Savings) for installing solar heating of pools (Solar Thermal system) on the CHC pools.

The solar collectors are made out of polypropylene by Heliocol. P2S recommends HC-50 collectors. The tube bundles look similar to evacuated tube, but there is no evacuated tube of vacuum in this construction. They are much more cost effective compared to flat plates and evacuated tube collectors and offer better paybacks based on engineering study conducted for Crafton Hills College Wellness pool.

#	Item	Large Pool	Small Pool	Units	Comments
1	Capital cost	$197,219	$65,690	$	No Storage included
2	Savings	$16,254.88	$5,179.70	$/yr	for 1825/8760 Hrs
3	Rebates	$22,646.74	$7,216.50	$	Efficiency Improvements over conventional Design, @ CCC-IOU Rebate of $ 1/therm
4	Simple Payback	10.7	11.3	Years	for 51% of heating only

COSTS, SAVINGS AND REBATES FOR SOLAR WATER HEATING



Appendix A—Existing Conditions

Laboratory / Administration Building

Laboratory/Administration Building is a three story building and has 30,650 ft^2 of conditioned floor area. Its usage range from offices to auditorium and biology labs spaces. Building is approximately forty years old and has been retrofitted on systems in past.

Mechanical

Building has five mechanical rooms with six air handling units and central plant with chiller room, and boiler room.

Cooling: Total installed cooling capacity for the building is calculated as 155 Tons. This 155 tons capacity is for six coils with peak flow of chilled water at 347 gpm. This translates of 200 ft2/ton of installed capacity.

Heating: Total installed heating capacity for the building is calculated as 500 MBH for six heating coils. No equipment schedules are available for verifying this data.

Ventilation: Laboratory/Administration Building has five heating/cooling multizone (10,750 CFM, 15,015 CFM, 7,000 CFM, 6,185 CFM, 4,580 CFM) units and one heating/cooling single zone air handling unit (2,960 CFM)

Mechanical room 243 serving biology labs have two 7.5HP and 5HP multizone units with economizer and VFDs on each supply fans, and have four 1/2HP exhaust fans, one 1HP exhaust fan, and one 7.5 HP vacuum blower. This mechanical room has also one 4.5kW, 58 gallons electric water heater with domestic hot water circulation pump.

Mechanical room 227 has one 7,000 CFM multizone unit with economizer and VFD on supply fan.

Mechanical room 301 has one 10,750 CFM multizone unit with economizer and VFD on supply fan.

Mechanical room 406 has 2,960 CFM single zone unit, and two exhaust fans (3HP and 1/4 HP).

Mechanical room 103 has one 15,015 CFM, 7.5 HP multizone unit with VFD on supply fan.

There are multiple exhaust fans in rest rooms and in labs. Laboratories have multiple exhaust fans. The relays of exhaust fans are being wired in to the Siemens APOGEE controller and during the time of this energy audit, they were not wired for LADM building. The exhaust fans on laboratories are reported to be scheduled based on instructor's requests in control system.

No data on fan wheel efficiency is available and it is suspected that the fan wheels are inefficient to current efficiency standards by 10-15%.

Most of the supply and return fans have variable speed controller on them and they seem to operate at near full load condition all the times. This was observed during site visits and verified from CV trends of Siemens Front end display in Maintenance and Operations Offices.

Air is only heated or cooled at a given point of time. There is mixing of return air and conditioned air (heated or cold air) as can be seen from the graphics of screens for air handlers.

There is an air compressor in the chiller room.

Schedule

The building is occupied from 700 AM till 500 PM, most of times. The custodian occupy the building till 1200 AM midnight. The mechanical systems, lighting are consuming electrical and thermal energy from 400 AM to 1000 PM. Evening or night classes on this campus are not offered.

Laboratory / Administration Building (cont.)

Lighting

Indoor lighting is 1st generation fluorescent T8 with 32W lamps and electronic ballasts. Ballast were found with normal ballast factors of 0.89. The lamps and ballasts were replaced campus wide in 2004. The majority of occupied spaces are lit with fluorescent lights. There is no inventory of lighting fixtures available. CFLs (Compact fluorescents) were also found in rest rooms, mechanical rooms and stairways. Administration offices and classrooms have windows in adequate quantities to harvest daylight, which is not done currently. All the lighting circuits were found wired on relays and occupancy sensors in the LADM building. Installed indoors lighting is estimated in range of 18,400 Watts to 23,000 watts.

Controls

LADM building has Siemens Apogee controllers with several inputs and outputs controlling six air handlers and the central plant. Approximately 308 points are identified from the drawing. Chillers, Boilers and other packaged units are self contained; from controls perspective and have manufacture supplied controls. Campus EMS system only gets the data from these self controlled packaged units.

Air temperature in the building is controlled by air handling unit zone temperature sensors. Static pressure in the multi zone air supply ducts is controlled by supply air static pressure sensor. The static pressure set points appear to be dictated by some algorithm from controller based on supply air temperature control loop. Two multi zone units in the Mechanical Rooms 243, 247, 301 and Admin AH-1 have economizers controlled based on outside air temperature. Set points for economizer cycle are provided from the controller based on user inputs

Single zone constant flow unit is calling for heating/cooling based on setup of temperature on the temperature sensor in the zone.

Central Plant

Central plant is housed in the basement of LADM building and it has Boiler room, Chiller room, electrical room, and telecommunications rooms, with cooling towers located outdoors

<u>Boiler Room:</u>

- Boilers:

  2x3,500 MBH input/2,940 MBH output Bryan boilers

  1x9,000 MBH input brand new Cleaver –Brooks boiler.

Laboratory / Administration Building (cont.)

- Pumps:

  2x125HP heating hot water pumps with 93% nominal efficiency motor and VFD,

<u>Chiller room:</u>

- Chillers:

  2x222 tons Trane Chillers,

  1x250 Tons Trane Chiller

- Cooling towers: 3xBaltimore 520 GPM, 94/84°F cooling towers,

- Pumps:

  Chilled water pump:

  2x100 HP with VFD with bypass and NEMA premium efficiency motors, (Secondary Pumps

  3x20 HP Armstrong Pumps with NEMA premium efficiency motors for three each chillers (Primary, feeding return water to chillers)

  1x15 HP with VFD with bypass and NEMA premium efficiency motor,

  2x5 HP Armstrong pumps on water filtration system

  Condenser water pumps:

  3x520 gpm at 45 ft with 10 HP motors.

Baseline Energy consumption Observations

Chilled water system is primary/variable secondary. Chillers operate with efficiency of 0.55 kW/Ton at full load. Chillers are rarely found operational at full load conditions looking at past year's data. Chillers operate efficiently at part load conditions then at full load conditions. Each chiller has a dedicated primary chilled water pump on chilled water return side. Campus chilled water loop is fed by two pumps with VFD. Chillers are operated from 4:00 AM to 10:00 PM

Heating hot water is primary variable. Boilers have 84% efficiency rating. 160˚F supply water temperature is maintained

Ventilation, outdoor Lighting, Cooling, Heating is connected to energy management system (EMS) and is provided only during scheduled business hours of the building.

Laboratory / Administration Building (cont.)

Boilers are programmed to turn off when outdoor temperature exceeds 72˚F. All the buildings start to operate in economizer mode when temperature of outside air exceeds 72˚F.

After reviewing the trends on Siemens front end, it is reported that at least one chiller operates year round, even during winter months.

There are no set-back controls on DHW (Domestic Hot Water) heater and the pump.

Set-back controls for exhaust fans of restrooms are reported as work in progress and were not operational during the site visits.

Plumbing

Domestic hot water (DHW) is heated by one 4.5kW, 58 gallons electric water heater with domestic hot water circulation pump located in Mechanical Room 243 and two 3.5kW, 30 gallons electric water heaters with domestic hot water circulation pumps located in Custodian Rooms.

The building has two male restrooms with four urinals of interest from water conservation interests. The building also has water closets, lavatories and water fountains as other plumbing fixtures that were identified during the site visits.

Other Observations

Chilled water loop has hydraulic issues.

There is parasitic load that needs to be identified after sub-meter installation on gas and electricity for the building to minimize the energy waste during off campus hours. Exhaust fans, selective lights, DHW pump are prime candidates for setback controls. This building s a good candidate for MBCx (Monitoring Based Commissioning).

There is ample roof space on this building to install 250-400 kW PV panels.

Library

Library is a three story building and has 36,900 ft^2 floor area. Its usage is for library purposes. Building is forty years old.

Building has four multizone units and two single zone air handling units.

Heating/Cooling: Library building has four heating/cooling multizone units (10,920 CFM, 21,000CFM, 7,500 CFM, and 15,600 CFM) and two single zone air handling units (3,750 CFM and 2,730 CFM). Total installed capacity for the building is calculated as 105 Tons. This translates into 350 ft^2/ton of installed capacity.

Heating hot water and chilled water to multizone unit are provided from Central Plant. Total installed capacity for the building is estimated at 700 MBH.

Since the Library building is planned to be demolished entirely in a near future only preliminary energy use analysis was performed. In place of Library A student center will be constructed. The existing building was constructed circa 1970. Air handling unit systems have undergone an energy savings retrofit and DDC conversion through the addition of fan VFDs, control dampers, etc. It should be considered, that despite the recent energy savings and DDC conversion, the air handling units be replaced to address leakage from the air handling unit cabinets and probable degradation in chilled water and heating hot water performance due to the age and condition of the coils.

College Center

College Center is a three story building and has 8,560 ft^2 floor area. Its usage range from offices to auditorium and kitchen spaces. Building is forty years old.

Mechanical

Building has one multizone unit and one split system heat pump.

<u>Heating/Cooling</u>: College Center building has one heating hot water/chilled water multizone unit (25,360 CFM) with VFD and one two tons Carrier split system heat pump (EER=10.2, SEER=10.7). Split system serves office space. Rest of the building is served by multizone.

Total installed cooling capacity for the building is calculated as 93 tons (93 ft^2/ton). Total installed heating capacity for the building is estimated at 160 MBH.

Schedule

The building is occupied from 700 AM till 500 PM, most of times. The custodian occupy the building till 1200 AM midnight. The mechanical systems, lighting are consuming electrical and thermal energy from 400 AM to 1000 PM. Evening or night classes on this campus are not offered.

Lighting

Indoor lighting is 1st generation fluorescent T8 with 32W lamps and electronic ballasts. The lamps and ballasts were replaced campus wide in 2004. The majority of occupied spaces are lit with fluorescent lights. There is no inventory of lighting fixtures available. All the lighting circuits were found wired on relays and occupancy sensors in the College Center building. There is LC&D Lighting Controls in the building. Installed indoors lighting is estimated in range of 5,150 watts to 6,400 watt.

College Center (cont.)

Controls

Air temperature in the building is controlled by zone temperature sensors. Static pressure in the multizone is controlled by supply air static pressure sensor. The static pressure set points appear to be dictated by some algorithm from controller based on supply air temperature control loop. Multizone unit have economizer controlled based on outside air temperature. Set points for economizer cycle are provided form controller based on user inputs.

Plumbing

Domestic hot water (DHW) is heated by one 100 MBH, 100 gallons gas water heater with circulation pump.

Baseline Energy Consumption

Ventilation, Lighting, Cooling, Heating is connected to energy management system (EMS) and is provided only during scheduled business hours of the building.

Other Observations

Multizone unit does not have economizer.

Vending machines are not Energy Star rated, but are equipped with energy-saving motion sensor.

Student Center A

Student Services A building is a three story building and has 9,970 ft^2 floor area. Its usage is mainly for offices and classes spaces. Building is forty years old.

Mechanical

Building has three mechanical rooms with two air handling units and central plant with chiller room and boiler room.

Heating/Cooling: Student Services A has two heating/cooling single zone constant flow (5,135 CFM and 7,420 CFM) units. Both of the units have 5HP supply fans. Total installed cooling capacity for the building is calculated as 29 tons. This translates into 340 ft2/ ton of installed capacity. Total installed heating capacity for the building is estimated at 190 MBH.

Schedule

The building is occupied from 700 AM till 500 PM, most of times. The custodian occupy the building till 1200 AM midnight. The mechanical systems, lighting are consuming electrical and thermal energy from 400 AM to 1000 PM. Evening or night classes on this campus are not offered.

Lighting

Indoor lighting is 1st generation fluorescent T8 with 32W lamps and electronic ballasts. The lamps and ballasts were replaced campus wide in 2004. The majority of occupied spaces are lit with fluorescent lights. There is no inventory of lighting fixtures available. All the lighting circuits were found wired on relays and occupancy sensors in the SSA building. There is LC&D Lighting Controls in the building. Installed indoors lighting is estimated in range of 6,000 Watts to 7,500 watt.

Student Center A (cont.)

Central Plant

<u>Boiler Room</u>:

- Boilers:

  2x1,500 MBH input/1,253 MBH output Bryan boilers(1999) with dedicated circulation pumps.

- Pumps:

  2x20 HP heating hot water pumps with 91% nominal efficiency motors on VFDs,

<u>Chiller Room</u>:

- Chillers:

  2x70 tons Trane chillers. One of the chillers was retrofitted with turbo core compressor.

  1x35 tons Carrier semi hermetic reciprocating chiller (2001).

- Cooling Towers:

  Baltimore cooling tower with VFD on the fan.

<u>Pumps</u>

- Chilled Water Pump:

  2x40 HP with VFD with bypass secondary chilled water pumps,

  2x3 HP constant flow primary chilled water pumps,

  1x1/2 HP constant flow primary chilled water pump serving Carrier chiller.

- Condenser water pumps:

  3xcondenser water pump (no nameplate data is available).

Baseline Energy Consumption Observations

Chilled water system is primary/variable secondary. Chillers operate with efficiency of 0.65 kW/Ton at full load. Each chiller has a dedicated primary chilled water pump on chilled water return side. Campus chilled water loop is fed by two pumps with VFD. Chillers are operated from 4:00 AM to 10:00 PM, as back-up to LADM chillers.

Heating hot water is primary variable. Boilers have 84% efficiency rating. 160˚F supply water temperature is maintained in the loop.

Student Center A (cont.)

Ventilation, outdoor Lighting, Cooling, Heating is connected to energy management system (EMS) and is provided only during scheduled business hours of the building.

Boilers are programmed to turn off when outdoor temperature exceeds 72˚F. All the buildings start to operate in economizer mode when temperature of outside air exceeds 72˚F.

Controls

Air temperature in the building is controlled by air handling unit zone temperature sensors. Static pressure in the supply plenum is controlled by supply static pressure sensor and connected VFD and EMS. Multizone unit is calling for heating/cooling based on set-points of temperature on the temperature sensor in the zone.

Chillers, boilers, and other packaged units are self contained from controls perspective and have manufacture supplied controls.

Plumbing

Domestic hot water (DHW) is heated by 155 MBH, 89 gallons gas water heater with domestic hot water circulation pump located in Boiler Room.

The building has two male restrooms with two 1 gallon per flush urinals.

Other Observations

Some of the heating hot water and chilled water piping serving air handling units in the mechanical room is lacking insulation.

Student Services C (Classroom Building)

Student Services C Building is a two story building and has 6,800 ft^2 floor area. Building contains mainly classroom spaces. Building is forty years old.

Mechanical

Building has one multizone unit.

Heating/Cooling: Center College Building has one heating/cooling multizone (9,920 CFM) unit with VFD and economizer. Heating hot water and chilled water is provided to the unit from Central Plant. Total installed cooling capacity for the building is calculated as 29 tons (235 ft^2/ton). Total installed heating capacity for the building is estimated at 130 MBH.

Schedule

The building is occupied from 700 AM till 500 PM, most of times. The custodian occupy the building till 1200 AM midnight. The mechanical systems, lighting are consuming electrical and thermal energy from 400 AM to 1000 PM. Evening or night classes on this campus are not offered.

Lighting

Indoor lighting is 1st generation fluorescent T8 with 32W lamps and electronic ballasts. The lamps and ballasts were replaced campus wide in 2004. The majority of occupied spaces are lit with fluorescent lights. There is no inventory of lighting fixtures available. All the lighting circuits were found wired on relays and occupancy sensors in the SSC building. There is LC&D Lighting Controls in the building. Installed indoors lighting is estimated in range of 4,100 Watts to 5,100 watt.

Student Service C (cont.)

Controls

Air temperature in the building is controlled by zone temperature sensors. Static pressure in the multizone is controlled by supply air static pressure sensor in main ductwork, downstream of supply fan, and connected to VFD and EMS. The static pressure set points appear to be dictated by some algorithm from controller based on supply air temperature control loop. Multizone unit have economizer controlled based on outside air temperature. Set points for economizer cycle are provided form controller based on user inputs.

Baseline Energy Consumption Observations

Ventilation, Lighting, Cooling, Heating is connected to energy management system (EMS) and is provided only during scheduled business hours of the building.

Student Services B (Health and Wellness Center)

Student Services B Building is a two story building and has 5,575 ft^2 floor area. Building contains mainly office and administration spaces. Building is twelve years old.

Mechanical

<u>Cooling</u>: Five chilled water/heating hot water fan coils is used to provide cooling for Student Services B Building. Chilled water cooling coils are controlled by two-way control valves. Building is supplied with chilled water from Central Plant. Total installed cooling capacity for the building is calculated as 26 tons (215 ft^2/ton).

<u>Heating</u>: Five fan coils is provided with heating hot water coils which provide heating to building conditioned space. Heating hot water coils of fan coils are controlled by three way control valves. Buildings is supplied with heating hot water from Central Plant. Total installed heating capacity for the building is calculated as 130 MBH.

<u>Ventilation</u>: Outside air is provided to fancoils through roof outside air intakes. All fan coils operate during occupied hours.

List of Major Mechanical Equipment

- Fan coils (4)
- Exhaust fans (5).

Schedule

The building is occupied from 700 AM till 500 PM, most of times. The custodian occupy the building till 1200 AM midnight. The mechanical systems, lighting are consuming electrical and thermal energy from 400 AM to 1000 PM. Evening or night classes on this campus are not offered.

The majority of occupied spaces are lit with parabolic recessed fluorescent lights (5,115W). There are also aperature downlight and lensed recessed troffer lighting. All the lighting circuits were found wired on relays and occupancy sensors in the SSB building. The building lighting shutoff system consists of the automatic lighting control time switch. There is LC&D Lighting Controls in the building. Installed indoors lighting is estimated in range of 3,350 Watts to 4,200 watt.

Student Service B (cont.)

Plumbing

- Domestic hot water (DHW) is heated by 6kW, 10 gallons electric water heater with domestic hot water circulation pump.
- Building has one male restrooms with one, one gallon per flush, touch less urinal.

Controls

- Fan coils are operating all the times during occupied hours, either in heating or cooling mode.
- Air temperature in envelope is controlled by fan coil temperature sensors and thermostats.

Baseline Energy Consumption Observations

Ventilation, Lighting, Cooling, Heating are connected to energy management system (EMS) and is provided only during scheduled business hours of the building.

Other Observations

There is no gas pipeline in the building, which could be used for replacement of electric water heater with gas tankless domestic water heater. The closest connection to gas pipeline could be done from Student Services-A Building.

Occupational Education 1

Occupational Education 1 is a one story building and has 9,850 ft^2 floor area. Building contains mainly art laboratory and studio spaces. Building is thirty five years old.

Mechanical

Building have two multizone units.

Heating/Cooling: Occupational Education Building has two heating/cooling multizone (8,000 CFM, 6,000 CFM) units with VFDs on supply (10 HP and 7.5 HP), return fans (3HP and 2HP), and economizers. Total installed cooling capacity for the building is calculated as 38 tons (260 ft^2/ton). Total installed heating capacity for the building is estimated at 560 MBH.

Heating hot water and chilled water to multizone units are provided from Central Plant.

Schedule

The building is occupied from 700 AM till 500 PM, most of times. The custodian occupy the building till 1200 AM midnight. The mechanical systems, lighting are consuming electrical and thermal energy from 400 AM to 1000 PM. Evening or night classes on this campus are not offered.

Lighting

Indoor lighting is 1st generation fluorescent T8 with 32W lamps and electronic ballasts. The lamps and ballasts were replaced campus wide in 2004. The majority of occupied spaces are lit with fluorescent lights. There is no inventory of lighting fixtures available. All the lighting circuits were found wired on relays and occupancy sensors in the OE1 building. There is LC&D Lighting Controls in the building. Installed indoors lighting is estimated in range of 5,900 Watts to 7,400 watt. A reading of 90-100 fc (foot candles) was recorded in studios.

Occupational Education (cont.)

Controls

Air temperature in the building is controlled by zone temperature sensors. Static pressure in the multizone is controlled by supply air static pressure sensor in main ductwork, downstream of supply fan, and connected to VFD and EMS. The static pressure set points appear to be dictated by some algorithm from controller based on supply air temperature control loop. Multizone unit have economizer controlled based on outside air temperature. Set points for economizer cycle are provided form controller based on user inputs.

Plumbing

Domestic hot water (DHW) is heated by one 6kW, 50 gallons electric water heater with circulation pump.

Building has one male restrooms with two one gallon per flush, urinal.

Baseline Energy Consumption Observations

Ventilation, Lighting, Cooling, Heating is connected to energy management system (EMS) and is provided only during scheduled business hours of the building.

Other Observations

Vending machines are not Energy Star rated, but are equipped with SCE approved vending energy miser controls.

Occupational Education 2

Occupational Education 2 is a two story building and has 15,750 ft^2 floor area. Its usage range from offices, classrooms, computer laboratory, auto shop garage spaces, and for firefighting training. Building is thirty five years old.

Mechanical

Building has one multizone unit, three rooftop package units, and three makeup air evaporative cooling units. Not all spaces are conditioned.

Heating/Cooling: In the building there is one multizone chilled water (240 MBH), duct furnace (600 MBH) unit with 7.5 HP supply fan motor on VFD. Chilled water is provided from chilled water loop connected to central plants. Total installed cooling capacity for the building is calculated as 45 tons (350 ft^2/ton). Total installed heating capacity for the building is estimated at 300 MBH.

On the roof of the building are:

- Two Carrier gas heating/electric rooftop packaged units (5 and 6 tons with EER=11, approximately 13 years old),
- DX 5 ton rooftop package unit,
- Two make-up air units with gas heating and evaporative cooling with 1.5HP supply fan motor. It looks like units are not in operation.
- One evaporative cooler with 3HP supply fan motor. Unit is in poor conditions.

Building also have nine exhaust fans on the roof.

Occupational Education 2 (cont.)

Schedule

The building is occupied from 700 AM till 500 PM, most of times. The custodian occupy the building till 1200 AM midnight. The mechanical systems, lighting are consuming electrical and thermal energy from 400 AM to 1000 PM. Evening or night classes on this campus are not offered.

Lighting

Indoor lighting is 1st generation fluorescent T8 with 32W lamps and electronic ballasts. The lamps and ballasts were replaced campus wide in 2004. The majority of occupied spaces are lit with fluorescent lights. There is no inventory of lighting fixtures available. All the lighting circuits were found wired on relays and occupancy sensors in the OE2 building. There is LC&D Lighting Controls in the building. Installed indoors lighting is estimated in range of 9,450 Watts to 11,800 watt.

Controls

Air temperature in the building is controlled by zone temperature sensors. Static pressure in the multizone is controlled by supply air static pressure sensor. The static pressure set points appear to be dictated by some algorithm from controller based on supply air temperature control loop. Multizone unit have economizer controlled based on outside air temperature. Set points for economizer cycle are provided form controller based on user inputs.

Rooftop package units are operating all the times during occupied hours, either in heating or cooling mode. Air temperature in the building is controlled by temperature sensors in the building.

Evaporative coolers are operating all the time during occupied hours. Air temperature in the evaporative coolers zones is controlled by thermostat.

RTUs are controlled by space thermostats.

Plumbing

Domestic hot water (DHW) is heated by one 68,000 BTU, 50 gallons gas water heater with circulation pump.

Building has one male restroom with two urinals.

Occupational Education 2 (cont.)

Baseline Energy Consumption Observations

Lighting and only multizone unit is connected to energy management system (EMS) and is provided only during scheduled business hours of the building.

Other Observations

Vending machines are not Energy Star rated, but are equipped with SCE rebated vending energy miser controls.

LCD screens and computers in Computer Lab are not Energy Star Rated.

Bookstore

Bookstore building is one story building and has 5,750 ft^2 floor area. Its usage is mainly for bookstore spaces. Building is less than ten years old.

Mechanical

Cooling: Bookstore Building has installed cooling capacity of 27.5 tons. There are six Carrier rooftop dx/gas heating packaged units (4x5 tons, 1x4 tons, 1x3.5 tons, SEER=10).

Heating: Bookstore Building has installed heating capacity of 510 MBH (5x90 MBH in/72.1 out, 1x60 MBH in/48 MBH out). Six Carrier roof top units have thermal efficiency of 80%.

Ventilation: Outside air is provided by supply air from rooftop packaged units.

List of Major Mechanical Equipment

- Carrier rooftop packaged units (6)

Schedule

The building is occupied from 700 AM till 500 PM, most of times. The custodian occupy the building till 1200 AM midnight. The mechanical systems, lighting are consuming electrical and thermal energy from 400 AM to 1000 PM. Evening or night classes on this campus are not offered.

Lighting

Indoor lighting is 1st generation fluorescent T8 with 32W lamps and electronic ballasts. The lamps and ballasts were replaced campus wide in 2004. The majority of occupied spaces are lit with fluorescent lights. All the lighting circuits were found wired on relays and occupancy sensors in the Bookstore building. There is LC&D Lighting Controls in the building. Installed indoors lighting is calculated as 8,900 watts. Measured lighting intensity during site visit was 90-100 fc (foot- candles).

Bookstore (cont.)

Plumbing

Domestic hot water (DHW) is heated by one 1.5kW, 6 gallons electric water heater.

Building has one male restroom with two urinals.

Controls

Rooftop package units are operating all the times during occupied hours, either in heating or cooling mode. Air temperature in the building is controlled by rooftop package units temperature sensors (thermostats). Set point can be provided to thermostats from Siemens Front-end.

Baseline Energy Consumption Observations

Ventilation, Lighting, Cooling, Heating is connected to energy management system (EMS) and is provided only during scheduled business hours of the building.

Classroom at Bookstore Building

Classroom at Bookstore building is one story building and has 4,350 ft^2 floor area. Its usage is for classroom spaces. Building is less than ten years old.

Mechanical

Cooling: Classrom Building has installed cooling capacity of 24.5 tons. There are six Carrier rooftop dx/gas heating packaged units (2x5 tons, 1x4 tons, 3x3 tons, SEER=10).

Heating: Bookstore Building has installed heating capacity of 450 MBH (3x90 MBH in/72.1 out, 3x60 MBH in/48 MBH out). Six Carrier roof top units have thermal efficiency of 80%.

Ventilation: Outside air is provided by supply air from rooftop packaged units.

List of Major Mechanical Equipment

- Carrier rooftop packaged units (6),

Schedule

The building is occupied from 700 AM till 500 PM, depending on schedule. The custodian occupy the building till 1200 AM midnight. The mechanical systems, lighting are consuming electrical and thermal energy from 400 AM to 1000 PM. Evening or night classes on this campus are not offered.

Lighting

Indoor lighting is 1st generation fluorescent T8 with 32W lamps and electronic ballasts. The lamps and ballasts were replaced campus wide in 2004. The majority of occupied spaces are lit with fluorescent lights. All the lighting circuits were found wired on relays and occupancy sensors in the Classroom building. There is LC&D Lighting Controls in the building. Installed indoors lighting is calculated as 6,348 watts. Spot measurement of lighting intensity during site visit was recorded in range of 85-95 fc (foot-candles).

Plumbing

There are no water consuming plumbing devices.

Classroom Building at Bookstore (cont.)

Controls

Rooftop package units are operating all the times during occupied hours, either in heating or cooling mode. Air temperature in the building is controlled by thermostats in the building. Set points to thermostats can be provided from Siemens Front-end in M&O.

Baseline Energy Consumption Observations

Ventilation, Lighting, Cooling, Heating is connected to energy management system (EMS) and is provided only during scheduled business hours of the building.

Performing Arts Center

Performing Arts Center is a three story building and has 29,850 ft^2 floor area. Its is used for auditorium with stage, workshop and exhibition spaces. Building is thirty five years old. The structure is cast in place concrete.

Mechanical

Building has two multizone air handling units on the second floor of the building.

Heating/Cooling: Performing Arts Center Building has two heating/cooling multizone units with VFDs on supply fan (26,000 CFM with 20 HP and 23,000 CFM with 15 HP motors) and return fans (20,800 CFM with 7.5 HP and 19,000 CFM with 5 HP motors). Both units have economizer. Total installed cooling capacity for the building is calculated as 172 tons (173 ft^2/ton). Total installed heating capacity for the building is estimated at 570 MBH.

Heating hot water and chilled water to multizone units are provided from Central Plant.

Schedule

The building is occupied from 700 AM till 500 PM, most of times. The custodian occupy the building till 1200 AM midnight. The mechanical systems, lighting are consuming electrical and thermal energy from 400 AM to 1000 PM. Evening or night classes on this campus are not offered.

Lighting

Indoor lighting is 1st generation fluorescent T8 with 32W lamps and electronic ballasts. The lamps and ballasts were replaced campus wide in 2004. The majority of occupied spaces are lit with fluorescent lights. There is no inventory of lighting fixtures available. All the lighting circuits were found wired on relays and occupancy sensors in the Performing Arts Center building. There is LC&D Lighting Controls in the building. Installed indoors lighting is estimated in range of 18,000 Watts to 22,400 watt. A spot measurement of lighting intensity in classrooms was measured at 15-35 fc (foot-candles). Lighting in auditorium has incandescent lights. Lighting in auditorium has theater lighting control system.

Performing Arts Center (cont.)

Controls

Air temperature in the building is controlled by zone temperature sensors. Static pressure in supply plenum is controlled by supply air static pressure sensor. The static pressure set points appear to be dictated by some algorithm from controller based on supply air temperature control loop. AHUs have economizer controlled based on outside air temperature. Set points for economizer cycle are provided form controller based on user inputs.

Plumbing

Domestic hot water (DHW) is heated by one 12kW, 50 gallons electric water heater with circulation pump.

Building has two male restrooms with four urinals.

In the basement there are two sump pumps with 7.5 Hp motor each, for sewer, operating on level dead band of 9” setting.

Baseline Energy Consumption Observations

Ventilation, Lighting, Cooling, Heating is connected to energy management system (EMS) and is provided only during scheduled business hours of the building.

Other Observations

There are two 7.5 HP sump pumps in the building.

Maintenance and Operations

Maintenance and Operation building is a one story building and has 6,400 ft^2 floor area. Its usage is mainly for maintenance, tools, custodians, and offices spaces. Building is thirty five years old.

Mechanical

<u>Cooling</u>: Maintenance and Operation building has installed cooling capacity of 7 tons. There are two Rheem rooftop dx/gas heating packaged units (2x3.5 tons, EER=8.7, SEER=10).

<u>Heating</u>: On the top of two dx/gas heating rooftop units (2x80 MBH input/64 MBH output), M&O building has eight Reznor gas unit heaters (2x150 MBH and 6x125 MBH). Only on unit heater is in operation (the one installed in Equipment Room).

Schedule

The building is occupied from 700 AM till midnight, most of times.

Lighting

Indoor lighting is 1st generation fluorescent T8 with 32W lamps and electronic ballasts. The lamps and ballasts were replaced campus wide in 2004. The majority of occupied spaces are lit with fluorescent lights. There is no inventory of lighting fixtures available. All the lighting circuits were found wired on relays and occupancy sensors in the Performing Arts Center building. There is LC&D Lighting Controls in the building. Installed indoors lighting is estimated in range of 3,850 watts to 4,800 watt. A spot measurement of lighting intensity was measured in range of 95-120 fc (foot candles) during site visit.

Maintenance and Operations (cont.)

Plumbing

Domestic hot water (DHW) is heated by one 32 MBH, 30 gallons gas water heater.

Building has one male restroom with two urinals.

Controls

Rooftop package units are operating all the times during occupied hours, either in heating or cooling mode. Air temperature in the building is controlled by thermostats in the building.

Baseline Energy Consumption Observations

Lighting and rooftop upackage units are not connected to energy management system (EMS).

Gymnasium

Gymnasium building is a two story building and has 27,900 ft^2 floor area. Its usage is gym spaces. Building is thirty five years old.

Mechanical

Building has six air handling units on the roof, seven fan coils, chiller plant, and boiler room in the basement of the building.

Heating/Cooling: Gymnasium building has six heating hot water/chilled water air handlings units. Four of them are constant flow 9,000 CFM, 3HP supply fan units with economizer. One of the air handling units is constant flow 3,000 CFM, 1HP supply fan, and one is constant flow 1,460 CFM with 1.5 HP supply fan.

There are four heating hot water/chilled water fan coils in men's and women's locker rooms and three heating hot water/chilled water fan coils in the basement.

Total installed cooling capacity for the building is calculated as 142 tons (196 ft^2/ton). Total installed heating capacity for the building is estimated at 1,948 MBH.

Schedule

The building is occupied from 700 AM till 500 PM, most of times. The custodian occupy the building till 1200 AM midnight. The mechanical systems, lighting are consuming electrical and thermal energy from 400 AM to 1000 PM.

Lighting

Indoor lighting is 1st generation fluorescent T8 with 32W lamps and electronic ballasts. The lamps and ballasts were replaced campus wide in 2004. The majority of occupied spaces are lit with fluorescent lights. There is no inventory of lighting fixtures available. Installed indoors lighting is estimated in range of 16,700 watts to 21,000 watts. A major space (basketball court) is lit by sky-lights during day.

Controls

Chillers, boilers and other packaged units are self contained; from controls perspective and have manufacture supplied controls. Campus EMS system only gets the data from these self controlled packaged units.

Gymnasium (cont.)

Air temperature in the building is controlled by air handling unit zone temperature sensors.

Central Plant

Central Plant is housed in the basement of Gymnasium building and it has boiler room and chiller room, with cooling towers located outdoors.

Boiler Room:

- Boilers:

  2x900 MBH input/832 MBH output Raypak boilers with dedicated circulation pumps.

- Pumps:

  2x3 HP heating hot water pumps with 84% nominal efficiency motors on VFDs,

  2x2 HP heating hot water pumps with 78% nominal efficiency motors,

Chiller room:

- Chillers:

  1x70 tons Trane chillers.

  1x35 tons Carrier semi hermetic reciprocating chiller.

- Cooling towers:

  Baltimore cooling tower with VFD on the 10 HP fan.

- Pumps:

  Chilled water pump:

  2x3 HP constant flow chilled water pumps,

  Condenser water pumps: 1x3HP constant flow pump.

Gymnasium (cont.)

Baseline Energy Consumption Observations

Chilled water system is constant flow with approximate efficiency of 0.8 kW/Ton. Each chiller has a dedicated chilled water pump on chilled water return side. Chillers are operated from 4:00 AM to 10:00 PM.

Heating hot water is primary variable. 180˚F supply water temperature is maintained. Boilers have 84% efficiency, at full load.

Ventilation, outdoor Lighting, Cooling, Heating is connected to energy management system (EMS) and is provided only during scheduled business hours of the building.

Boilers are programmed to turn off when outdoor temperature exceeds 72˚F. All the buildings start to operate in economizer mode when temperature of outside air exceeds 72˚F.

There are no set-back controls on DHW (Domestic Hot Water) heater and the pump.

Plumbing

Domestic hot water (DHW) is heated by Patterson-Kelly Compact 400 packaged water heater served by hydronic boiler.

There is one male restroom with two urinals. The building has several shower heads in locker rooms.

Other Observations

The upper roof is covered with photovoltaic laminate.

Chemistry Building

Chemistry Building is a two story building and has 17,250 ft^2 floor area. Its usage range from biology, physic, and chemistry labs to lecture hall spaces. Building is thirty five years old.

Mechanical

Building has two heating hot water/chilled water multizone units.

<u>Heating/Cooling</u>: Chemistry building has two heating hot water/chilled water, variable air volume multizone air handling units with economizer. One of the units is 9,600 CFM with 10HP supply fan motor on the VFD. Another is 7,360 CFM with 7.5 HP supply fan motor on VFD. Both units are served by one in-line exhaust fan with VFD.

There are seven exhaust fans (2ea x 1 HP, 3ea x 1/2 HP, 1ea x 1/4 HP, and 1ea x1/6 HP).

Total installed cooling capacity for the building is calculated as 57 tons (300 ft^2/ton). Total installed heating capacity for the building is estimated at 330 MBH.

Schedule

The building is occupied from 700 AM till 500 PM, most of times. The custodian occupy the building till 1200 AM midnight. The mechanical systems, lighting are consuming electrical and thermal energy from 400 AM to 1000 PM. Evening or night classes on this campus are not offered.

Lighting

Indoor lighting is 1st generation fluorescent T8 with 32W lamps and electronic ballasts. The lamps and ballasts were replaced campus wide in 2004. The majority of occupied spaces are lit with fluorescent lights. There is no inventory of lighting fixtures available. All the lighting circuits were found wired on relays and occupancy sensors in the Chemistry building. There are LC&D Lighting Controls in the building. Installed indoors lighting is estimated in range of 10,350 watts to 12,950 watt. Measured spot lighting intensity in classrooms was 75 fc (foot candles) and 45 fc on A-B switches.

Chemistry Building (cont.)

Controls

Air temperature in the building is controlled by zone temperature sensors. Static pressure in the multizone is controlled by supply air static pressure sensor. The static pressure set points appear to be dictated by algorithm from controller based on supply air temperature control loop. Multizone unit have economizer controlled based on outside air temperature. Set points for economizer cycle are provided form controller based on user inputs.

Plumbing

Domestic hot water (DHW) is heated by one 4.5kW, 50 gallons electric water heater with domestic hot water circulation pump located.

Baseline Energy Consumption Observations

Ventilation, Lighting, Cooling, Heating is connected to energy management system (EMS) and is provided only during scheduled business hours of the building.

Other Observations

Vending machines are not Energy Star rated, but are equipped with SCE approved vending energy miser controls.

Child Development Center 1

Child Development Center 1 Building is one story building and has 3,450 ft^2 floor area. Its usage is mainly for classrooms, toddler rooms, and play area for children. Building is ten years old.

Mechanical

Cooling: Child Development 1 Building has installed cooling capacity of 17.5 tons. There are three BDP Co. rooftop dx/gas heating packaged units (1x7.5 ton, 2x5 ton, EER/SEER=11/13).

Heating: Child Development Center has installed heating capacity of 269 MBH input/ 220.58 MBH output (1x 125 MBH in/102.5 out, 2x72 MBH in/59.04 MBH out). Roof top units have thermal efficiency of 82%.

Ventilation: Outside air is provided by supply air from rooftop packaged units.

List of Major Mechanical Equipment

- BDP Co. rooftop dx/gas packaged units (3),

Schedule

The building is occupied from 700 AM till 500 PM, most of times. The custodian occupy the building till 1200 AM midnight. The mechanical systems, lighting are consuming electrical and thermal energy from 400 AM to 1000 PM.

Lighting

Indoor lighting is 1st generation fluorescent T8 with 32W lamps and electronic ballasts. The lamps and ballasts were replaced campus wide in 2004. The majority of occupied spaces are lit with fluorescent lights. There is no inventory of lighting fixtures available. All the lighting circuits were found wired on occupancy sensor relays in the Child Development Center 1 building. There is LC&D Lighting Controls in the building. Installed indoors lighting is estimated in range of 3,500 watts to 4,000 watts.

Child Development Center (cont.)

Plumbing

Domestic hot water (DHW) is heated by one 34 MBH, 40 gallons gas water heater.

Controls

Rooftop package units are operating all the times during occupied hours, either in heating or cooling mode. Air temperature in the building is controlled by thermostats in the building. Set points can be provided to thermostats from Siemens Front-end in M&O.

Baseline Energy Consumption Observations

Lighting and rooftop upackage units are connected to energy management system (EMS) and are provided only during scheduled business hours of the building.

Other Observations

Vending machine is not Energy Star rated, but is equipped with SCE approved vending energy miser controls.

Child Development Center 2

Child Development Center 2 Building is one story building and has 2,450 ft^2 floor area. Its usage is mainly for preschool classrooms. Building is ten years old.

Mechanical

Cooling: Child Development 2 Building has installed cooling capacity of 11 tons. There are two BDP Co. rooftop dx/gas heating packaged units (1x6 ton, 2x5 ton , EER/SEER=11/13).

Heating: Child Development Center has installed heating capacity of 144 MBH input/ 118.08 MBH output (2x 72 MBH in/59.04 out). Roof top units have thermal efficiency of 82%.

Ventilation: Outside air is provided by supply air from rooftop packaged units.

List of Major Mechanical Equipment

- BDP Co. rooftop dx/gas packaged units (2),

Schedule

The building is occupied from 700 AM till 500 PM, most of times. The custodian occupy the building till 1200 AM midnight. The mechanical systems, lighting are consuming electrical and thermal energy from 400 AM to 1000 PM.

Lighting

Indoor lighting is 1st generation fluorescent T8 with 32W lamps and electronic ballasts. The lamps and ballasts were replaced campus wide in 2004. The majority of occupied spaces are lit with fluorescent lights. There is no inventory of lighting fixtures available. All the lighting circuits were found wired on relays and occupancy sensors in the Child Development Center 2 building. There is LC&D Lighting Controls in the building. Installed indoors lighting is estimated in range of 2,400 watts to 2,800 watts.

Child Development Center 2 (cont.)

Plumbing

Domestic hot water (DHW) is heated by one 34 MBH, 40 gallons gas water heater.

Controls

Rooftop package units are operating all the times during occupied hours, either in heating or cooling mode. Air temperature in the building is controlled by temperature sensors in the building.

Baseline Energy Consumption Observations

Lighting and rooftop package units are connected to energy management system (EMS) and are provided only during scheduled business hours of the building.

Appendix B—Energy Conservation Measures

After reviewing technical information on drawings and conducting two site visits to observe the installed equipment consuming energy, this report documents ten ECMs (Energy Conservation Measures) outlined in the table below.

Several conservation measures were analyzed and those meeting the financial merits are reported below. ECMs that have paybacks exceeding the remaining lives of existing buildings are also ruled out assuming the renovation or new construction would incorporate the energy efficient design features.

Individual ECMs and their descriptions are outlined in this section. Individual ECMs attempt to describe the conservation methodology, establish capital costs, savings and simple payback.

The conservation measures identified can save up to 14.3% of existing electrical energy consumption.

SAVINGS IN PERCENTAGE OF BASELINE ENERGY CONSUMPTION

#	Parameter	Value	Units
1	∑ Savings with Central Plant & TES	534,064	kWh/Yr
2	∑ Savings without Central Plant & TES	412,218	kWh/Yr
3	Baseline Energy Consumption	3,304,162	kWh/Yr
4	% Savings wihtout Central Plant & TES	12.5%	%
5	% Savings with Central Plant & TES	16.2%	%

LIST OF ECMS

#	ECM Description	Energy Savings (kWh/Yr)	Demand Savings (kW)	Energy Savings (Therms/Yr)	Capital Cost of ECM ($)	Rebate	Savings	Simple Payback (Yrs)
1	Controls and Post MBCx Measures	219,982	55.0	390	$83,980	$53,186	$32,047	1.0
2	TES (Thermal Energy Storage)	162,461	101.5		$1,650,000	$38,991	$93,716	17.2
3	Fan Wheels Retrofit	102,844	25.7		$52,000	$24,683	$14,810	1.8
4	Plug Load Control	100,521	25.1		$67,500	$24,125	$14,512	3.0
5	Lighting Retrofits	65,422	22.5		$106,665	$15,701	$9,493	9.6
6	RTUS Upgrade	57,513	35.9		$140,000	$13,803	$8,052	15.7
7	Tankless DHW Heaters	54,760	13.7	-	$35,600	$13,142	$6,321	3.6
8	Premium Efficiency Motors	50,817	14.5		$48,963	$12,196	$7,374	5.0
10	Decommission Gym Chiller	18,200	14.6		$58,966	$4,368	$2,627	20.8
11	Return Air Heat Recovery	14,223	4.7	3,048	$110,475	$6,461	$2,476	42.0
12	SSA Bldg VFD	4,226	1.4		$4,050	$1,014	$610	5.0
13	High SEER Split Condensing Units	1,280	1.3		$1,875	$307	$179	8.7
14	Low Flush Urinals				$21,000	$-	$2,008	10.5
Totals		852,250	316	3,438	$2,381,074	$207,978	$194,225	

EEM 01—Monitoring Based Commissioning (MBCx) & Energy Scheduler

Background

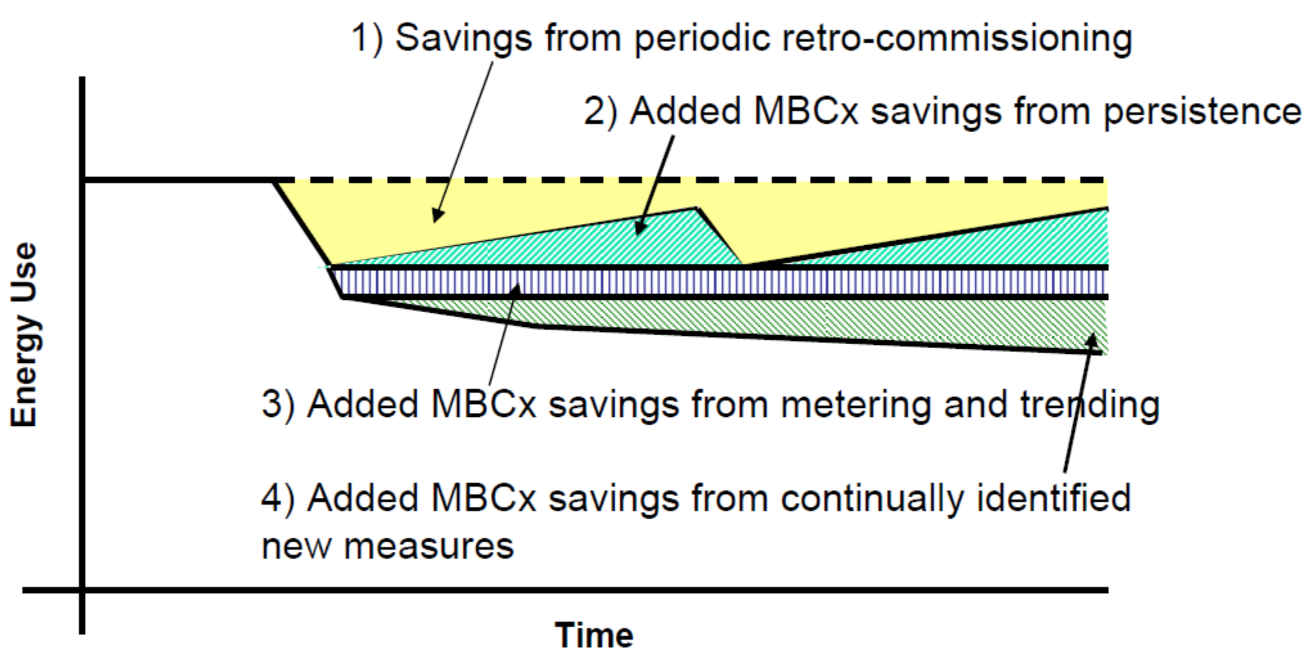
This ECM attempts to identify measures in the Crafton Hills College buildings that can lead to savings after the sub-meters for electricity and gas are installed at each building. The measures identified during this energy audit are of type 4 (identified new measures).

STATISTICAL DEMAND PATTERN

Parameter	On-Peak kW	Mid-Peak kW	Off-Peak kW
Minimum	1,114	1,018	902
Maximum	691	557	538
Median	945	865	730
Average	979	883	749

After reviewing the internal data, it is brought to the attention of reader that CHC consumes 540-690 kW as minimum electric consumption, as outlined in Table-1. Minimum demands are on weekends and nights, which are non business hours for the campus. It is important to turn off the electric consumption when not required. After sub-meters are installed under MBCx, buildings are expected to demonstrate 15-35 kW demand during these non business hours. Measures identified under this ECM are not limited to MBCx and energy efficiency.

TYPES OF SAVINGS FROM MBCX



Inputs and Assumptions

The following inputs and assumptions are using to compute the savings for the measures identified under this ECM.

INPUTS AND ASSUMPTIONS

#	Parameter	Value	Units	Comments
1	Cost of Electricity	$0.14	$/kWh	From Utility Bills
2	Gas Rebate	$1.00	$/Therm	CCC-IOU Rebate
3	Electricity Rebate	$0.24	$/kWh	CCC-IOU Rebate
4	Cost of Natural Gas	$0.72	$/Therm	Current Meter Costs

Typical measures recommended for the buildings in this ECM are outlined briefly below:

Demand Ventilation

Demand ventilation reduces heating, cooling and fan costs by managing CO_2 in the occupancies and spaces of the buildings. Capital costs are cost of additional CO_2 sensors in each space where demand ventilation is recommended per Title-24 requirements. PIER (Public Interest Energy Research) reports 20% savings for average outdoor temperature of 90˚F, which are used to stay on conservative side. Actual savings would be much higher.

Occupancy Sensors based Heating / Cooling Set-Backs

Currently only lighting loads are relayed with occupancy sensor. Under this measure, it is proposed that occupancy sensor be tied in toe the EMS, which can in turn setback the thermostat settings of the occupancies that are not used. Conference rooms, meeting rooms, not-in-session classes are examples of spaces that can reduce the heating and cooling load and ventilation load for the buildings recommended for retrofit under this ECM.

Exhaust Fan Set-Backs

Exhaust fans are proposed to be set-back with demand ventilation algorithm during occupied hours with inputs from all occupancies of the building, proposed under occupancy sensor based set-backs. Exhaust fans of restrooms also need to be operated on demand with delay timer shut off mechanism programmed in EMS.

UNIT COSTS FOR CAPITAL COSTS

#	Cost Element	Material Cost	Labor Cost	Total Cost	Notes
1	CO_2 Sensors	$195	$200	$395	Integrate the CO_2 sensor inputs with Occ Sensors
2	Duct Static Pressure Sensor			$510	RS Means
3	DDC Inputs			$530	for ON/OFF Maintained Contacts

Conclusion

The measures outlined above will need M&V to establish the accurate baseline, which is currently beyond the scope of this report. SCE (Southern California Edison) can help to provide the baseline measurements that can be used to compute the savings in quantities more than those taken for credit under this ECM. Typical paybacks for these measures are from 2-3 years from multiple resources including PIER (Public Interest Energy Research). All the measures are recommended for implementation.

ESTIMATE OF SAVINGS, COSTS, REBATES AND PAYBACK FOR MISCELLANEOUS MEASURES

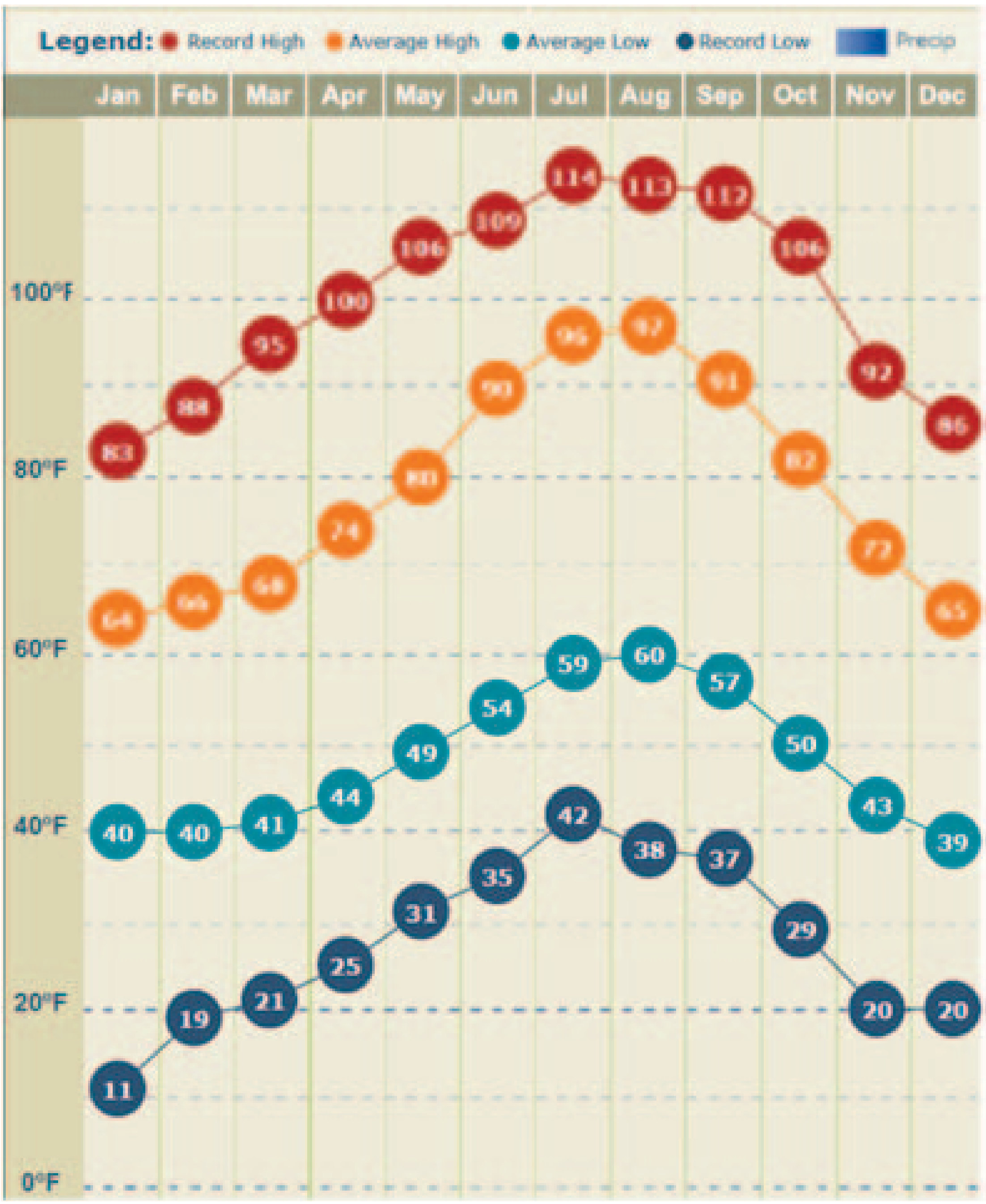
Bldg	Sq. Ft	Post Sub-Metering MBCx Measure	Baseline Energy Use (kWh/yr)	Savings (kWh/yr)	Savings (Therms/yr)	Cost Savings	CCC-IOU Rebates	Estimated Capital Costs	Simple Payback (Years)	Notes
Lab/Admin.	30,621	Demand Ventilation	87,282	17,456	63	$2,566	$4,253	$7,900	1.4	20 CO_2 Sensors
		Static Pressure Reset		17,456		$2,521	$4,190	$2,040	Immediate	
		Exhaust Fan Set-back		12,352		$1,784	$2,965	$1,060	Immediate	
		Occ Sensor based Heating/Cooling set-backs	64,304	9,646	34	$1,417	$2,349	$10,600	5.8	
College Center	8,560	Static Pressure Rest	36,256	7,251		$1,047	$1,740	$510	Immediate	
		Occ Sensor based Heating/Cooling set-backs	17,976	2,696	10	$396	$657	$2,650	5.0	
SSA	9,970	Static Pressure Rest (after applying VFD)	26,856	5,371		$776	$1,289	$1,020	Immediate	
		Occ Sensor based Heating/Cooling set-backs	20,937	3,141	11	$461	$765	$5,300	9.8	
Classroom Building (SSC)	6,800	Static Pressure Reset	20,142	4,028		$582	$967	$510	Immediate	
		Occ Sensor based Heating/Cooling set-backs	14,280	2,142	8	$315	$522	$3,710	10.1	
OE1	9,842	Static Pressure Reset	46,998	9,400		$1,357	$2,256	$1,020	Immediate	
		Occ Sensor based Heating/Cooling set-backs	20,668	3,100	11	$456	$755	$3,710	6.5	
OE2	15,730	Static Pressure Rest	20,142	4,028		$582	$967	$510	Immediate	
		Occ Sensor based Heating/Cooling set-backs	33,033	4,955	17	$728	$1,207	$6,360	7.1	
Performing Arts Center	29,851	Static Pressure Reset	127,566	25,513		$3,684	$6,123	$1,020	Immediate	
		Demand Ventilation	127,566	25,513	62	$3,729	$6,185	$4,740	Immediate	12 CO_2 Sensors
		Occ Sensor based Heating/Cooling set-backs	62,687	9,403	33	$1,382	$2,290	$6,360	2.9	
Gymansium	27,250	Static Pressure Reset (after applying VFD)	61,313	12,263		$1,771	$2,943	$3,060	0.	
		Demand Ventilation	24,525	4,905	56	$749	$1,234	$3,950	3.6	10 CO_2 Sensors
		Occ Sensor based Heating/Cooling set-backs	57,225	8,584	30	$1,261	$2,090	$5,300	2.5	
Chemistry	17,238	Demand Ventilation	46,998	9,400	36	$1,383	$2,292	$4,740	1.8	12 CO_2 Sensors
		Static Pressure Reset	46,998	9,400		$1,357	$2,256	$1,020	Immediate	
		Exhaust Fan Set-back		6,548		$946	$1,572	$530	Immediate	
		Occ Sensor based Heating/Cooling set-backs	36,200	5,430	19	$798	$1,322	$6,360	6.3	
Totals				219,982	390	$32,047	$53,186	$83,980	1.0	

EEM 02—Thermal Energy Storage (TES)

Background

Currently the Crafton Hills College (CHC) campus has an existing central plant which serves chilled water throughout the campus. This ECM quantifies the savings associated with installing and utilizing thermal energy storage (TES) for the central plant. The TES system will provide savings by shifting the production of chilled water to off-peak hours allowing for more desirable utility rates as well as a reduction of energy usage through the chillers themselves as the chillers will operate at a higher efficiency during the off-peak hours.

AMBIENT TEMPERATURES FOR YACAIPA, CA



This analysis is done for peak load and is hence limited at 1,600 hrs/yr of annual cooling operation. These 1,600 hours include 480 hrs/yr for 16 weeks of summer peak energy consumption. The chiller currently operates during peak hours at an operational efficiency of 0.6 kW/Ton at standard conditions (95˚F condenser temperature). With TES, the chiller is expected to operate during non-peak hours. The average night time temperature is 57˚F for summer conditions, based on the weather data in Figure-1 above. Since chillers are expected to operate at near peak loads at night with lower condenser temperatures, they will operate more efficiently than the peak-hours efficiency of 0.6 kW/ton. For calculation purposes, this is conservatively estimated at 0.5 kW/ton, as outlined in Table-1. Savings for the central plant are a result of improved chiller efficiencies compared to current peak hour efficiencies of the chillers, load shifting energy cost savings, and demand savings for improved energy efficiency. Load shift energy cost savings are the savings from the lower cost of energy for operating the chillers at night rather than during peak and mid-peak conditions. Table-1 defines these charges from the utility bills provided by the College.

Inputs and Assumptions

The inputs and assumptions in performing calculations for this measure are tabulated below.

INPUTS AND ASSUMPTIONS

#	Parameter	Value	Comments
#	Parameter	Value	Comments
1	Operating Hrs/Yr	1,600	Equivalent Full Load Operating Hours
2	Peak Load Operating Hrs/Yr	480	16 Summer Weeks*5 days/Week * 6 Peaks Hrs/ Day
3	Part Peak Operating Hrs/Yr	1120	Hrs/Year
4	Baseline Cost of Energy	$0.14	$/kWh, from Utility Bills
5	Peak Summer Demand Cost	$15.45	$/kW, from Utility Bills
6	Peak Summer Energy Surcharge	$0.11	$/kWh, from Utility Bills
7	Mid Peak Summer Energy Surcharge	$0.0815	$/kWh, from Utility Bills
8	Off Peak Summer Energy Surcharge	$0.0451	$/kWh, from Utility Bills
9	TES Peak Load Shifting Savings	$0.0642	$/kWh, (Peak Summer-Off Peak Summer)
10	TES Mid Peak Load Shifting Savings	$0.0364	$/kWh, (Mid Peak Summer-Off Peak Summer)
11	Utility Inflation Rate	4.00%	Reasonable Assumption
12	Parametric Cost of Chiller	$480.00	$/Ton
13	RTU Retrofit Parametric Cost	$1,000	$/Ton
14	Night Operations Efficiency Rating	0.5	kW/Ton (Chiller Design Rating)
15	CCC-IOU Rebate Rate	$0.24	CCC-IOU Program

Note—Not all assumptions are utilized as part of this ECM

Savings

Savings for existing and future buildings are summarized in the tables provided in this section. Existing energy consumption and cooling demands (Refrigeration Load only) are taken in the analysis of this measure. No calculations and savings for improved efficiencies on air side and on water side (pumping) are taken into the analysis. New energy consumption is computed at efficient night time operation of the chiller at 0.5 kW/ton. Operating the chillers at night time will also result in shifting the load from peak and mid-peak conditions to off-peak conditions. New energy consumption (reduced due to improved efficiency) consumed during peak and mid-peak conditions are reported as 'Peak kWh/yr' and 'Mid Peak kWh/Yr', respectively. These numbers are used for computing cost savings resulting from differential energy charges from tariff/Utility Bills.

Capital Costs, Savings and Paybacks

The capital costs for the TES system, chilled water piping additions, and rebates are summarized in the table below. Please refer to Central Plant section for a detailed breakdown of the cost elements.

CAPITAL COST AND PERFORMANCE STATISTICS

#	Cost Element	Cost	Comments
1	TES Costs	$1,650,000	See Central Plant & TES section of this report
2	Rebates	$38,991	Efficiency Improvement
3	Rebates	$-	DSM @ $ 300/kW
4	Savings	$96,095	
5	Simple Payback	16.8	Years

This table summarizes the savings and payback after full build out of proposed new construction including the future buildings listed in Table-2.

CALCULATIONS FOR EXISTING BUILDINGS

Building (E)	Tons	kW/Ton	kW	kWh/Yr	Peak kWh/Yr	Mid Peak kWh/Yr	Peak Summer Energy Savings	Mid-Peak Energy Savings	TES Savings	Cost of Efficiency Improvement for Night Operations	Rebates for Efficiency
Lab/Administration	64	0.60	38	61,242	18,373	42,869	$828	$1,562	$2,390	$1,474	$2,450
Student Center (previously Library)	77	0.60	46	73,800	22,140	51,660	$998	$1,882	$2,880	$1,776	$2,952
College Center	18	0.60	11	17,120	5,136	11,984	$231	$437	$668	$412	$685
Student Services A	21	0.60	12	19,940	5,982	13,958	$270	$509	$778	$480	$798
Student Services C	14	0.60	9	13,600	4,080	9,520	$184	$347	$531	$327	$544
Occupational Education I	21	0.60	12	19,684	5,905	13,779	$266	$502	$768	$474	$787
Emergency Services, Bookstore, and Classroom (previously Occ. Ed. II)	71	0.60	43	68,208	20,462	47,746	$922	$1,740	$2,662	$1,641	$2,728
Performing Arts Center	62	0.60	37	59,702	17,911	41,791	$807	$1,523	$2,330	$1,436	$2,388
Gymnasium	57	0.60	34	54,500	16,350	38,150	$737	$1,390	$2,127	$1,311	$2,180
Chemistry	36	0.60	22	34,476	10,343	24,133	$466	$879	$1,345	$830	$1,379
Student Services B	12	0.60	7	11,150	3,345	7,805	$151	$284	$435	$268	$446
Learning Resource Center	123	0.60	74	118,200	35,460	82,740	$1,598	$3,015	$4,613	$2,844	$4,728
Totals	575		345	551,622	165,487	386,135	$7,457	$14,071	$21,528	$13,273	$22,065

CALCULATIONS FOR FUTURE BUILDINGS

Future Buildings	Tons	kW/Ton	kW	kWh/Yr	Peak kWh/Yr	Mid Peak kWh/Yr	Peak Summer Energy Savings	Mid-Peak Energy Savings	TES Savings	Cost of Efficiency Improvement for Night Operations	Rebates for Efficiency	Planned Year of Occupancy
Wellness Center	42	0.60	25	40,000	12,000	28,000	$541	$1,020	$1,561	$962	$1,600	2015
Sciences	92	0.60	55	88,000	26,400	61,600	$1,190	$2,245	$3,434	$2,117	$3,520	2015
Community Recreational Facility	31	0.60	19	30,000	9,000	21,000	$406	$765	$1,171	$722	$1,200	2015
Humanities #1	51	0.60	30	48,738	14,621	34,117	$659	$1,243	$1,902	$1,173	$1,950	2015
Humanities #2	93	0.60	56	89,062	26,719	62,343	$1,204	$2,272	$3,476	$2,143	$3,562	2015
Performing Arts Center Expansion	42	0.60	25	40,000	12,000	28,000	$541	$1,020	$1,561	$962	$1,600	2025
Child Development Center Expansion	2	0.60	1	1,920	576	1,344	$26	$49	$75	$46	$77	2025
Administration/ Student Services	58	0.60	35	55,426	16,628	38,798	$749	$1,414	$2,163	$1,334	$2,217	2025
Community Center	31	0.60	19	30,000	9,000	21,000	$406	$765	$1,171	$722	$1,200	2025
Totals	441		264	423,146	126,944		$5,720	$10,794	$16,514	$10,181	$16,926	

Total savings are computed as arithmetic sum of

a) TES Savings – Sum of Peak Summer Energy Savings and Mid-Peak Energy Savings

b) Cost of Efficiency Improvement for Night Operations

EEM 03—Fan Efficiency Improvement

Background

This ECM analyzes the multi-zone VAV Air Handling Units located throughout the campus. An opportunity lies in energy consumption reduction by replacing the existing fan wheels with a new fan wheels with improved energy efficiency (Airfoil).

All of the buildings evaluated utilize fans which were installed during the original design and construction. Most of the original installations occurred between 35 years ago. Developments in impeller design over the years have increased the fan efficiency from 50% up to 65% and even higher in some cases of larger AHU (Air Handling Unit) capacities

FAN SECTION OF AIR HANDLING UNIT IN PAC BUILDING

Assumptions

Assumptions made in performing the calculations are summarized in the table below.

ASSUMPTIONS FOR FAN EFFICIENCY IMPROVEMENT ANALYSIS

#	Parameter	Value	Units	Comments
1	Blended cost of electricity ($/kWh)	$0.14	Needs to be Validated	From Utility Bills
2	kW/Ton for Central Chiller	0.6	Needs to be Validated	CCC-IOU Rebate
3	Annual Operation (Hrs)	3,600	Hrs/Yr, Needs to be Validated	CCC-IOU Rebate
4	η-Existing Fan	50%	Assumption, To be Verified	To be Validated
5	η-Proposed Fan Wheel	65%	Reasonable Assumption	
6	2010 Rebate = 2009 Rebate ($/kWh)	$0.24	Needs to be Validated	Assumption to be validated
7	1 kW = 3412.14 Btu/h	3412.14	Conversion Factor	
8	VFD output	90%	Reasonable Assumption	

50% of annual operating hours (3,600 hrs) are assumed as cooling hours and the remaining 50% are heating hours.

Savings Calculations

SAVINGS CALCULATIONS

Bldg #	Bldg Name	AHU#	Fan CFM	Existing Supply Fan HP (50% Efficient)	Proposed Fan Wheel Motor BHP (65% Efficient)	Load Factor/VFD Output	Existing Annual Energy Usage (kW-Hrs/Yr) - Fan Motor	Proposed Annual Energy Use (KW-Hrs/Yr) - Fan Motor	Fan Motor Annual Energy Use Savings (kW-Hrs/Yr)	Reduced Cooling Load (BTUH)	Reduced Chiller Load (Tons)	Assumed kW/Ton of Central Plant	Reduced Chiller Load (kW)	Chiller Energy Savings (kW-Hrs/Yr)	Sum of Fan Motor Energy and Chiller Energy Savings (kW-Hrs/Yr)	Operational Cost Savings ($/Yr)	One-Time Rebate Savings ($)	Capital Costs ($)	Simple Payback, w/o Rebate(Yrs)	Simple Payback, w/ Rebate (Yrs)
10	Laboratory/ Administration (LADM)	MZ-1	10,750	7.5	5.77	90%	18,128	13,944	4,183	4,406	0.37	0.6	0.22	793	4,976	$717	$1,194	$3,500	4.88	3.22
		MZ-2	15,015	7.5	5.77	90%	18,128	13,944	4,183	4,406	0.37	0.6	0.22	793	4,976	$717	$1,194	$3,500	4.88	3.22
		MZ-3	7,000	5	3.85	90%	12,085	9,296	2,789	2,937	0.24	0.6	0.15	529	3,318	$478	$796	$2,000	4.19	2.52
		MZ-1-1M	6,185	7.5	5.77	90%	18,128	13,944	4,183	4,406	0.37	0.6	0.22	793	4,976	$717	$1,194	$2,000	2.79	1.12
		MZ-2-1M	4,580	5	3.85	90%	12,085	9,296	2,789	2,937	0.24	0.6	0.15	529	3,318	$478	$796	$2,000	4.19	2.52
	College Center Building	M2-C	24,360	15	11.54	90%	36,256	27,889	8,367	8,811	0.73	0.6	0.44	1,586	9,953	$1,433	$2,389	$5,000	3.49	1.82
17	Student Services A (SSA)	SS-1	5,132	5	3.85	90%	12,085	9,296	2,789	2,937	0.24	0.6	0.15	529	3,318	$478	$796	$2,000	4.19	2.52
		SS-2	7,420	5	3.85	90%	12,085	9,296	2,789	2,937	0.24	0.6	0.15	529	3,318	$478	$796	$2,000	4.19	2.52
6	Student Services C (CL)	M1-C	9,920	7.5	5.77	90%	18,128	13,944	4,183	4,406	0.37	0.6	0.22	793	4,976	$717	$1,194	$2,000	2.79	1.12
14	Occupational Education 1 (OE1)	MZ-1	8,000	10	7.69	90%	24,170	18,593	5,578	5,874	0.49	0.6	0.29	1,057	6,635	$955	$1,592	$2,000	2.09	0.43
		MZ-2	6,000	7.5	5.77	90%	18,128	13,944	4,183	4,406	0.37	0.6	0.22	793	4,976	$717	$1,194	$2,000	2.79	1.12
15	Occupational Education 2 (OE2)	MZ-2	6,000	7.5	5.77	90%	18,128	13,944	4,183	4,406	0.37	0.6	0.22	793	4,976	$717	$1,194	$2,000	2.79	1.12
16	Performing Arts Center (PAC) SAF	MZ-1	26,000	20	15.38	90%	48,341	37,185	11,156	11,748	0.98	0.6	0.59	2,115	13,270	$1,911	$3,185	$5,000	2.62	0.95
		MZ-1	20,800	7.5	5.77	90%	18,128	13,944	4,183	4,406	0.37	0.6	0.22	793	4,976	$717	$1,194	$4,000	5.58	3.92
		MZ-2	23,000	15	11.54	90%	36,256	27,889	8,367	8,811	0.73	0.6	0.44	1,586	9,953	$1,433	$2,389	$5,000	3.49	1.82
		MZ-2	19,000	5	3.85	90%	12,085	9,296	2,789	2,937	0.24	0.6	0.15	529	3,318	$478	$796	$4,000	8.37	6.71
7	Chemistry/Health Sciences (CHS)	MZ-1-2m	9,600	10	7.69	90%	24,170	18,593	5,578	5,874	0.49	0.6	0.29	1,057	6,635	$955	$1,592	$2,000	2.09	0.43
		MZ-2-2M	7,360	7.5	5.77	90%	18,128	13,944	4,183	4,406	0.37	0.6	0.22	793	4,976	$717	$1,194	$2,000	2.79	1.12
Totals															102,844	$14,810	$24,683	$52,000	2.11	1.84

Comments and Conclusions

Fan efficiency improvement results in reduced fan motor consumption and reduced cooling load.

Savings are calculated using the existing fan efficiency of 50% as a baseline and calculating the proposed BHP and annual kW-hrs using a fan efficiency of 65% by installing a new fan wheel. The calculations are performed assuming that the existing fan is operating at 90% of the nominal motor HP since recorded operating BHP values were not available for this analysis. To keep an apples-to-apples comparison, both the existing and proposed cases were evaluated at an operating load of 90%. Increased efficiency reduces thermal heat load from fan inefficiencies and reduces cooling loads, which are also calculated in table above. A payback based on the sum of the fan motor energy use and chiller energy savings has been evaluated versus the capital costs including installation and labor.

It can be concluded that an opportunity is available for the replacement of the fan wheels to results in a significant energy and cost savings. This ECM can be used as justification to replace 35 years old air handling units.

EEM 04—Plug Load Reduction

Whenever an electronic device is plugged in, it adds to building's plug load, which increases energy consumption and, in turn, increases your energy bill. If you manage and reduce this load, you can cut your building's energy consumption.

In addition to lowering energy consumption from devices themselves, cutting the plug load can reduce air-conditioning loads. Researchers at the Florida Solar Energy Center found that, for every 100-watt reduction in computer energy consumption in an office building, there's a corresponding 28-watt drop in cooling loads. Because large offices are commonly charged higher rates during peak cooling hours, these midday HVAC savings can be especially lucrative.

Standby Isn't Sufficient

As convenient as it is for a computer to go into standby mode and instantly respond when turned back on, it's consuming energy all the time. Any device that uses a remote control or microprocessors – including computers, printers, TVs, etc. – probably falls into this category. The phenomenon has been more widely studied for homes, but the DOE (Department of Energy) says that it's about 5 percent of total electricity use in schools.

To eliminate standby plug loads, make sure equipment is completely turned off, which can be done via power strips. Personnel can be assigned to turn off power strips during off hours; power strips can be connected to timers or occupancy sensors, and smart power strips with built-in occupancy sensors or activity sensors are available.

The Road to Reduction

There are three ways to reduce plug loads. Setting up purchasing policies so that only the most efficient products are purchased; raising employee awareness about things like turning off equipment and establishing policies that prohibit certain kinds of equipment; and installing controls, such as occupancy sensors, that will turn things off when not in use.

Supplying power strips to employees to use for their often-forgotten energy users – such as computer speakers and radios – is a low-cost approach to reducing energy. Power strips are an easy way to quickly and easily shut off these devices at the end of the day, and can yield additional savings if also used with computers because they eliminate off-mode power draw.

Since computers are often the major load in office buildings, set aggressive power-management settings on all computer equipment. Ensure that all office equipment (PCs, displays, copiers, etc.) have their power management – or 'sleep' settings – enabled. Also, back up disks during lunchtime or off usage duration, so that all equipment can be switched off at night.

Although encouraging employees to set aggressive power-management settings on their computer equipment is essentially free and may result in greater awareness and less energy waste, there's no way to ensure that employees will comply with the power-management policy. If this proves to be ineffective, P2S recommends using low-cost or free (Windows based) network-based power-management software. Unlike individual computer power settings, this software is centrally controlled, helping IT personnel ensure maximum energy savings, and making it less likely that users will disable it. Power management software is available both open source and commercially.

POWER MANAGEMENT SOFTWARE MANUFACTURERS APPROVED BY DOE

Company	Website
Surveyor	http://www.verdiem.com/
EZ Save	http://www.energystar.gov/index.cfm?c=power_mgt.pr_power_mgt_ez_wiz
EZ GPO	http://www.energystar.gov/index.cfm?c=power_mgt.pr_power_mgt_ez_gpo
BigFix	http://bigfix.com/
e!Power Saver Solution	http://entisp.com/pages/eiPowerSaver.php
Faronics Power Save	http://faronics.com/
Night Watchman	http://www.1e.com/softwareproducts/NightWatchman/Index.aspx

A 2004 study by the Lawrence Berkeley National Laboratory revealed that 60 percent of office computers remain on overnight and during weekends, and only 6 percent use aggressive power-management settings.

The analysis in the table below is limited to 750 computers. P2S was informed by Mr. Wayne Bogh of IT systems at Crafton Hills College that no power management software similar to listed in the table above exists at the campus. There are approximately 1000 computers at the campus.

ANALYSIS FOR PLUG LOAD REDUCTION FOR CRAFTON HILLS COLLEGE

#	Item	Value	Units	Comments
1	# of computers	750	Ea	Assumption
2	Electric consumption per computer	894	kWh/Yr	102 Watts/Station
3	Computer Plug Load	670,140	kWh/yr	Baseline
4	Cost of Electricity	$0.144	$/kWh	
5	Watt Stopper Energy Savings	100,521	kWh/Yr	15% Savings on 450 Work Stations
6	Watt Stopper Energy Savings	134.03	kWh/yr	15% Savings per Work Station
6	Cost / Ea	$90	$/Ea	List Price
7	Savings, $/Ea	$19.35	$/Ea	
8	Rebate, $/Ea	$32.17	$/Ea	
9	Simple Payback without Rebate	4.65	Years	
10	Simple Payback w/Rebate	$2.99	Years	

It is recommended that all the new computers and appliances (Refrigerators, Washers, Dryers, soda vending machines, water fountains, bottled water dispensing machines etc) be Energy Star rated to help conserve energy and promote efficiency. These savings do not calculate the reduction in energy consumption of HVAC systems during summer.

Scheduled based controls should also be considered where cluster of computers are installed in classrooms and library buildings. These schedule based savings are not included in the 15% savings required by ASHRAE 90.1 for Watt Stopper. Actual savings may be higher than reported above conservatively.

EEM 05—Lighting Energy Efficiency Measures

Background

This ECM analyzes the Lighting in the buildings being analyzed for energy conservation. LECM (Lighting Energy Conservation Measures) are defined in this ECM. LECMs provide general understanding of the equipment involved and the purpose of the measure. Some retrofits may make more economic sense when major tenant improvements or building modernizations are implemented.

The recommended foot-candle lighting levels per the Illuminating Engineering Society (IES) at 30” above finished floor are shown below:

Classrooms	50-100
Corridors/Foyers/ Entry	10-20
Stairways	10-20
Dining	5-10
Kitchen	50-100
Offices	20-50
Toilets	10-20

Our recommendations are made to hold the foot-candle levels shown above.

Assumptions and Inputs

It was informed to P2S Engineering that a global (campus wide) retrofit was made in year 2004 to replace all the fluorescent lights with T832W style of lamps and ballasts. The inputs and assumptions made for this ECM are listed in the table below.

ASSUMPTIONS AND INPUTS

#	Parameter	Value	Comments
1	Blended cost of electricity ($/kWh)	$0.15	From SCE Bills
2	Rebate rate, if available for 2010 ($/kWh)	$0.24	CCC-IOU Rebate
3	Existing Ballast Factor	0.88	from PAC AHU room Ballast

Although most campus buildings operate from 400 AM till midnight for teaching and custodian usage, it is assumed that lights are used for 12 hours from Monday thru Thursday and 10 hours on Friday for 50 weeks, which is 2900 hours of annual usage. Typical average for campus lighting systems utilization is found to be 4,000 hours/yr for interior lighting. Considering the fact that there are no evening classes offered at Crafton Hills College the lighting system utilization is computed as 2,900 hours/yr.

Methodology and Calculations

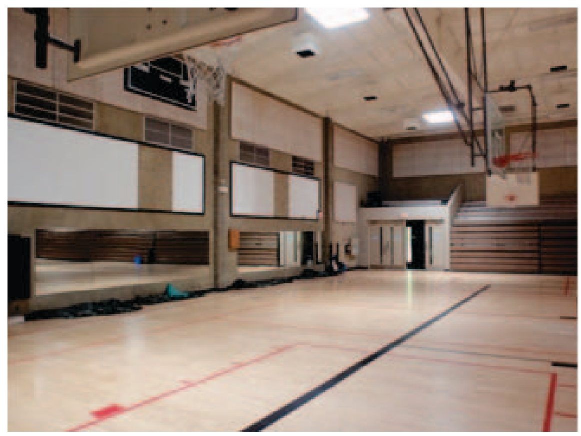
Buildings of Crafton Hills College were analyzed for following the conservation measures on lighting.

TYPICAL LIST OF LEEMS

#	Energy Conservation Measures:
LEEM 1	Replace ballast and lamps with daylight harvesting ballast (photocell and ballast factor adjustable by dip switch on ballast).
LEEM 2	Replace lamp and ballast of a T8 - 32 W to T8 -25W.

Light intensity readings were taken at several spots in the buildings during the site visits. It is concluded that with the retrofit implemented campus wide to replace all the lights with T832W lamps and ballasts, there is not much opportunity to reduce the lighting energy consumption (kWhr/Yr) that will payback for itself in less than ten years.

Table-3 outlines the LEEMS that are recommended for implementation. Day lighting is not new at Crafton Hills College. Gymnasium building already has roof lights mounted on it and the spot readings of 200 fc (foot candles) were recorded in the building.



SUMMARY OF LIGHTING ENERGY EFFICIENCY MEASURES

	Existing Conditions								Post-Retrofit Conditions										Cost, Rebate & Payback Analysis				
Item #	Building	Location	Type	Fixture	Fixture Qty	Watts per fixture	Total kWatts	Total kWh (E)	Replacement Fixture	LECM#	New Watts/fixture	Total kW	kW Demand Reduction	Operating Hours	kWh/yr (N)	kWh saved (kWh)/yr	Cost Savings ($/yr)	Annual Cost Savings ($) at $.15/kWh	Installation Cost/fixture	Total Installed Cost ($)	Rebate	Simple Payback (Yrs)	Comments
1	Bookstore & Class Rooms	Entire Book Store & Class Rooms Bldg	Fluor	4 lamps/fixture x 4' lamps	130	114	14.8	42,978	Flour	8	114	14.8	9.9	2,900	14,326	28,652	$3,438.24	$4,157	$225	$41,710	$6,876	8.4	"Add dimming ballasts with photocell. Install 8 ea Skylights (3'x3') on Bookstore Install 6 ea Skylights (3'*3') on Classrooms Demand Reduction by (2/3) with Skylights"
2	Emergency Services	Hallway	Fluor	2 lamps/fixture x 4' lamps	33	58	1.9	5,551	Flour	8	58	1.9	1.3	2,900	1,850	3,700	$444.05	$537	$125	$5,655	$888	8.9	Cut skylights in roof and provide photocell control. Installed cost is based on experience of prior work.
3	LADM	Administration Wing (300A)	Fluor	2 lamps/fixture x 4' lamps	34	58	2.0	5,719	Flour	8	58	2.0	1.3	2,900	1,906	3,813	$457.50	$553	$125	$4,880	$915	7.2	"Install dimming Ballasts & two Photo sensors Demand Reduction by (2/3) with Skylights"
4	M&O	East & West M&O open spaces outside offices	Fluor	2 lamps/fixture x 4' lamps	56	58	3.2	9,419	Flour	8	58	3.2	2.2	2,900	3,140	6,279	$753.54	$911	$125	$8,910	$1,507	8.1	"Install dimming Ballasts & two Photo sensors Demand Reduction by (2/3) with Skylights"
5	Child Care Center	Perripheral Occupancies with daylighting	Fluor	2 lamps/fixture x 4' lamps	52	58	3.0	8,746	Flour	8	58	3.0	2.0	2,900	2,915	5,831	$699.71	$846	$125	$9,650	$1,399	9.8	"Install dimming Ballasts & ten Photo sensors Demand Reduction by (2/3) with Skylights"
6	CC	Dinning Halls (C-130/1) & Admin Offices with daylights	Fluor	2 lamps/fixture x 4' lamps	46	58	2.7	7,737	Flour	8	58	2.7	1.8	2,900	2,579	5,158	$618.98	$748	$125	$7,010	$1,238	7.7	"Install dimming Ballasts & four Photo sensors Demand Reduction by (2/3) with Skylights"
7	OE-1	OE-101, OE-130 & OE-135	Fluor	2 lamps/fixture x 4' lamps	60	58	3.5	10,092	Flour	8	58	3.5	2.3	2,900	3,364	6,728	$807.36	$976	$125	$8,130	$1,615	6.7	"Install dimming Ballasts & two Photo sensors Demand Reduction by (2/3) with Skylights 70 foot candles measured with lights off"
8	Chemistry	Class Rooms & Labs	Fluor	2 lamps/fixture x 4' lamps	96	58	5.6	13,363	Flour	9	46	4.4	1.2	2,400	10,598	2,765	$331.78	$401	$140	$13,440	$664	31.8	T832 replaced with T825
9	Child Care Center	Non Perripheral Occupancies	Fluor	2 lamps/fixture x 4' lamps	52	58	3.0	12,064	Flour	9	46	2.4	0.6	4,000	9,568	2,496	$299.52	$362	$140	$7,280	$599	18.4	T832 replaced with T826
Total Savings:								115,669								65,422	$7,850.67	$9,493		106,665	$15,701	9.6	

Most of the energy conservation measures include harvesting day light. Some measures require installation of sky lights, while other buildings have fenestration to harvest day light to conserve lighting kWhrs. The bookstore and classrooms have simple paybacks of less than 10 years. Both of these buildings have wood roof structures making it easy to install the skylights. These buildings are not decided for demolition per information provided during the site visits to P2S. If the buildings are torn down, it would be in 2020 or after that, per construction activities schedule provided to P2S during the site visits; making the retrofit a viable alternative to conserve energy and payback. Some mechanical rooms were found to have incandescent lamps, but they are used for less than 100 hours per year and are hence ruled out as replacement or retrofit candidates.

LECM 2 has longer payback because of insufficient hours/year being available for the class room to justify any replacement of T832W technology. With occupancy sensors for setback installed in 2004, replacing the T832 lamps with T825W lamps and ballasts does not pay off quickly. Over 800,000 kWh/Yr of classrooms audited fall under this category. This is the reason why they are not reported for any lighting energy conservation measures. It is not recommended to retrofit the LECM-1 in table-3 above currently, but if the buildings are renovated or the lighting fixtures are replaced building wide, use of T825W technology is recommended.

EEM 06—High SEER Condensing Units / RTUs

Background

Crafton Hills College has several buildings with roof top units (RTUs) with SEER ratings of 10-11. Cooling capacity of this RTUs varies from 24,000 Btu/h (2 tons) to 72000 Btu/h (6 Tons). For smaller capacities the newer technology allows 21 SEER condensing units that generate room for energy conservation by energy efficient retrofit. Using of Energy Star rated condensing units when choosing a retrofit will provide rebates and reliable energy efficiency.

Implementation of this ECM will allow CHC to eliminate CFC based refrigerants from the subject buildings.

INSTALLATION OF CONDENSING UNITS AT CHC

Assumptions

ASSUMPTIONS FOR RETROFIT

#	Parameter	Value	Comments
1	Blended cost of electricity ($/kWh)	$0.14	From SCE Bills
2	Non Data Center Cooling Hrs/Yr	1600	Standard Seasonal Hrs
3	Rebate rate, if available for 2010 ($/kWh)	$0.24	CCC-IOU Rebate

RTUs have on/off controls and operate on full capacity only.

Analysis for Savings, Rebates, Costs and Payback for RTUs

ROOF TOP UNITS ANALYSIS FOR HIGH SEER UNITS

ID#	Bldg	Cooling BTU/h	Existing Cooling				Cooling kWH/Yr Savings	Cooling Savings ($/yr)	Replacement Cost	Rebate	Savings ($/Yr)	Simple Payback (Yrs)
			SEER	Operating Cost $/Yr	SEER	Operating Cost $/Yr						
CU-1	Occupational Education 2	60,000	11	$1,221.82	15	$896.00	2,327	$326	$5,825	$559	$326	16.2
CU-2	Occupational Education 2	72,000	11	$1,466.18	15	$1,075.20	2,793	$391	$7,625	$670	$391	17.8
CU-3	Occupational Education 2	60,000	11	$1,221.82	15	$896.00	2,327	$326	$5,825	$559	$326	16.2
CU-1	Bookstore	60,000	10	$1,344.00	15	$896.00	3,200	$448	$7,625	$768	$448	15.3
CU-2	Bookstore	60,000	10	$1,344.00	15	$896.00	3,200	$448	$7,625	$768	$448	15.3
CU-3	Bookstore	60,000	10	$1,344.00	15	$896.00	3,200	$448	$7,625	$768	$448	15.3
CU-4	Bookstore	60,000	10	$1,344.00	15	$896.00	3,200	$448	$7,625	$768	$448	15.3
CU-5	Bookstore	48,000	10	$1,075.20	15	$716.80	2,560	$358	$5,400	$614	$358	13.4
CU-6	Bookstore	42,000	10	$940.80	15	$627.20	2,240	$314	$5,400	$538	$314	15.5
CU-1	Classroom at Bookstore	60,000	10	$1,344.00	15	$896.00	3,200	$448	$7,625	$768	$448	15.3
CU-2	Classroom at Bookstore	60,000	10	$1,344.00	15	$896.00	3,200	$448	$7,625	$768	$448	15.3
CU-3	Classroom at Bookstore	48,000	10	$1,075.20	15	$716.80	2,560	$358	$5,400	$614	$358	13.4
CU-4	Classroom at Bookstore	36,000	10	$806.40	15	$537.60	1,920	$269	$5,825	$461	$269	20.0
CU-5	Classroom at Bookstore	36,000	10	$806.40	15	$537.60	1,920	$269	$5,825	$461	$269	20.0
CU-6	Classroom at Bookstore	36,000	10	$806.40	15	$537.60	1,920	$269	$5,825	$461	$269	20.0
CU-1	Maintenance&Operations	42,000	10	$940.80	15	$627.20	2,240	$314	$5,400	$538	$314	15.5
CU-2	Maintenance&Operations	42,000	10	$940.80	15	$627.20	2,240	$314	$5,400	$538	$314	15.5
CU-1	Child Development Center 1	90,000	11	$1,832.73	15	$1,344.00	3,491	$489	$5,400	$838	$489	9.3
CU-2	Child Development Center 1	60,000	11	$1,221.82	15	$896.00	2,327	$326	$5,825	$559	$326	16.2
CU-3	Child Development Center 1	60,000	11	$1,221.82	15	$896.00	2,327	$326	$5,825	$559	$326	16.2
CU-1	Child Development Center 2	72,000	11	$1,466.18	15	$1,075.20	2,793	$391	$7,625	$670	$391	17.8
CU-2	Child Development Center 2	60,000	11	$1,221.82	15	$896.00	2,327	$326	$5,825	$559	$326	16.2
Totals				$26,330.18		$18,278.40	57,513	$8,052	$140,000	$13,803	$8,052	15.7

Notes:

A. Buildings that are not confirmed for demolition are listed as follows:

    1. Bookstore

    2. Classrooms at Bookstore

    3. Occupational Education 2

B. Child Development center is a relatively new building. We recommend replacement of RTUs towards the end of the useful life (Approx 2020)

C. Maintenance and Operations is scheduled for replacement. We recommend that new units on M&O be high SEER units as analyzed in the table above or the new building be connected to the chilled water loop.

EEM 07—Tankless DWH Heaters

Background

Domestic Hot Water (DHW) is heated by electric and gas heaters with storage tanks in buildings of Crafton Hills College. Electric heating of DHW is three times more expensive at CHC at its current energy costs outlined in Energy costs section of this report. To heat 1 gallon of water by 60˚F, it will cost almost three times to heat the water, with efficiencies and energy factors included. This energy conservation measure (ECM) attempts to replace existing electric water heaters with high efficiency tankless water heaters, with high energy factors.

Assumptions

Assumptions made and inputs used to compute the savings are tabulated below.

INPUTS AND ASSUMPTIONS

#	Parameter	Value	Units	Comments
1	Cost of Natural Gas	$0.72	$/Therm	From Utility Bills
2	Cost of Electricity	$0.14	$/kWh	From Utility Bills
3	Gas Rebate	$1.00	$/Therm	CCC-IOU Rebate
4	Electricity Rebate	$0.24	$/kWh	CCC-IOU Rebate
5	DHW Consumption	1.6	GPD/Person	Reasonable assumption
6	Existing Pump Work = New Pump Work		kWh/Yr	
7	Utilization	250	days/yr	Assumption to be validated
8	Occupant/Sq. ft	100		Assumption to be validated
9	Average ΔT, 60˚F	60	˚F	
10	Baseline Tanked Energy Factor (EF)	0.65		DOE Published data
11	Tankless Energy Factors (EF)	0.9		0.98 EF is recommended

Capital Cost Estimate

Capital cost estimate of replacing existing water heater with gas (tankless) water heater is summarized in the table below.

CAPITAL COST ESTIMATE FOR TANKLESS WATER HEATERS

#	CBS Description	Unit Cost	Qty	Units	Item Cost	Notes/Comments
1	Heater	$1,950.00	1	Ea	$1,950	
2	Piping	$22.00	30	LF	$660	Means 23.1200
3	Insulation	$5.30	30	LF	$159	
4	Electrical Conduit, 1"	$22.00	10	Ea	$220	
5	Flue Duct	$4.44	25	LF	$111	Means 16.5420
6	Duct Accessories	$450.00	1	LOT	$450	
7	Demolition	$500.00	1	Ea	$500	
8	Contingency				$400	
Total Installed Cost of Installation					$4,450	

Analysis and Savings Calculations

Using the established inputs and assumptions and capital costs, calculations summarized in the table below were performed to establish baseline energy consumption and baseline energy costs. Proposed energy consumption and energy costs were calculated for the same baseline DHW consumption to establish the proposed energy costs with gas tankless water heaters. The difference between the baseline and proposed configurations is reported as savings for energy and energy costs respectively to perform a simple payback analysis.

SAVINGS, REBATES AND PAYBACK

Bldg #	Existing Design	Conditioned Area, ft^2	Occupants	DHW Consumption (GPD)	Baseline Energy Consumption	Baseline Energy Consumption Units	Baseline Energy Consumption Costs	Proposed Energy Consumption	Proposed Energy Consumption Units	Proposed Energy Consumption Costs	Capital Cost ($)	Savings ($)	Rebates ($)	Simple Payback (Yrs)
LADM	4.5 kW w/58 Gallons Storage, 3.5 kW w/30 Gallons Storage, and 3.5 kW Electric w/30 Gallons Storage	30,621	306	490	19,953	kWh/yr	$2,793.5	681	Therms/Yr	$490.3	$13,350.0	$2,303.2	$4,788.8	3.7
SSB	6 kW Electric w/10 Gallon Storage	5,575	56	89	3,633	kWh/yr	$508.6	124	Therms/Yr	$89.3	$4,450.0	$419.3	$871.9	8.5
OE1	6 kW Electric w/50 Gallon Storage	9,842	98	157	6,413	kWh/yr	$897.9	219	Therms/Yr	$157.6	$4,450.0	$740.3	$1,539.2	3.9
Bookstore	1.5 kW Electric w/6 Gallon Storage	5,760	58	92	3,753	kWh/yr	$525.5	128	Therms/Yr	$92.2	$4,450.0	$433.2	$900.8	8.2
Performing Arts Center	12 kW Electric w/50 Gallon Storage	29,851	150	240	9,774	kWh/yr	$1,368.4	334	Therms/Yr	$240.2	$4,450.0	$1,128.2	$2,345.9	1.9
Chemistry	4.5 kW w/50 Gallons Storage	17,238	172	276	11,233	kWh/yr	$1,572.6	383	Therms/Yr	$276.0	$4,450.0	$1,296.6	$2,695.9	1.4
Totals		98,887	840	1,345			$7,666.4			$1,345.7	$35,600.0	$6,320.8	$13,142.4	3.6

The buildings having gas connections only are analyzed for replacement. The buildings that do not have gas connections and use electricity for heating DHW (domestic hot water) are not listed for retrofit in the table above.

EEM 08—Premium Efficiency Motors

Background & Observations

Crafton Hills College have over 100 motors in seventeen buildings being analyzed for energy conservation. It is recommended that Crafton Hills College maintains the inventory of motors with the appropriate data, using a DOE (Department of Energy) tool called MotorMaster+. It is observation of the job walks on this energy conservation study that not too many building with large motors (HP>1) have been retrofitted with premium efficiency motors. Premium efficiency motors are a right replacement for any motor that operates more than 2000 hours/yr. Crafton Hills College should mandate the use of premium efficiency motors for all future retrofits and new buildings.

Assumptions

1. The operating hours of the motors being analyzed are conservatively estimated as 3500 hours. No data logging, or M&V is performed to validate this.
2. The load factors are based on general observations during the site visits of the conservation study and they are on conservative side.
3. Not all motors are studied or evaluated. Motors with power rating greater than 1 HP, and having a significant return is reported here.
4. Current rebate program for premium efficiency motors is CCC-IOU Energy Efficiency Partnership Program. Incentive rate is $0.24/kWh of energy saved.

Cost, Savings, Rebate and Paybacks

Table -1 summarizes the Costs, Analysis, Payback for the motors recommended for replacement. MotorMaster+ 4.0 was used for cost of replacement and installation. MotorMaster4.0 database has data for standard and premium efficiency motors.

The following Attachments are attached to substantiate the calculations in Table ECM-10-1.

Attachments

Attachment 8-1 MotorMaster Summary for I HP motor at Laboratory Center(EF Biology), Chemistry(EF), and Gymnasium (SF-AHU)

Attachment 8-2 MotorMaster Summary for 1-1/2 HP motor at Gymnasium (SF-AHU)

Attachment 8-3 MotorMaster Summary for 2 HP motor at Laboratory Center (EF-AHU, RM 406), Chemistry (RF), and Occupational Education I (RF, MZU)

Attachment 8-4 MotorMaster Summary for 2 HP motor at Gymnasium (HHWP, Central Plant)

Attachment 8-5 MotorMaster Summary for 3 HP motor at Gymnasium (CWP, CHWP at Central Plant), Laboratory Center (EF, AHU, RM 406), Occupational Education I (RF, MZU)

Attachment 8-6 MotorMaster Summary for 3 HP motor at Gymnasium (SF, AHU)

Attachment 8-7 MotorMaster Summary for 3 HP motor at Gymnasium (HHWP, Central Plant)

Attachment 8-8 MotorMaster Summary for 3 HP motor at SSA (CHWP, Central Plant)

Attachment 8-9 MotorMaster Summary for 5 HP motor at Laboratory Center (SF, MZ, RM 227), SSA (SF), and Performing Arts Center (RF, MZU)

Attachment 8-10 MotorMaster Summary for 5 HP motor at Laboratory Center (CHWP, Central Plant)

Attachment 8-11 MotorMaster Summary for 7.5 HP motor at Laboratory Center (SF, MZU, Biology; SF, MZU, RM 301), Occupational Education I (SF, MZU), Occupational Education II (SF, MZU), Performing Arts Center (RF, MZU), Chemistry (SF, MZU)

Attachment 8-12 MotorMaster Summary for 10 HP motor at Laboratory Center (SF, AHU, RM 103), Chemistry (SF, MZU), Occupational Education I (SF, MZU)

Attachment 8-13 MotorMaster Summary for 15 HP motor at Performing Arts Center (SF, MZU)

Attachment 8-14 MotorMaster Summary for 20 HP motor at Performing Arts Center (SF, MZU)

Attachment 8-15 MotorMaster Summary for 20 HP motor at SSA (HHWP, CP)

Attachment 8-16 MotorMaster Summary for 40 HP motor at SSA (CHWP, CP)

Attachment 8-17 MotorMaster Summary for 125 HP motor at Laboratory Center (HHWP, CP)

Attachment 8-18 MotorMaster Summary for 7.5 HP motor at SSA (SF, MZU)

Attachment 8-19 MotorMaster Summary for 7.5 HP motor at Laboratory Center (Vacuum Fan, Biology)

TABLE 2 COST, SAVINGS, PAYBACK ANALYSIS

Equipment	Bldg	Hrs/Yr	Qty	% Load	Enclosure	Voltage	η-Std	η-Premium	Measure	HP Rating	kWH/Yr Savings	Cost	Rebate	Savings ($/Yr)	Simple Payback	Payback, w/Rebate	Attachment #
Exhaust Fan, Biology	Laboratory Center	3,500	1	75%	ODP	460	76.9	85.1	Replace Motor	1	245	$388	$59	$36	10.8	9.1	10-1
Supply Fan, MZU, Biology	Laboratory Center	3,500	2	75%	ODP	460	86.0	91.5	Replace Motor	7.5	2,050	$1,624	$492	$298	5.4	3.8	10-11
Vaccum Fan, Biology	Laboratory Center	3,500	1	75%	ODP	460	84.0	89.6	Replace Motor	7.5	1,081	$724	$259	$157	4.6	3.0	10-19
Supply Fan, Mzu, Rm 227	Laboratory Center	3,500	1	75%	ODP	460	84.3	90.4	Replace Motor	5	781	$581	$187	$113	5.1	3.5	10-9
Supply Fan, MZU, Rm 301	Laboratory Center	3,500	1	75%	ODP	460	86.0	91.5	Replace Motor	7.5	1,025	$812	$246	$149	5.4	3.8	10-11
Supply Fan, AHU, Rm 406	Laboratory Center	3,500	1	75%	ODP	460	80.9	86.9	Replace Motor	2	332	$454	$80	$48	9.5	7.8	10-3
Exhaust Fan, AHU, Rm 406	Laboratory Center	3,500	1	75%	ODP	460	83.2	89.7	Replace Motor	3	517	$509	$124	$75	6.8	5.1	10-5
Supply Fan, AHU, Rm 103	Laboratory Center	3,500	1	75%	ODP	460	87.4	91.9	Replace Motor	10	1,089	$994	$261	$158	6.3	4.6	10-12
HHWP, Central Plant	Laboratory Center	3,500	2	75%	ODP	460	93.0	95.6	Replace Motor	125	14,478	$12,282	$3,475	$2,100	5.8	4.2	10-17
CHWP, Central Plant	Laboratory Center	3,500	2	75%	ODP	460	87.5	90.4	Replace Motor	5	718	$1,162	$172	$104	11.2	9.5	10-10
Supply Fan, MZU	Chemistry	3,500	1	75%	ODP	460	87.4	91.9	Replace Motor	10	1,089	$994	$261	$158	6.3	4.6	10-12
Supply Fan, MZU	Chemistry	3,500	1	75%	ODP	460	86.0	91.5	Replace Motor	7.5	1,025	$812	$246	$149	5.4	3.8	10-11
Return Fan	Chemistry	3,500	1	75%	ODP	460	80.9	86.9	Replace Motor	2	332	$454	$80	$48	9.5	7.8	10-3
Exhaust Fan	Chemistry	3,500	2	75%	ODP	460	76.9	85.1	Replace Motor	1	490	$776	$118	$72	10.8	9.1	10-1
Supply Fan	SSA	3,500	2	75%	ODP	460	84.3	90.4	Replace Motor	5	1,562	$1,162	$375	$226	5.1	3.5	10-9
HHWP, Central Plant	SSA	3,500	2	75%	ODP	460	91.0	93.4	Replace Motor	20	2,194	$3,274	$527	$318	10.3	8.6	10-15
CHWP, Central Plant	SSA	3,500	2	75%	ODP	460	86.5	89.7	Replace Motor	3	490	$1,018	$118	$72	14.1	12.5	10-8
CHWP, Central Plant	SSA	3,500	2	75%	ODP	460	89.7	93.7	Replace Motor	40	7,420	$5,204	$1,781	$1,076	4.8	3.2	10-16
Supply Fan, MZU	SSA	3,500	2	75%	TEFC	460	89.5	92.6	Replace Motor	7.5	812	$2,042	$195	$118	17.3	15.7	10-18
Supply Fan, MZU	OE1	3,500	1	75%	ODP	460	87.4	91.9	Replace Motor	10	1,089	$994	$261	$158	6.3	4.6	10-12
Return Fan, MZU	OE1	3,500	1	75%	ODP	460	83.2	89.7	Replace Motor	3	517	$509	$124	$75	6.8	5.1	10-5
Supply Fan, MZU	OE1	3,500	1	75%	ODP	460	86.0	91.5	Replace Motor	7.5	1,025	$812	$246	$149	5.4	3.8	10-11
Return Fan, MZU	OE1	3,500	1	75%	ODP	460	80.9	86.9	Replace Motor	2	332	$454	$80	$48	9.5	7.8	10-3
Supply Fan, MZU	OE2	3,500	1	75%	ODP	460	86.0	91.5	Replace Motor	7.5	1,025	$812	$246	$149	5.4	3.8	10-11
Supply Fan, Mzu	Perf. Arts Center	3,500	1	75%	ODP	460	89.4	93.4	Replace Motor	20	1,879	$1,637	$451	$273	6.0	4.3	10-14
Return Fan, Mzu	Perf. Arts Center	3,500	1	75%	ODP	460	86.0	91.5	Replace Motor	7.5	1,025	$812	$246	$149	5.4	3.8	10-11
Supply Fan, Mzu	Perf. Arts Center	3,500	1	75%	ODP	460	88.8	93.1	Replace Motor	15	1,515	$1,290	$364	$220	5.9	4.2	10-13
Return Fan, Mzu	Perf. Arts Center	3,500	1	75%	ODP	460	84.3	90.4	Replace Motor	5	781	$581	$187	$113	5.1	3.5	10-9
Supply Fan, Ahu	Gymnasium	3,500	4	75%	ODP	460	87.5	89.7	Replace Motor	3	672	$2,036	$161	$96	21.2	19.5	10-6
Supply Fan, Ahu	GYMNASIUM	3,500	1	75%	ODP	460	76.9	85.1	Replace Motor	1	245	$388	$59	$36	10.8	9.1	10-1
Supply Fan, Ahu	GYMNASIUM	3,500	1	75%	ODP	460	82.5	86.3	Replace Motor	1.5	158	$428	$38	$23	18.6	17.0	10-2
Hhwp, Central Plant	GYMNASIUM	3,500	2	75%	ODP	460	84.4	89.7	Replace Motor	3	828	$1,018	$199	$120	8.5	6.8	10-7
Hhwp, Central Plant	GYMNASIUM	3,500	2	75%	ODP	460	78.5	86.9	Replace Motor	2	962	$908	$231	$140	6.5	4.8	10-4
Cwp	GYMNASIUM	3,500	1	75%	ODP	460	83.2	89.7	Replace Motor	3	517	$509	$124	$75	6.8	5.1	10-5
Chwp, Central Plant	GYMNASIUM	3,500	2	75%	ODP	460	83.2	89.7	Replace Motor	3	517	$509	$124	$75	6.8	5.1	10-5
Totals											50,817	$48,963	$12,196	$7,374	6.6	5.0	

Attachment 8-1

Comparison Savings (Replace Existing)
1HP motor

MotorMaster+ 4.0
from US DOE

For : Crafton Hills College **Page : 1**
By : Rafal Jankowski **07-21-2010**

Facility : Crafton Hills College
Utility: Southern California Edison
(Blended Cost of Electricity- Crafton HC)

Energy Price : $0.145100/kWh
Demand charge: $0.00/kW

	Standard Efficiency Motor	Premium Efficiency Motor	
COMPARISON DATA			
Standard Motor:	<Avg Std Efficiency>	<Avg Premium Efficiency>	
Manufacturer:			
Size:	1 Hp	1 Hp	
Speed:	1800 RPM	1800 RPM	
Enclosure:	ODP	ODP	
Voltage:			
Definite Purpose:			
Hours use/yr:	3500	3500	
Load:	75.0 %	75.0 %	
Efficiency:	76.9 %	85.1 %	
Full Load RPM:			
Centrifugal Load:	No		
Old Motor Eff. Loss:			
Dealer Discount:			
Purchase Price:		$318	
Installation Cost:		$70	
Motor Rebate:			
Peak Months:	12	12	
SAVINGS			
Motor Premium:	$388		
Energy Use:	2548 kWh	2302 kWh	
Energy Cost:	$370	$334	
Demand Charge:			
Energy Savings:		245 kWh	$36
Demand Savings:		0.1 kW	
Total Savings:			$36
Simple Payback:			10.9 Yrs

Attachment 8-2

Comparison Savings (Replace Existing)
1-1/2 HP motor

MotorMaster+ 4.0
from US DOE

For : CHC **Page : 1**
By : Rafal Jankowski **07-21-2010**

Facility : Crafton Hills College
Utility: Southern California Edison
(Blended Cost of Electricity- Crafton HC)

Energy Price : $0.145100/kWh
Demand charge: $0.00/kW

COMPARISON DATA

	Standard Efficiency Motor	Premium Efficiency Motor
Standard Motor:	<Avg Std Efficiency>	<Avg Premium Efficiency>
Manufacturer:		
Size:	1.5 Hp	1.5 Hp
Speed:	1800 RPM	1800 RPM
Enclosure:	ODP	ODP
Voltage:		
Definite Purpose:		
Hours use/yr:	3500	3500
Load:	75.0 %	75.0 %
Efficiency:	82.5 %	86.3 %
Full Load RPM:		
Centrifugal Load:	No	
Old Motor Eff. Loss:		
Dealer Discount:		
Purchase Price:		$358
Installation Cost:		$70
Motor Rebate:		
Peak Months:	12	12

SAVINGS

	Standard Efficiency Motor	Premium Efficiency Motor	
Motor Premium:	$428		
Energy Use:	3560 kWh	3402 kWh	
Energy Cost:	$517	$494	
Demand Charge:			
Energy Savings:		158 kWh	$23
Demand Savings:		0.0 kW	
Total Savings:			$23
Simple Payback:			18.7 Yrs

Attachment 8-3

Comparison Savings (Replace Existing)
2 HP motor w/ 80.9% eff

MotorMaster+ 4.0
from US DOE

For : CHC **Page : 1**

By : Rafal Jankowski **07-21-2010**

Facility : Crafton Hills College
Utility: Southern California Edison
(Blended Cost of Electricity- Crafton HC)

Energy Price : $0.145100/kWh
Demand charge: $0.00/kW

COMPARISON DATA

	Standard Efficiency Motor	Premium Efficiency Motor
Standard Motor:	<Avg Std Efficiency>	<Avg Premium Efficiency>
Manufacturer:		
Size:	2 Hp	2 Hp
Speed:	1800 RPM	1800 RPM
Enclosure:	ODP	ODP
Voltage:		
Definite Purpose:		
Hours use/yr:	3500	3500
Load:	75.0 %	75.0 %
Efficiency:	80.9 %	86.9 %
Full Load RPM:		
Centrifugal Load:	No	
Old Motor Eff. Loss:		
Dealer Discount:		
Purchase Price:		$379
Installation Cost:		$75
Motor Rebate:		
Peak Months:	12	12

SAVINGS

	Standard Efficiency Motor	Premium Efficiency Motor	
Motor Premium:	$454		
Energy Use:	4841 kWh	4508 kWh	
Energy Cost:	$702	$654	
Demand Charge:			
Energy Savings:		332 kWh	$48
Demand Savings:		0.1 kW	
Total Savings:			$48
Simple Payback:			9.4 Yrs

Attachment 8-4

Comparison Savings (Replace Existing)
2 HP motor w/ 78.5% eff

MotorMaster+ 4.0
from US DOE

For : CHC **Page : 1**
By : Rafal Jankowski **07-21-2010**

Facility : Crafton Hills College
Utility: Southern California Edison
(Blended Cost of Electricity- Crafton HC)

Energy Price : $0.145100/kWh
Demand charge: $0.00/kW

COMPARISON DATA

	Standard Efficiency Motor	Premium Efficiency Motor
Standard Motor:	<Avg Std Efficiency>	<Avg Premium Efficiency>
Manufacturer:		
Size:	2 Hp	2 Hp
Speed:	1800 RPM	1800 RPM
Enclosure:	ODP	ODP
Voltage:		
Definite Purpose:		
Hours use/yr:	3500	3500
Load:	75.0 %	75.0 %
Efficiency:	78.5 %	86.9 %
Full Load RPM:		
Centrifugal Load:	No	
Old Motor Eff. Loss:		
Dealer Discount:		
Purchase Price:		$379
Installation Cost:		$75
Motor Rebate:		
Peak Months:	12	12

SAVINGS

	Standard Efficiency Motor	Premium Efficiency Motor	
Motor Premium:	$454		
Energy Use:	4989 kWh	4508 kWh	
Energy Cost:	$724	$654	
Demand Charge:			
Energy Savings:		481 kWh	$70
Demand Savings:		0.1 kW	
Total Savings:			$70
Simple Payback:			6.5 Yrs

Attachment 8-5

Comparison Savings (Replace Existing)
3 HP motor w/ standart eff

MotorMaster+ 4.0
from **US DOE**

For : CHC **Page : 1**

By : Rafal Jankowski **07-21-2010**

Facility : Crafton Hills College
Utility: Southern California Edison
(Blended Cost of Electricity- Crafton HC)

Energy Price : $0.145100/kWh
Demand charge: $0.00/kW

	Standard Efficiency Motor	Premium Efficiency Motor	
COMPARISON DATA			
Standard Motor:	<Avg Std Efficiency>	<Avg Premium Efficiency>	
Manufacturer:			
Size:	3 Hp	3 Hp	
Speed:	1800 RPM	1800 RPM	
Enclosure:	ODP	ODP	
Voltage:			
Definite Purpose:			
Hours use/yr:	3500	3500	
Load:	75.0 %	75.0 %	
Efficiency:	83.2 %	89.7 %	
Full Load RPM:			
Centrifugal Load:	No		
Old Motor Eff. Loss:			
Dealer Discount:			
Purchase Price:		$434	
Installation Cost:		$75	
Motor Rebate:			
Peak Months:	12	12	
SAVINGS			
Motor Premium:	$509		
Energy Use:	7064 kWh	6546 kWh	
Energy Cost:	$1025	$950	
Demand Charge:			
Energy Savings:		517 kWh	$75
Demand Savings:		0.1 kW	
Total Savings:			$75
Simple Payback:			6.8 Yrs

Attachment 8-6

Comparison Savings (Replace Existing)
3 HP motor w/ 87.5% eff

MotorMaster+ 4.0
from US DOE

For :

Page : 1

By : Rafal Jankowski

07-21-2010

Facility : Crafton Hills College
Utility: Southern California Edison
(Blended Cost of Electricity- Crafton HC)

Energy Price : $0.145100/kWh
Demand charge: $0.00/kW

COMPARISON DATA

	Standard Efficiency Motor	Premium Efficiency Motor
Standard Motor:	<Avg Std Efficiency>	<Avg Premium Efficiency>
Manufacturer:		
Size:	3 Hp	3 Hp
Speed:	1800 RPM	1800 RPM
Enclosure:	ODP	ODP
Voltage:		
Definite Purpose:		
Hours use/yr:	3500	3500
Load:	75.0 %	75.0 %
Efficiency:	87.5 %	89.7 %
Full Load RPM:		
Centrifugal Load:	No	
Old Motor Eff. Loss:		
Dealer Discount:		
Purchase Price:		$434
Installation Cost:		$75
Motor Rebate:		
Peak Months:	12	12

SAVINGS

	Standard Efficiency Motor	Premium Efficiency Motor	
Motor Premium:	$509		
Energy Use:	6714 kWh	6546 kWh	
Energy Cost:	$974	$950	
Demand Charge:			
Energy Savings:		168 kWh	$24
Demand Savings:		0.0 kW	
Total Savings:			$24
Simple Payback:			20.9 Yrs

Attachment 8-7

Comparison Savings (Replace Existing)
3 HP motor w/ 84.4% eff

MotorMaster+ 4.0
from US DOE

For : CHC
By : Rafal Jankowski

Page : 1
07-21-2010

Facility : Crafton Hills College
Utility: Southern California Edison
(Blended Cost of Electricity- Crafton HC)

Energy Price : $0.145100/kWh
Demand charge: $0.00/kW

COMPARISON DATA

	Standard Efficiency Motor	Premium Efficiency Motor
Standard Motor:	<Avg Std Efficiency>	<Avg Premium Efficiency>
Manufacturer:		
Size:	3 Hp	3 Hp
Speed:	1800 RPM	1800 RPM
Enclosure:	ODP	ODP
Voltage:		
Definite Purpose:		
Hours use/yr:	3500	3500
Load:	75.0 %	75.0 %
Efficiency:	84.4 %	89.7 %
Full Load RPM:		
Centrifugal Load:	No	
Old Motor Eff. Loss:		
Dealer Discount:		
Purchase Price:		$434
Installation Cost:		$75
Motor Rebate:		
Peak Months:	12	12

SAVINGS

	Standard Efficiency Motor	Premium Efficiency Motor	
Motor Premium:	$509		
Energy Use:	6961 kWh	6546 kWh	
Energy Cost:	$1010	$950	
Demand Charge:			
Energy Savings:		414 kWh	$60
Demand Savings:		0.1 kW	
Total Savings:			$60
Simple Payback:			8.5 Yrs

Comparison Savings (Replace Existing)
3 HP motor w/ 86.5% eff

MotorMaster+ 4.0
from US DOE

For : CHC
By : Rafal Jankowski

Page : 1
07-21-2010

Facility : Crafton Hills College
Utility: Southern California Edison
(Blended Cost of Electricity- Crafton HC)

Energy Price : $0.145100/kWh
Demand charge: $0.00/kW

COMPARISON DATA

	Standard Efficiency Motor	Premium Efficiency Motor
Standard Motor:	<Avg Std Efficiency>	<Avg Premium Efficiency>
Manufacturer:		
Size:	3 Hp	3 Hp
Speed:	1800 RPM	1800 RPM
Enclosure:	ODP	ODP
Voltage:		
Definite Purpose:		
Hours use/yr:	3500	3500
Load:	75.0 %	75.0 %
Efficiency:	86.5 %	89.7 %
Full Load RPM:		
Centrifugal Load:	No	
Old Motor Eff. Loss:		
Dealer Discount:		
Purchase Price:		$434
Installation Cost:		$75
Motor Rebate:		
Peak Months:	12	12

SAVINGS

	Standard Efficiency Motor	Premium Efficiency Motor	
Motor Premium:	$509		
Energy Use:	6792 kWh	6546 kWh	
Energy Cost:	$985	$950	
Demand Charge:			
Energy Savings:		245 kWh	$36
Demand Savings:		0.1 kW	
Total Savings:			$36
Simple Payback:			14.3 Yrs

Attachment 8-9

Comparison Savings (Replace Existing)
5 HP motor w/ standard eff

MotorMaster+ 4.0
from **US DOE**

For : **CHC** | **Page : 1**

By : **Rafal Jankowski** | **07-22-2010**

Facility : Crafton Hills College
Utility: Southern California Edison
(Blended Cost of Electricity- Crafton HC)

Energy Price : $0.145100/kWh
Demand charge: $0.00/kW

COMPARISON DATA

	Standard Efficiency Motor	Premium Efficiency Motor
Standard Motor:	<Avg Std Efficiency>	<Avg Premium Efficiency>
Manufacturer:		
Size:	5 Hp	5 Hp
Speed:	1800 RPM	1800 RPM
Enclosure:	ODP	ODP
Voltage:		
Definite Purpose:		
Hours use/yr:	3500	3500
Load:	75.0 %	75.0 %
Efficiency:	84.3 %	90.4 %
Full Load RPM:		
Centrifugal Load:	No	
Old Motor Eff. Loss:		
Dealer Discount:		
Purchase Price:		$506
Installation Cost:		$75
Motor Rebate:		
Peak Months:	12	12

SAVINGS

	Standard Efficiency Motor	Premium Efficiency Motor	
Motor Premium:	$581		
Energy Use:	11612 kWh	10831 kWh	
Energy Cost:	$1685	$1572	
Demand Charge:			
Energy Savings:		781 kWh	$113
Demand Savings:		0.2 kW	
Total Savings:			$113
Simple Payback:			5.1 Yrs

Comparison Savings (Replace Existing)
5 HP motor w/ 87.5% eff

MotorMaster+ 4.0
from US DOE

For : **CHP** **Page : 1**

By : **Rafal Jankowski** **07-22-2010**

Facility : Crafton Hills College
Utility: Southern California Edison
(Blended Cost of Electricity- Crafton HC)

Energy Price : $0.145100/kWh
Demand charge: $0.00/kW

COMPARISON DATA

	Standard Efficiency Motor	Premium Efficiency Motor
Standard Motor:	<Avg Std Efficiency>	<Avg Premium Efficiency>
Manufacturer:		
Size:	5 Hp	5 Hp
Speed:	1800 RPM	1800 RPM
Enclosure:	ODP	ODP
Voltage:		
Definite Purpose:		
Hours use/yr:	3500	3500
Load:	75.0 %	75.0 %
Efficiency:	87.5 %	90.4 %
Full Load RPM:		
Centrifugal Load:	No	
Old Motor Eff. Loss:		
Dealer Discount:		
Purchase Price:		$506
Installation Cost:		$75
Motor Rebate:		
Peak Months:	12	12

SAVINGS

	Standard Efficiency Motor	Premium Efficiency Motor	
Motor Premium:	$581		
Energy Use:	11190 kWh	10831 kWh	
Energy Cost:	$1624	$1572	
Demand Charge:			
Energy Savings:		359 kWh	$52
Demand Savings:		0.1 kW	
Total Savings:			$52
Simple Payback:			11.2 Yrs

Attachment 8-11

Comparison Savings (Replace Existing)
7.5 HP motor w/ standard eff

MotorMaster+ 4.0
from US DOE

For : CHC
By : Rafal Jankowski

Page : 1
07-22-2010

Facility : Crafton Hills College
Utility: Southern California Edison
(Blended Cost of Electricity- Crafton HC)

Energy Price : $0.145100/kWh
Demand charge: $0.00/kW

COMPARISON DATA

	Standard Efficiency Motor	Premium Efficiency Motor	
Standard Motor:	<Avg Std Efficiency>	<Avg Premium Efficiency>	
Manufacturer:			
Size:	7.5 Hp	7.5 Hp	
Speed:	1800 RPM	1800 RPM	
Enclosure:	ODP	ODP	
Voltage:			
Definite Purpose:			
Hours use/yr:	3500	3500	
Load:	75.0 %	75.0 %	
Efficiency:	86.0 %	91.5 %	
Full Load RPM:			
Centrifugal Load:	No		
Old Motor Eff. Loss:			
Dealer Discount:			
Purchase Price:		$732	
Installation Cost:		$80	
Motor Rebate:			
Peak Months:	12	12	

SAVINGS

	Standard Efficiency Motor	Premium Efficiency Motor	
Motor Premium:	$812		
Energy Use:	17076 kWh	16051 kWh	
Energy Cost:	$2478	$2329	
Demand Charge:			
Energy Savings:		1025 kWh	$149
Demand Savings:		0.3 kW	
Total Savings:			$149
Simple Payback:			5.5 Yrs

Comparison Savings (Replace Existing)
10 HP motor w/ standard eff

MotorMaster+ 4.0
from US DOE

For : CHC
By : Rafal Jankowski

Page : 1
07-22-2010

Facility : Crafton Hills College
Utility: Southern California Edison
(Blended Cost of Electricity- Crafton HC)

Energy Price : $0.145100/kWh
Demand charge: $0.00/kW

COMPARISON DATA

	Standard Efficiency Motor	Premium Efficiency Motor
Standard Motor:	<Avg Std Efficiency>	<Avg Premium Efficiency>
Manufacturer:		
Size:	10 Hp	10 Hp
Speed:	1800 RPM	1800 RPM
Enclosure:	ODP	ODP
Voltage:		
Definite Purpose:		
Hours use/yr:	3500	3500
Load:	75.0 %	75.0 %
Efficiency:	87.4 %	91.9 %
Full Load RPM:		
Centrifugal Load:	No	
Old Motor Eff. Loss:		
Dealer Discount:		
Purchase Price:		$909
Installation Cost:		$85
Motor Rebate:		
Peak Months:	12	12

SAVINGS

	Standard Efficiency Motor	Premium Efficiency Motor	
Motor Premium:	$994		
Energy Use:	22393 kWh	21304 kWh	
Energy Cost:	$3249	$3091	
Demand Charge:			
Energy Savings:		1089 kWh	$158
Demand Savings:		0.3 kW	
Total Savings:			$158
Simple Payback:			6.3 Yrs

Attachment 8-13

Comparison Savings (Replace Existing)
15 HP motor w/ standard eff

MotorMaster+ 4.0
from US DOE

For : CHC — **Page :** 1
By : Rafal Jankowski — 07-22-2010

Facility : Crafton Hills College
Utility: Southern California Edison
(Blended Cost of Electricity- Crafton HC)

Energy Price : $0.145100/kWh
Demand charge: $0.00/kW

COMPARISON DATA

	Standard Efficiency Motor	Premium Efficiency Motor	
Standard Motor:	<Avg Std Efficiency>	<Avg Premium Efficiency>	
Manufacturer:			
Size:	15 Hp	15 Hp	
Speed:	1800 RPM	1800 RPM	
Enclosure:	ODP	ODP	
Voltage:			
Definite Purpose:			
Hours use/yr:	3500	3500	
Load:	75.0 %	75.0 %	
Efficiency:	88.8 %	93.1 %	
Full Load RPM:			
Centrifugal Load:	No		
Old Motor Eff. Loss:			
Dealer Discount:			
Purchase Price:		$1190	
Installation Cost:		$100	
Motor Rebate:			
Peak Months:	12	12	

SAVINGS

	Standard Efficiency Motor	Premium Efficiency Motor	
Motor Premium:	$1290		
Energy Use:	33069 kWh	31554 kWh	
Energy Cost:	$4798	$4579	
Demand Charge:			
Energy Savings:		1515 kWh	$220
Demand Savings:		0.4 kW	
Total Savings:			$220
Simple Payback:			5.9 Yrs

Attachment 8-14

Comparison Savings (Replace Existing)
20 HP motor w/ standard eff

MotorMaster+ 4.0
from US DOE

For :

Page : 1

By : Rafal Jankowski

07-22-2010

Facility : Crafton Hills College
Utility: Southern California Edison
(Blended Cost of Electricity- Crafton HC)

Energy Price : $0.145100/kWh
Demand charge: $0.00/kW

COMPARISON DATA

	Standard Efficiency Motor	Premium Efficiency Motor
Standard Motor:	<Avg Std Efficiency>	<Avg Premium Efficiency>
Manufacturer:		
Size:	20 Hp	20 Hp
Speed:	1800 RPM	1800 RPM
Enclosure:	ODP	ODP
Voltage:		
Definite Purpose:		
Hours use/yr:	3500	3500
Load:	75.0 %	75.0 %
Efficiency:	89.4 %	93.4 %
Full Load RPM:		
Centrifugal Load:	No	
Old Motor Eff. Loss:		
Dealer Discount:		
Purchase Price:		$1512
Installation Cost:		$125
Motor Rebate:		
Peak Months:	12	12

SAVINGS

	Standard Efficiency Motor	Premium Efficiency Motor	
Motor Premium:	$1637		
Energy Use:	43821 kWh	41942 kWh	
Energy Cost:	$6358	$6086	
Demand Charge:			
Energy Savings:		1879 kWh	$273
Demand Savings:		0.5 kW	
Total Savings:			$273
Simple Payback:			6.0 Yrs

Comparison Savings (Replace Existing)
20 HP motor w/ 91% eff

MotorMaster+ 4.0
from **US DOE**

For :
Page : 1

By : Rafal Jankowski
07-22-2010

Facility : Crafton Hills College
Utility: Southern California Edison
(Blended Cost of Electricity- Crafton HC)

Energy Price : $0.145100/kWh
Demand charge: $0.00/kW

COMPARISON DATA

	Standard Efficiency Motor	Premium Efficiency Motor
Standard Motor:	<Avg Std Efficiency>	<Avg Premium Efficiency>
Manufacturer:		
Size:	20 Hp	20 Hp
Speed:	1800 RPM	1800 RPM
Enclosure:	ODP	ODP
Voltage:		
Definite Purpose:		
Hours use/yr:	3500	3500
Load:	75.0 %	75.0 %
Efficiency:	91.0 %	93.4 %
Full Load RPM:		
Centrifugal Load:	No	
Old Motor Eff. Loss:		
Dealer Discount:		
Purchase Price:		$1512
Installation Cost:		$125
Motor Rebate:		
Peak Months:	12	12

SAVINGS

	Standard Efficiency Motor	Premium Efficiency Motor	
Motor Premium:	$1637		
Energy Use:	43038 kWh	41942 kWh	
Energy Cost:	$6245	$6086	
Demand Charge:			
Energy Savings:		1097 kWh	$159
Demand Savings:		0.3 kW	
Total Savings:			$159
Simple Payback:			10.3 Yrs

Attachment 8-16

Comparison Savings (Replace Existing)
40 HP motor w/89.7 eff 3525 RPM

MotorMaster+ 4.0
from US DOE

For :
Page : 1
By : Rafal Jankowski
07-22-2010

Facility : Crafton Hills College
Utility: Southern California Edison
(Blended Cost of Electricity- Crafton HC)

Energy Price : $0.145100/kWh
Demand charge: $0.00/kW

COMPARISON DATA

	Standard Efficiency Motor	Premium Efficiency Motor
Standard Motor:	<Avg Std Efficiency>	<Avg Premium Efficiency>
Manufacturer:		
Size:	40 Hp	40 Hp
Speed:	3600 RPM	3600 RPM
Enclosure:	ODP	ODP
Voltage:		
Definite Purpose:		
Hours use/yr:	3500	3500
Load:	75.0 %	75.0 %
Efficiency:	89.7 %	93.7 %
Full Load RPM:		
Centrifugal Load:	No	
Old Motor Eff. Loss:		
Dealer Discount:		
Purchase Price:		$2442
Installation Cost:		$160
Motor Rebate:		
Peak Months:	12	12

SAVINGS

	Standard Efficiency Motor	Premium Efficiency Motor	
Motor Premium:	$2602		
Energy Use:	87289 kWh	83579 kWh	
Energy Cost:	$12666	$12127	
Demand Charge:			
Energy Savings:		3710 kWh	$538
Demand Savings:		1.1 kW	
Total Savings:			$538
Simple Payback:			4.8 Yrs

Attachment 8-17

Comparison Savings (Replace Existing)
125 HP motor w/ 93% eff

MotorMaster+ 4.0
from **US DOE**

For :

Page : 1

By : Rafal Jankowski

07-22-2010

Facility : Crafton Hills College
Utility: Southern California Edison
(Blended Cost of Electricity- Crafton HC)

Energy Price : $0.145100/kWh
Demand charge: $0.00/kW

COMPARISON DATA

	Standard Efficiency Motor	Premium Efficiency Motor
Standard Motor:	<Avg Std Efficiency>	<Avg Premium Efficiency>
Manufacturer:		
Size:	125 Hp	125 Hp
Speed:	1800 RPM	1800 RPM
Enclosure:	ODP	ODP
Voltage:		
Definite Purpose:		
Hours use/yr:	3500	3500
Load:	75.0 %	75.0 %
Efficiency:	93.0 %	95.6 %
Full Load RPM:		
Centrifugal Load:	No	
Old Motor Eff. Loss:		
Dealer Discount:		
Purchase Price:		$5691
Installation Cost:		$450
Motor Rebate:		
Peak Months:	12	12

SAVINGS

	Standard Efficiency Motor	Premium Efficiency Motor	
Motor Premium:	$6141		
Energy Use:	263206 kWh	255967 kWh	
Energy Cost:	$38191	$37141	
Demand Charge:			
Energy Savings:		7239 kWh	$1050
Demand Savings:		2.1 kW	
Total Savings:			$1050
Simple Payback:			5.8 Yrs

Comparison Savings (Replace Existing)
7.5 HP motor w/89.5 eff TEFC

MotorMaster+ 4.0
from US DOE

For :

Page : 1

By : Rafal Jankowski

07-22-2010

Facility : Crafton Hills College
Utility: Southern California Edison
(Blended Cost of Electricity- Crafton HC)

Energy Price : $0.145100/kWh
Demand charge: $0.00/kW

COMPARISON DATA

	Standard Efficiency Motor	Premium Efficiency Motor
Standard Motor:	<Avg Std Efficiency>	<Avg Premium Efficiency>
Manufacturer:		
Size:	7.5 Hp	7.5 Hp
Speed:	1800 RPM	1800 RPM
Enclosure:	TEFC	TEFC
Voltage:		
Definite Purpose:		
Hours use/yr:	3500	3500
Load:	75.0 %	75.0 %
Efficiency:	89.5 %	91.8 %
Full Load RPM:		
Centrifugal Load:	No	
Old Motor Eff. Loss:		
Dealer Discount:		
Purchase Price:		$941
Installation Cost:		$80
Motor Rebate:		
Peak Months:	12	12

SAVINGS

	Standard Efficiency Motor	Premium Efficiency Motor	
Motor Premium:	$1021		
Energy Use:	16410 kWh	16004 kWh	
Energy Cost:	$2381	$2322	
Demand Charge:			
Energy Savings:		406 kWh	$59
Demand Savings:		0.1 kW	
Total Savings:			$59
Simple Payback:			17.3 Yrs

Attachment 8-19

Comparison Savings (Replace Existing)
7.5 HP motor w/ standard eff 3,600 RPM

MotorMaster+ 4.0
***from* US DOE**

For :

Page : 1

By : Rafal Jankowski

08-02-2010

Facility : Crafton Hills College
Utility: Southern California Edison
(Blended Cost of Electricity- Crafton HC)

Energy Price : $0.145100/kWh
Demand charge: $0.00/kW

COMPARISON DATA

	Standard Efficiency Motor	**Premium Efficiency Motor**
Standard Motor:	<Avg Std Efficiency>	<Avg Premium Efficiency>
Manufacturer:		
Size:	7.5 Hp	7.5 Hp
Speed:	3600 RPM	3600 RPM
Enclosure:	ODP	ODP
Voltage:		
Definite Purpose:		
Hours use/yr:	3500	3500
Load:	75.0 %	75.0 %
Efficiency:	84.0 %	89.6 %
Full Load RPM:		
Centrifugal Load:	No	
Old Motor Eff. Loss:		
Dealer Discount:		
Purchase Price:		$644
Installation Cost:		$80
Motor Rebate:		
Peak Months:	12	12

SAVINGS

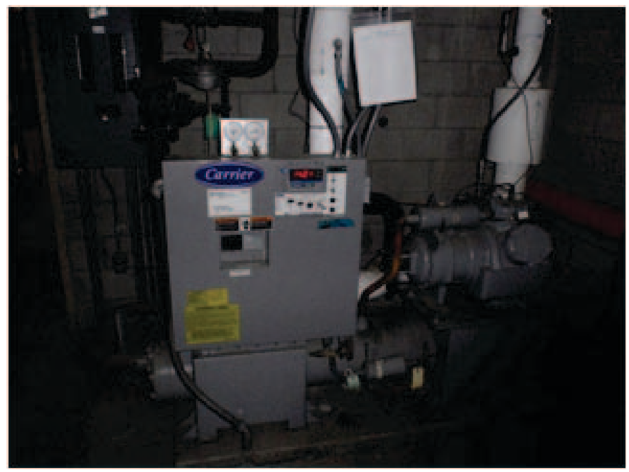
Motor Premium:	$724		
Energy Use:	17480 kWh	16399 kWh	
Energy Cost:	$2536	$2379	
Demand Charge:			
Energy Savings:		1081 kWh	$157
Demand Savings:		0.3 kW	
Total Savings:			$157
Simple Payback:			4.6 Yrs

EEM 10—Abandon Gymnasium Chillers

Background

Gymnasium has currently two chillers. Total peak load for Gymnasium is assumed as 57 tons and this analysis attempts to assign operating costs at peak energy consumption for 57 Tons, which is proposed to be turned off by connecting gymnasium to the central plant and take advantage of switching the energy consumption to lower tariffs at night with Thermal Energy storage. Economic advantage of Thermal energy storage is not included here, since it is captured in Thermal energy storage EEM (Energy Efficiency Measure).

EXISTING CHILLER AT GYMNASIUM



Inputs and Assumptions

The inputs and assumptions made for performing the calculations of this energy efficiency measure (EEM) are summarized in the Table below.

INPUTS AND ASSUMPTIONS

#	Description	Value	Units	Comments
1	Cost of Electricity	$0.14	$/kWh	From Utility Bills
2	Chiller Capacity	57	Tons	Existing Conditions
3	Chiller Efficiency	0.9	kW/Ton	Assumption for Gymnasium
4	Chiller Hours/Year	1600	Hrs/Yr	Energyexperts.org
5	Central Plant Chiller Efficiency	0.7	kW/Ton	From Mfr
6	CCC-IOU Rebate	$0.24	$/kHz	CCC-IOU

The calculations are for peak consumption for cooling hours/year.

Energy Savings Calculations

Energy savings is calculated as reduction in kWh per year by switching over to central plant from the Gymnasium chillers. It is verified that central plants have ample spare capacity.

CALCULATIONS FOR SAVINGS

#	Description	Value	Units	Comments
1	Baseline Chiller Energy Consumption	81,900	kWh/Yr	Calculated
2	Central Plant Chiller Energy Consumption	63,700	kWh/Yr	Calculated
3	Total Energy Savings	18,200	kWh/Yr	Calculated

Capital Costs

Costs of switching over to central plant will involve cost to run a new pipe from central plant to Gymnasium. It is proposed to abandon the existing chillers and not demolish them. The chillers can be available as backup units if required. Valves for this transition are included in the cost estimate. The following table establishes the cost of switching from Gymnasium chillers to central plant chillers as $ 58, 966.

Payback Analysis

The analysis for simple payback is summarized in the table below.

SIMPLE PAYBACK

#	Description	Value	Units	Comments
1	Cost Estimate	$58,966.00	$	Estimate
2	Energy Savings	18,200	kWh/Yr	
3	Energy Cost Savings	$2,627.47	$/Yr	
4	Rebate	$4,368.00	$	CCC-IOU Rebate
5	Demand Savings	11.4	kW	
6	Simple Payback	20.78	Years	

COST TO SWITCH FROM GYMNASIUM CHILLERS TO CENTRAL PLANT

Qty	CSI Number	Description	Crew	Daily Output	Labor Hours	Unit	Bare Mat.	Bare Labor	Bare Equip.	Total	Total Incl. O&P
6	22052 360 3320	Valves, plastic, PVC, ball check, socket or threaded, 4"	Q1	20	0.8	Ea.	$2,340.00	$216.00	$-	$2,556.00	$2,910.00
800	22111 374 1150	Pipe, plastic, PVC, high impact/ pressure, 4" diameter, schedule 80, includes couplings 10' OC, and hangers 3 per 10'	Q1	46	0.348	L.F.	$24,800.00	$12,800.00	$-	$37,600.00	$46,800.00
800	31231 613 0062	Excavating, trench or continuous footing, common earth, 3/4 C.Y. excavator, 1' to 4' deep, excludes sheeting or dewatering	B12F	270	0.059	B.C.Y.	$-	$1,960.00	$1,984.00	$3,944.00	$5,160.00
800	31232 313 2200	Backfill, trench, 6" to 12" lifts, dozer backfilling, compaction with vibrating roller	B10C	700	0.017	E.C.Y.	$-	$584.00	$1,832.00	$2,416.00	$2,904.00
800	07111 310 0100	Bituminous Asphalt Coating, for foundation, below grade, brushed on, 2 coat	1 Rofc	500	0.016	S.F.	$376.00	$480.00	$-	$856.00	$1,192.00
Totals							$27,516	$16,040	$3,816	$47,372	$58,966

EEM 11—Exhaust Air Heat Recovery

Background

Exhaust air is a measure of energy waste. School buildings, and in particularly laboratories have high air change requirements. Conditioned air being exhausted is a significant amount of waste. This energy conservation measure attempts to tap the heat content of conditioned air being exhausted for air handling units of several buildings.

There are three technological options to recover the heat content from the exhaust/relief air, namely heat pipes, enthalpy plate heat exchangers (Air to Air) and energy wheel. An Energy Wheel is a rotary air-to-air heat exchanger which uses adjacent counterflow outdoor air and exhaust air streams to transfer energy from the exhaust air to the outdoor air. The energy wheel also contains a fractional horsepower motor. Contamination of supply air with exhaust air is an issue of concern with energy wheels. Energy wheels are the most efficient return air heat recovery device of the three options. Enthalpy plates and heat tubes have lower heat recovery, but they do not have contamination as an issue. Lower heat recovery indicates higher wasted energy. Heat tubes can be cost prohibitive and are the most expensive option. Attachment ECM-1-1, a white paper on the heat recovery devices, is attached for more detailed information regarding heat recovery types and their associated costs. However, actual analysis performed is much more conservative than the savings presented in the white paper.

Table -1 lists the inputs and assumptions made for analyzing this energy conservation measure.

Table -2 the costs, savings and payback analysis for Energy Wheels

Every building is unique with its own complexities. It is recommended that every Air Handling Unit is analyzed on a case by case basis for address the complexities of individual buildings. Further analysis of the existing systems, including detailed information on the actual airflow values for return air, exhaust air, and outside air, will need to done in order to determine the actual savings available. The existing systems do not have all the necessary monitoring points to determine these values, as such, assumptions have been made but need to be confirmed in the field.

Energy baseline is defined as current day energy consumption. Energy baselines of buildings analyzed under this ECM are conservatively estimated at 1,500 annual hours of cooling and 1,500 annual hours of heating. The savings of heat recovery are estimated as 30% of annual cooling and heating energy at a very conservative average of 7.5˚F cooling and 10˚F heating temperature difference. Actual savings are generally 50% of exhaust air energy recovery for a well commissioned system.

ASSUMPTIONS

#	Parameter	Value	Comments
1	Blended cost of electricity ($/kWh)	$0.14	Needs to be Validated
2	kW/Ton for Central Chiller	0.7	Needs to be Validated
3	Annual Operation (16 hrs/ day* 5 days/wk * 50 wks/yr)	4000	Needs to be Validated
4	2010 Rebate = 2009 Rebate ($/kWh)	$0.24	CCC-IOU Rebate
5	1 kW = 3412.14 Btu/h	3413.12	Conversion Factor
6	Installation of Enthalpy Plate HX	$3,000.00	Reasonable Assumption
7	Cooling ΔT(˚F), Average over Summer	7.5	˚F
8	Heating ΔT(˚F), Average over Winter	10	˚F
9	Specific Heat of Air	0.24	Btu/Lbm-˚F
10	Standard Density of Air	0.075	Lbm/ft^3
11	Boiler Efficiency	80%	Reasonable Assumption
12	Retail Cost of Natural Gas Fuel ($/MMBTU)	6.5	$/MMBTU, from Tariff
13	Annaul Cooling Hrs	1600	Reasonable Assumption
14	Annual Heating Hrs	1500	Reasonable Assumption
15	TIC (Total Installed Cost)/Equipment Cost	2	Needs to be Validated
16	For Enthalpy Plates, Installation Cost/Unit	$3,000	Needs to be Validated
17	Rebate for savings on Heating, $/Therm	$1.00	CCC-IOU Rebate

Note—some of the assumptions listed are not used in this ECM

TABLE ECM-14-1 COSTS, SAVINGS AND PAYBACK ANALYSIS FOR ENERGY WHEELS

Bldg #	Bldg Name	AHU#	Supply CFM	Return CFM	Usable Relief/ Exhaust Air CFM	Capital	Unit Cooling Capacity (Btuh)	Unit Heating Capacity (Btuh)	Reduced Cooling Load (Tons-Hrs/Yr)	Reduced Heating Load (MMBTU)	kWh/Yr Cooling Savings	Annual Cost Savings - Cooling ($/Yr)	Annual Cost Savings - Heating ($/Yr)	Annual Savings, @ 50% energy recovery	Rebate ($)	Simple Payback (Yrs)	Payback, w/Rebates (Yrs)
10	Laboratory/Administration (LADM)	MZ-1	10,750	6,450	1,290	$8,875	335,000	386,000	1,393	21	975	$141	$170	$443	49.66	58.08	49.7
		MZ-2	15,015	9,009	1,802	$8,875	605,000	627,000	1,946	29	1362	$197	$237	$619	34.81	41.58	34.8
		MZ-3	7,000	4,200	840	$7,550	302,000	283,000	907	14	635	$92	$111	$288	65.68	75.87	65.7
		MZ-1	6,185	3,711	742	$7,550	86,000	329,000	802	12	561	$81	$98	$255	74.67	85.87	74.7
		MZ-2	4,580	2,748	550	$7,550	53,000	54,000	594	9	415	$60	$72	$189	101.76	115.96	101.8
6	Student Services C (CL)	M1-C	9,920	5,952	1,190	$8,875	350,000	359,000	1,286	19	900	$130	$157	$409	54.03	62.94	54.0
14	Occupational Education 1 (OE1)	MZ-1	8,000	7,000	1,400	$8,875	292,800	320,000	1,512	23	1058	$153	$184	$481	45.55	53.51	45.6
		MZ-2	6,000	5,200	1,040	$8,875	168,000	240,000	1,123	17	786	$114	$137	$357	62.22	72.04	62.2
15	Occupational Education 2 (OE2)	MZ-1	6,000	3,600	720	$7,550	240,000	600,000	778	12	544	$79	$95	$247	77.06	88.52	77.1
16	Performing Arts Center (PAC)	MZ-1	26,000	20,800	4,160	$10,400	775,000	1,200,000	4,493	67	3145	$454	$548	$1,429	16.38	21.10	16.4
		MZ-2	23,000	19,000	3,800	$10,400	685,000	1,080,000	4,104	62	2873	$415	$500	$1,305	18.18	23.10	18.2
7	Chemistry/Health Sciences (CHS)	MZ-1-2M	9,600	3,200	640	$7,550	340,000	345,000	691	10	484	$70	$84	$220	87.02	99.58	87.0
		MZ-2-2M	7,360	3,200	640	$7,550	265,000	345,000	691	10	484	$70	$84	$220	87.02	99.58	87.0
					18,814	$110,475			20,319	305	14,223	$2,054	$2,476	$6,461	42.00	49.57	42.0

Notes:

- All multi-zone units with known return fan CFMs were input as such based on scheduled data from existing drawings. Units without known return CFMs were input as 60% of unit supply airflow. The remainder of the airflow balance can be found via general building exhaust fans serving exhaust fans, toilet exhaust fans, etc.
- Only units with a return air duct system with integral exhaust/relief ducts have been analyzed.
- Usable relief/exhaust airflow was assumed as 20% of total return airflow back to the unit for all units. It was assumed that the remaining return airflow was returned to the unit and mixed with outside air. The quantity of airflow returned to the unit and mixed with outside air is not usable towards heat recovery via the enthalpy wheel or similar device. These values need to be confirmed in the field for further detailed analysis and plausibility of utilizing exhaust air heat recovery.
- Costs assume only equipment and installation of the enthalpy wheel. Rerouting of ducts has not been included at this time.

Observations and Comments

The cost of the energy conservation retrofit is high due to the fact that the installation costs are much higher in the field as opposed to having them manufactured as part of the unit prior to installation. The temperature difference (Average for season) of 7.5˚F for cooling and 10˚F for heating are conservative numbers. This ECM assumes that the heating and cooling operations will only be on during business hours of 6:00 AM to 10:00 PM for the subject buildings. Installed cost on replaced AHU is much lower since it is done at factory instead of in field.

All these factors combined contribute to lower payback and hence longer payback times.

Crafton Hills College should explore return air energy recovery devices on all the buildings for future upgrades and new buildings with high ventilation loads. Return air should be disposed centrally, if possible, allowing heat recovery.

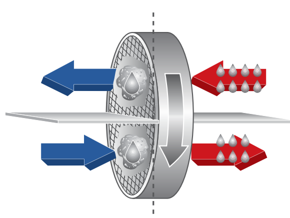
Return Air heat recovery is worth investigating with M&V for buildings with high ventilation loads and a centralized exhaust/relief system. Most of the existing buildings consist of both a return/relief air system and an exhaust system. A majority of the exhaust air for the building is being exhausted through decentralized general exhaust fans. This means that a majority of the return air being brought back to the central Air Handling Unit is being returned and not relieved/exhausted unless the unit is in economizer mode. This setup makes it difficult to utilize the exhaust air for the benefits of heat recovery.

Attachments

WHITE PAPER ON RETURN AIR HEAT RECOVERY DEVICES

ATTACHMENT 1-1

Energy recovery components quick comparaison chart:			
	Enthalpy Heat Wheel	**Plate Exchanger**	**Heat Pipe Exchanger**
Performance	Best	Very good	Good
Base price	Middle range	Lowest	Highest
Performance / Price	Best	Very good	Good
Exchanger size	Most compact	Biggest	Very compact Very flexible shape
Cross contamination levels	Highest contamination	No contamination up to 3” w.g.	No contamination
Application’s temperature	Up to approx. 104˚F	Up to 392˚F on certain models	Up to 450˚F
Corrosion resistance	Low	Great with certain models	Best
Cleaning requirements	Vaccum or compressed air	Cleaning with high pressure devices possible	Cleaning with high pressure devices possible, high water pressure possible
Maintenance	Some maintenance required	No maintenance	No maintenance
Moving parts	Yes	No	No
Typical airflow configuration	Counterflow top/bottom or side by side	Crossflow	Counterflow side by side only
CFM limitation	Approx. 35000 cfm	No limit	No limit



Wheel exchanger

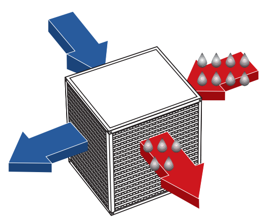
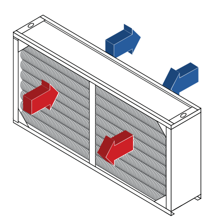


Plate exchanger



Heat pipe exchanger

ATTACHMENT 1-1

Heat Wheels, Fixed Plate Exchangers and Thermogain Heat Pipes

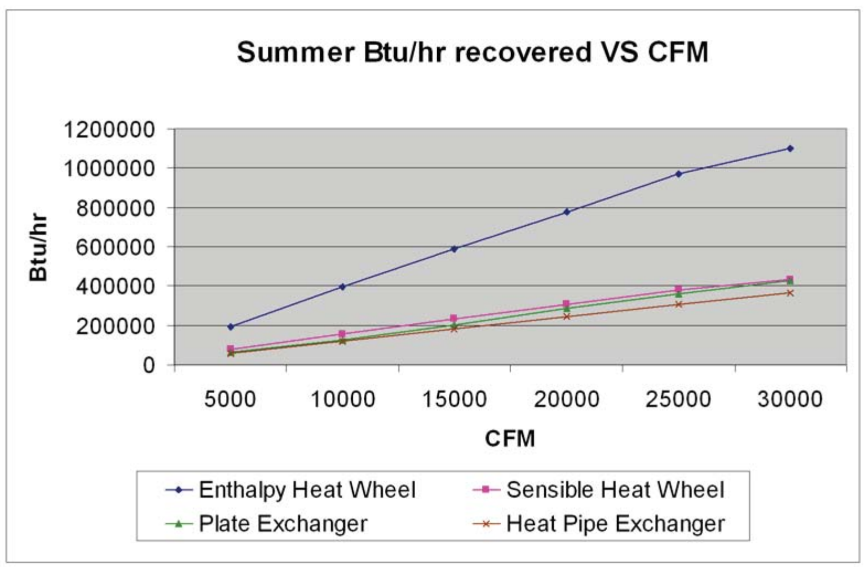
The goal of this document is to give you some general guidelines to help you select the best energy recovery component type for your application. While many manufacturers, who deal with a single air-to-air energy recovery component, will tell you that their product is superior in all aspects when compared to other component types, we know for a fact that the truth is unfortunately not that simple.

In reality, the best component for your application will depend on your specific conditions which mean entering temperatures, supply and exhaust CFM's, acceptable cross-contamination levels and air cleanliness. On top of that, standard design considerations must be analyzed like your maximum height, width and depth available for the energy recovery component as well as if you have high corrosion resistance requirements. Lastly, how much time you are willing to, or simply can spend on the maintenance of the energy recovery component will affect your final choice.

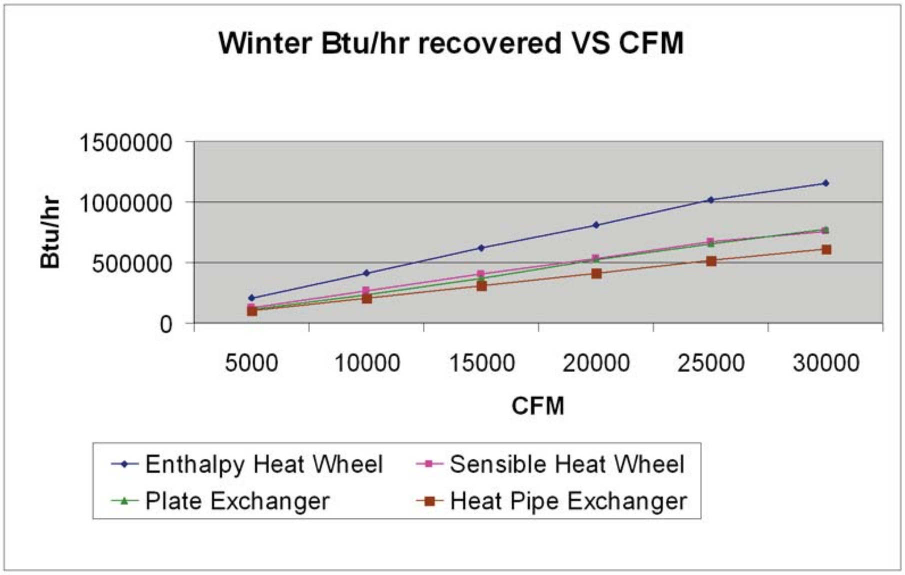
1. Performance comparison:

One of the most important factors when looking for an air-to-air energy recovery component is how the system will actually perform or its effectiveness. Again, we can never emphasis enough the importance of looking for AHRI (formally known as ARI) certified products. The AHRI 1060-2005 certification is your best insurance in making sure the component will perform as per the manufacturer's claims.

For the purpose of this document, a Btu/hr VS CFM chart is analyzed since it enables a better comparison between total and sensible energy recovery. Note that a component with a higher effectiveness will recover a higher amount of Btu/hr for a given CFM so a chart based on effectiveness would allow us to make similar conclusions.



ATTACHMENT 1-1



Based on these two charts which compare the enthalpy heat wheel, sensible heat wheel, plate and Thermogain heat pipe exchangers, some general conclusions can be made.

First, for nearly all CFM values (except for 30,000 CFM where the plate exceeds the sensible wheel) we can say that the enthalpy wheel is by far the component that will recover the most Btu/hr, followed by the sensible wheel, plate exchanger and lastly the Thermogain heat pipe. Also, we can see that the BTU/hr difference between the enthalpy wheel and sensible only exchangers' increases with CFM which means that under standard conditions, one could think that it becomes more and more worth it to use an enthalpy wheel as CFM increases. In fact, the opposite is closer to the truth since that ratio analysis tells us that a plate or heat pipe exchanger will recover a higher percentage of the wheel's total energy recovery for a given higher CFM.

Another important point to note concerning the heat wheel is the difference between the enthalpy and sensible curves. The latent energy recovery will greatly vary based on the difference of the supply and exhaust humidity ratio (grains of moisture per pound of dry air). For example looking at the two above charts, the summer latent energy recovery is based on a humidity ratio difference of 50.7gr/lb while the winter curve relies on a 28.2 gr/lb difference only. It is therefore easy to understand why the winter enthalpy curve is so much closer to the sensible ones. Concretely, this means that this delta in humidity ratio is a very good indication of whether or not you will greatly benefit for the enthalpy recovery boost.

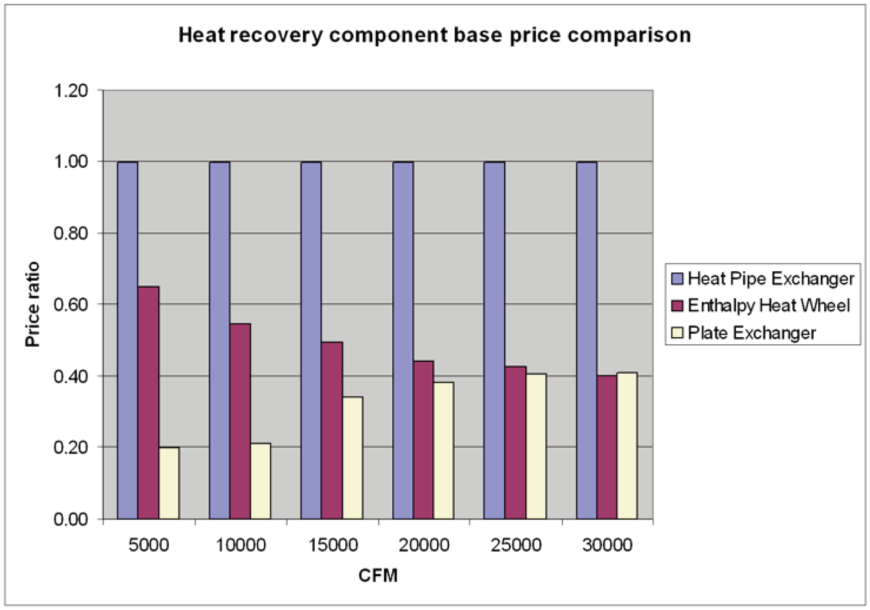
2. Price comparison:

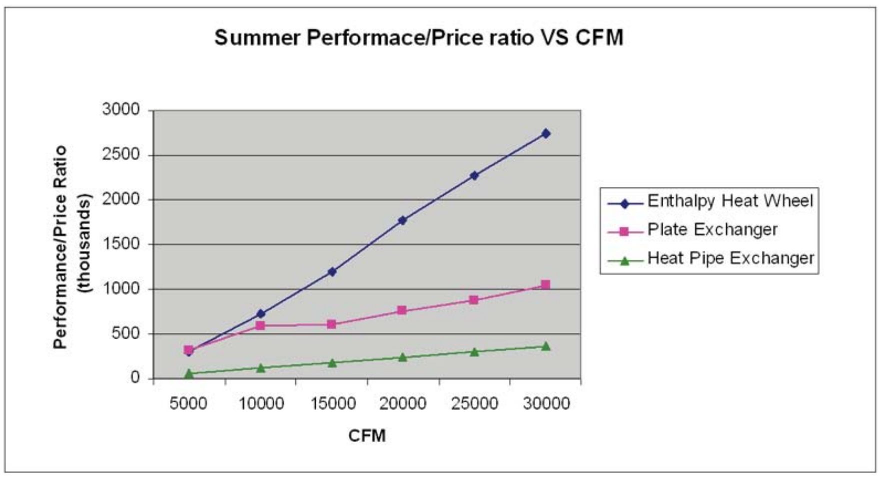
Price is of course another very important factor to consider when selecting your energy recovery component. In that respect, the following chart, which compares the price of each energy recovery component type VS the most expensive one (with a given value of 1 or 100%) for different CFM values is a very interesting tool.

As we can see here, heat pipe exchangers are the most expensive energy recovery component followed by the enthalpy wheel and plate exchangers. Another good observation we can make is that plate exchangers, really much less expensive at lower CFM's, become gradually more expensive and even exceed the enthalpy wheel's price at 30,000 CFM.

Based on the pricing comparison chart, we can also say that a little more money on the duct installation might still be worth it in the long run if it enables you to change your planned heat pipe for a plate exchanger.

ATTACHMENT 1-1





Regarding the Performance/Price ratio VS CFM chart, except for low CFM applications, the enthalpy wheel is shown to be the product that will give you the most Btu/hr recovered per dollar spent.

As a side note, based on the above performance and price information, many will be tempted to simply not consider the heat pipe for their selection which is often a mistake. In fact, Thermogain heat pipes also have great qualities like no moving parts, a tough construction which increases their reliability and ease of cleaning, the highest temperature range and most importantly, the greatest size flexibility. In addition, for CFM applications above 30,000 CFM, they are often the only component that will do the job. Also, other factors which are not shown on these charts must be considered like the added maintenance price required for the heat wheels or added price that comes with the plate exchanger's large dimensions.

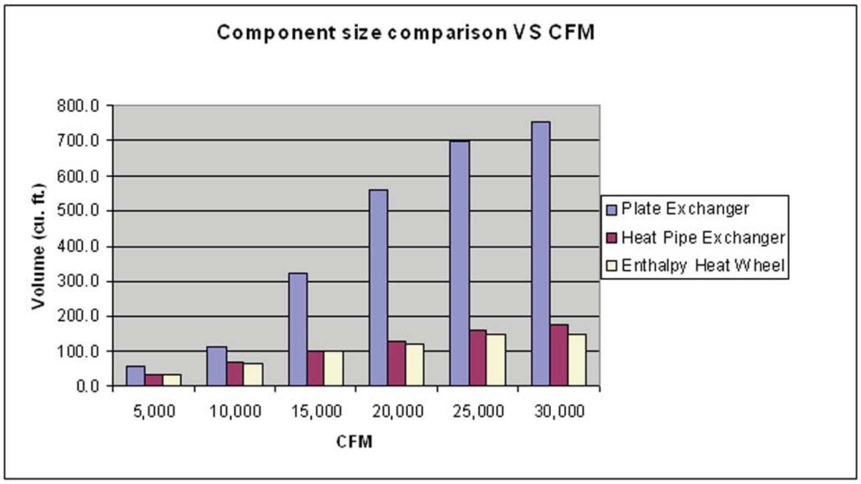
In conclusion, the first question you should ask yourself is really if you are buying the product you need for your application. More often than not, correctly answering this question will greatly help in lowering your cost or help define the reasons why more money must be spent for your application.

4

ATTACHMENT 1-1

3. Size considerations:

Perhaps one of the most overlooked factor when selecting a heat recovery component is the space that will be required in the ventilation unit. The following charts compared the three energy recovery components actual volume used in a ventilation unit. Note that it does not consider the required plenum space.



Note: Since plate exchangers are installed at 45 degrees, their volumes were calculated based on a product of their diagonals times the total width.

As you can see on the above chart, the fixed plate exchanger is by far the component that will require the biggest space in a ventilation unit. Furthermore, it should be noted that even if heat pipes and heat wheels are very close in terms of actual volume, heat pipes can easily be adjusted in height and width to fit exactly with the ventilation unit's dimensions which is a great advantage. In addition, for wrap-around dehumidification applications, heat pipes can be sized exactly as per the cooling coil's dimensions; resulting in the most compact assemblies.

4. Other considerations:

While the above factors are often the first to be considered, many other factors will influence your choice. The following paragraphs cover the most common ones.

a. Acceptable cross-contamination levels:

The acceptable contamination level is indeed a very important factor since some installations will have some kind of pollutants or even dangerous chemicals or biohazard components in the exhaust airstream that must not be transferred to the supply side. To eliminate any odor problems, other installations with high percentages of restroom or kitchen CFM's might also have very low acceptable contamination levels.

Enthalpy Heat Wheels: With heat wheels there will always be a certain degree of contamination. AHRI (ARI) certificates are showing values for our ERW3000 series between 2.8% to 6.3% EATR depending on pressure differentials (each wheel is tested at 0"w.g., 0.5"w.g. and 1"w.g.). Of course, higher pressure differentials from the supply to the exhaust side as well as the use of a purge section can reduce this value but a heat wheel should never be used with systems which have dangerous contaminants present in the exhaust air stream, no matter the heat wheel manufacturer or desiccant type.

ATTACHMENT 1-1

Plate Exchangers: Sensible plate exchangers are usually a far better option when it comes to limiting cross-contamination. For example, our Hoval series which were used in the above performance and price analysis are rated under AHRI as having 0% EATR up to 3"w.g.. While such outstanding results surely make the plate exchanger a solution for problematic odor applications, Innergy tech still recommend the use of a heat pipe exchanger when dangerous contaminants are present in the exhaust airflow.

Heat Pipe Exchangers: With their airtight middle partition, heat pipe exchangers are by far the safest product to use when dealing with dangerous exhaust air streams. Our standard Thermogain models are rated under AHRI as having 0% EATR up to 5"w.g.. Depending on the security level desired, improved partitions are available and some contamination tests can even be made upon request.

b. Application's temperatures:

For most standard ventilation units, all products can be used without any problem but some industrial applications require the use of special high temperature plate exchangers (up to 392˚F) or Thermogain heat pipes (450˚F). Concerning enthalpy wheels, they should not be used below minus 40˚F or above 104˚F. Please consult Innergy tech for some help with your high temperature selections.

c. Corrosion resistance requirements:

Innergy tech's heat recovery components, being almost entirely made of aluminum, generally offer an excellent corrosion resistance. However, when large amounts of condensate occur, in wet rooms, swimming pools, etc., and for mild corrosion atmospheres, special high corrosion resistance plate exchangers or coated heat pipes must be used. More aggressive environments might also call for our Thermogain heat pipe with stainless steel casing and full Heresite coating.

d. Cleaning requirements:

For most standard applications, the ease of cleaning is not that important since the mostly laminar flow going through the exchangers greatly reduces the dust accumulation. If any, the particles will usually accumulate on the exchanger's surfaces where they can be easily removed. Still, some special applications with contaminants susceptible to stick to the exchangers and block air paths will eliminate the possibility of using a heat wheel which can only be cleaned with the help of a vacuum cleaner or compressed air. For these applications, one should prefer the use of a plate or heat pipe exchanger which can be thoroughly cleaned with a water pressure washer on both sides. Regardless of the exchanger used, good filters and their maintenance are always very important in order to keep the exchanger clean and thus, operating at full capacity.

e. Maintenance and reliability requirements:

As we could see above, enthalpy heat wheels are by far the energy recovery components that will give you the best effectiveness. However, their moving parts also call for some added maintenance and a lower reliability that might not be acceptable for some applications. Fixed plate and heat pipe exchangers on the other hand have no moving parts and only require good filter maintenance.

5. Conclusion:

Going through this document reinforces the fact that there is no such thing as one energy recovery component better for all applications. Each application needs to be analyzed based on it particular requirements in order to find the component that will better fill your needs. While this document most likely does not offer a definite answer to your application, we hope that the basic information it provide will help you make a smarter decision and perhaps save you some time throughout your future selections.

We hope the information you found in this document was helpful and invite you to contact our sales department with any technical questions or if you would like to discuss your application with us.

Notes on this document's charts:

This document's charts were made considering a given CFM, AHRI standard temperatures and relative humidity as well as a fixed pressure drop value for the industry's three major heat recovery components. They represent some sample selections and should be considered as general guidelines only.

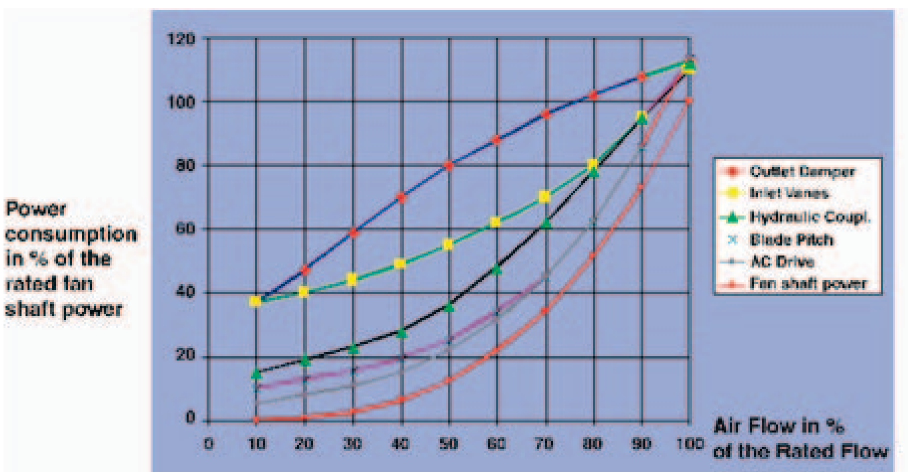
EEM 12—Install Variable Speed Drives on Supply Fans of AHUs

Background

Student Services A building has two heating/cooling single zone constant flow (5,135 CFM and 7,420 CFM) units. Both of the units have 5HP supply fans. This ECM attempts to install VFD and premium efficiency motors on the air handing units supply motors to evaluate the payback performance. E-Quest was used to model the performance of the baseline and savings.

Variable speed drives (VFDs) provide adjustable speed operation of motors that drive fans. Variable speed drive systems take an alternating current with a fixed voltage and frequency, and change it into an alternating current with adjustable frequency. Motor speed can then be adjusted and coordinated to match exact space air flow requirement. An adjustable AC frequency supply lets a motor operate at different speeds with about the same performance as its base speed. This system offers many benefits, including gains in system efficiency, precision, and reliability for greater productivity and/or improved product quality. They allow more efficient and effective use of electric power and, as a result, lower energy costs, extended equipment life, and reduce maintenance costs.

AC DRIVES AND POWER CONSUMPTION AT PART-LOADS



Assumptions

Inputs used for energy conservation calculations and other assumptions made are tabulated below.

ASSUMPTIONS AND INPUTS FOR ECM-5

#	Parameter	Value	Units	Comments
1	Cost of Electricity	$0.15	$/kWh	From Utility Bills
2	Gas Rebate	$1.00	$/Therm	CCC-IOU Rebate
3	Electricity Rebate	$0.24	$/kWh	CCC-IOU Rebate

Savings and Rebate

Calculations for savings and rebates are tabulated below based on the E-Quest results.

TABLE 2 SAVINGS AND REBATE FOR ECM-5

#	Parameter	Value	Units	Comments
1	AHU-1 CFM	5,138	CFM	From M-8 of Bldg Drawings
2	AHU-1 Fan BHP	5.00	BHP	From M-8 of Bldg Drawings
3	AHU-2 CFM	7,420	CFM	From M-8 of Bldg Drawings
4	AHU-2 Fan HP	5.00	HP	From M-8 of Bldg Drawings
5	Baseline Ventilation Fans Energy Consumption	33,117	kWh/yr	From E-Quest Preliminary Model
6	Proposed Ventilation Fans Energy Consumption	28,891	kWh/yr	From E-Quest Preliminary Model
7	Energy Savings	4226.0	kWh/yr	=Baseline-Proposed
8	Rebate	$1,014.24	$	@ 0.24$/kWh CCC-IOU Rebate
9	Cost Savings	$610.23	$/Yr	@ Calculated cost of Electricity

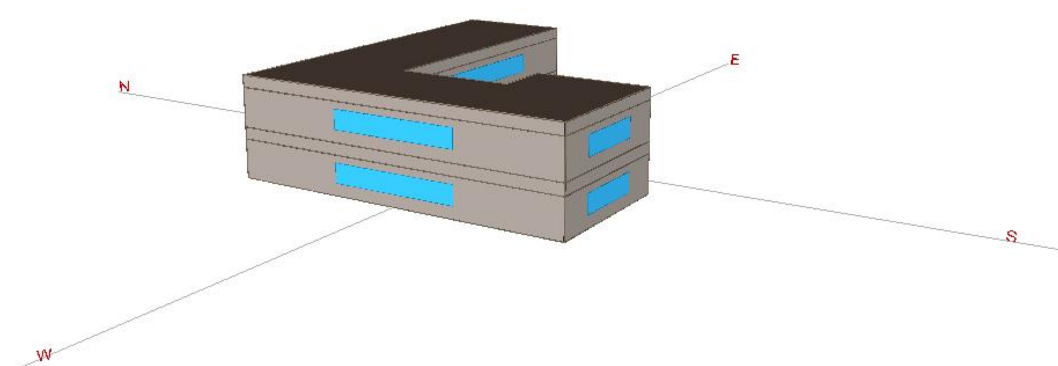
Capital Costs & Payback

Capital costs include installation of a premium efficiency motors and a variable speed drives on the supply fans of the AHUs. The table below summarizes capital costs required for this EEM.

CAPITAL COSTS AND PAYBACK

#	Parameter	Value	Units	Comments
#	Parameter	Value	Units	Comments
1	Cost of 5 BHP VFD	$2,025.00	$	RS Means
2	Cost of 5 BHP VFD	$2,025.00	$	RS Means
3	Total Installed Cost	$4,050.00	$	Item 1+ Item-2
4	Rebate	$1,014.24	$	CC-IOU Rebate
5	Net Installed Cost	$3,035.76	$	=Total Installed Costs-Rebates
6	Savings	$610.23	$/Yr	
7	Simple Payback	5.0	Yrs	

TABLES AND FIGURES 1 E-QUEST OUTPUT FOR SSA BLDG AHU SUPPLY FANS VFDS



TABLES AND FIGURES 1 E-QUEST OUTPUT FOR SSA BLDG AHU SUPPLY FANS VFDS

Project: Student Services A | Run Date/Time: 07/15/10 @ 14:59

Annual Energy and Demand (pg 1 of 2)

		Ann. Source Energy		Annual Site Energy		Lighting	HVAC Energy			Peak	
		Total Mbtu	EUI kBtu/sf/yr	Elect kWh	Nat Gas Therms	Electric kWh	Electric kWh	Nat Gas Therms	Total Mbtu	Elect kW	Cooling Tons
Annual Energy USE or DEMAND											
0	Base Design	909	91.38	83,940	493	36,064	27,751	281	123	35	20
1	0+Fan Power & Ctrl EEM	889	89.41	81,878	508	36,064	25,689	297	117	34	19
Incremental SAVINGS (values are relative to previous measure (% savings are relative to base case use), negative entries indicate increased use)											
1	0+Fan Power & Ctrl EEM	20	1.97 (2%)	2,062 (2%)	-15 (-3%)	0 (0%)	2,062 (7%)	-15 (-5%)	5 (4%)	1 (2%)	0 (1%)
Cumulative SAVINGS (values (and % savings) are relative to the Base Case, negative entries indicate increased use)											
1	0+Fan Power & Ctrl EEM	20	1.97 (2%)	2,062 (2%)	-15 (-3%)	0 (0%)	2,062 (7%)	-15 (-5%)	5 (4%)	1 (2%)	0 (1%)

eQUEST 3.63.6500 | Annual Building Summary (2 pgs) | Page 1

EEM 13—High SEER Condensing Units

Background

Crafton Hills College has one condensing units with SEER ratings of 11 (10 EER) on the buildings being analyzed for energy conservation. For smaller capacities the newer technology allows 21 SEER condensing units that generate room for energy conservation by energy efficient retrofit. Using of Energy Star rated condensing units when choosing a retrofit will provide rebates and reliable energy efficiency. This ECM targets split system condensing units and window AC units only.

Implementation of this ECM will allow CHC to eliminate CFC based refrigerants from the subject buildings.

INSTALLATION OF CONDENSING UNITS AT CHC

Assumptions

ASSUMPTIONS FOR RETROFIT

#	Parameter	Value	Comments
1	Blended cost of electricity ($/kWh)	$0.14	From SCE Bills
3	Non Data Center Cooling Hrs/Yr	1,600	Standard Seasonal Hrs
4	Rebate rate, if available for 2010 ($/kWh)	$0.24	CCC-IOU Rebate

Condensing units have on/off controls and operate on full capacity only.

Savings

Energy savings are generated based on operational efficiency gain. Unit analyzed under this ECM is serving office room and hence use of 1000 operational hours per year is conservative. Thermostats in these spaces are set to 72 ˚F temperature settings.

ENERGY EFFICIENCY IMPROVEMENT CALCULATIONS

ID#	Bldg	BTU/h	Existing		Proposed		kWH/Yr Savings	Savings. $/yr
			EER	Operating Cost $/Yr	EER	Operating Cost $/Yr		
CU-1	CC	24,000	10	$538	15	$358	1,280	$179
	Totals			$538		$358	1,280	$179

Cost Estimate

CAPITAL COST ESTIMATE

ID#	Bldg	BTUh	Total Installed Cost, $	Notes
CU-1	AUD	24000	$1,875	1,000 Hrs/ Yr Operation
Total Cost			$1,875	

Actual costs vary from manufacturer to manufacturer.

Payback Analysis

COST, REBATE AND PAYBACK ANALYSIS

ID#	Bldg	BTUh	Total Cost, $	kWH/Yr Savings	Savings. $/yr	Rebate, $	Simple Payback (Yrs), without Rebate	Simple Payback (Yrs), with Rebate
CU-1	AUD	24,000	$1,875	1,280	$179	$307	10.5	8.7
			$1,875	1,280	$179	$307	10.5	8.7

EEM 14—Zero Flush / Low Flush Urinals

Crafton Hills College has opportunity to retrofit 21 urinals in Buildings LADM, SSA, SSB, OE1, OE2, Bookstore, Performing Arts Center, M&O, and Gymnasium. This analysis is for 21 urinals on the Crafton Hills College Campus. This ECM analyzes and reports costs, savings and paybacks for both No flush and Low flush technologies available in market for water conservation.

INSTALLATIONS OF FLUSHED MALE URINALS

This ECM reduces electrical energy associated with water pumping and sewage treatment, included in savings. This is eco-friendly in nature reducing the carbon footprint of CHC.

Assumptions

Inputs and assumptions for this ECM are tabulated below.

ASSUMPTIONS

#	Parameter	Value	Comments
1	Cost of Water & Sewer ($/1000 Gallons)	$3.40	From Utility Bills
2	Male Urinals	21	From Plumbing Plans
3	Urinal's Flush Rate	1.0	Gallons/flush
4	Male Population of Buildings	900	50% of 1800 Occupants
5	Flushes/day/Occupant	3	From ASPE Handbook
6	Academic days/Yr	250	To be verified
7	Rebate	$-	No 2010 Rebates Available
9	Cost of Cartridges	$30.00	Manufacturer's Quote
10	Flushes/Cartridge	15000	Source: Zeroflush.com
11	New Flush Rate (Low Flush Option)	0.125	1/8th Gallon Flush

Calculations

Water savings and cost savings are calculated in the table below.

SAVINGS CALCULATIONS

#	Parameter	Value	Comments
1	Flushes/Day	2,700	=Assumption 4 * Assumption 5
2	Days/Yr	250	Assumption-6
3	Flushes/Yr	675,000	=flushes/day * Days/yr
4	Annual Water Usage (MG)	675.00	=Flushes -/Yr * Assumption-3 / 1000
5	Cost of Water & Sewer	$3.40	Assumption-1
6	Cost of Flushing Male Urinals ($/Yr)	$2,295	Operating Costs (Baseline Water Costs)
7	Number of Replacement Cartridges/Yr	45	=Flushes/Yr/Assumption-9
8	Cost of Cartridges ($/Yr)	$1,350	=Annual Water Consumption * Assumption-10
9	Net Savings	$945.00	Baseline - Cost of Cartridges
10	Low Flush Urinals Annual Water Usage	84.375	=flushes/yr * Assumption-11 (MG)
11	Water Savings for Low Flush Urinals	590.63	MG/Yr
12	Cost Savings for Low Flush Urinals	$2,008	

Capital Cost Estimate

Capital cost for installing new water free and Low flush Urinals are listed below.

INSTALLATION COSTS FOR NO FLUSH URINALS

#	Parameter	Unit Cost	Qty	Item Cost	Notes/Comments
1	Installation cost per Waterfree urinal	235	21	$4,935.00	
2	Waterfree Urinal cost	290	21	$6,090.00	WES-1000 (Sloan/Falcon)
3	Total Installed Cost/Ea	$525.00		$11,025.00	

INSTALLATION COSTS FOR LOW FLUSH URINALS

#	Parameter	Unit Cost	Qty	Item Cost	Notes/Comments
1	Installation cost per Pint flush urinal	750	21	$15,750	www.plumbingsupply.com
2	Low Flash Urinal cost	250	21	$5,250	CSI # 224213303140
3	Total Installed Cost/Ea	$1,000.00		$21,000	

Payback Analysis

Calculations for payback are summarized in the table below.

PAYBACK ANALYSIS FOR LOW FLUSH AND NO FLUSH URINALS

#	Parameter	Value	Notes/Comments
1	Capital Cost (No Flush Option)	$11,025	
2	Rebates	$0.00	
3	No Flush Option, Savings $/ Yr	$945.00	$/ Yr
4	Simple Payback(Yrs)	11.67	=(Capital costs-Rebates)/Savings
5	Low flush Urinals Capital Costs	$21,000.00	
6	Low flush Option, Savings $/Yr	$2,008.13	$/ Yr
7	Simple Payback(Yrs)	10.46	=(Capital costs-Rebates)/Savings

Metropolitan water district may fund the 'free urinals' program along with other water companies in the future. Falcon representative will advise about the rebate status as the program status evolves. It is confirmed that no rebates are offered for 2010 for geographical area of Yucaipa, CA.

Pursuant to previous discussions and lower payback, it is recommended to retrofit urinals with low flush Urinal option.

Appendix C—PV System Supporting Data

LEGEND

	EXISTING BLDG.
	FUTURE BLDG.
	PV PANEL - PHASE 1
	PV PANEL - PHASE 2
	PV PANEL - PHASE 3
	PV PANEL - PHASE 4

EXISTING AND FUTURE CHC BUILDINGS

EXISTING BLDG	BUILDING NAME	GSF	BUILDING/YEAR
1	LABORATORY CENTER (former Laboratory/Administration Building)	30,621	1970
3	COLLEGE CENTER	8,560	1970
4	STUDENT SERVICES A	9,970	1970
5	STUDENT SERVICES C (former Classroom Building)	6,800	1970
6	OCCUPATIONAL EDUCATION 1	9,842	1975
8	PERFORMING ARTS CENTER	29,851	1975
10	GYMNASIUM	27,250	1970
12	CHEMISTRY	17,238	1978
13	CHILD DEVELOPMENT CENTER 1	4,900	2002
14	CHILD DEVELOPMENT CENTER 2	3,150	2002
16	STUDENT SERVICES B	5,575	1998
20	LEARNING RESOURCE CENTER	59,100	2010
25	COMMUNITY RECREATIONAL FACILITY	5,000	2009

FUTURE BLDG	BUILDING NAME	GSF	BUILDING/YEAR
2	STUDENT CENTER (Library replacement building)	36,900	2015
7	EMERGENCY SERVICES (OE 2 replacement building)	15,730	2015
9	MAINTENANCE & OPERATIONS	6,400	2015
11	WELLNESS CENTER	20,000	2015
15	CHILD DEVELOPMENT CENTER EXPANSION	960	2015
19	ADMINISTRATION/STUDENT SERVICES	27,713	2015
21	HUMANITIES #1	24,369	2015
22	HUMANITIES #2	44,531	2015
23	PERFORMING ARTS CENTER EXPANSION	20,000	2025
24	SCIENCES	44,000	2025
26	COMMUNITY CENTER	15,000	2025

Proposed PV Site Plan

KWH OUTPUT FOR 200 KW PV SYSTEM

PVWatts * * *

AC Energy & Cost Savings

Cautions for Interpreting the Results

(Type comments here to appear on printout; maximum 1 row of 80 characters.)

Station Identification	
City:	Daggett
State:	California
Latitude:	34.87° N
Longitude:	116.78° W
Elevation:	588 m
PV System Specifications	
DC Rating:	200.0 kW
DC to AC Derate Factor:	0.850
AC Rating:	170.0 kW
Array Type:	Fixed Tilt
Array Tilt:	15.0°
Array Azimuth:	180.0°
Energy Specifications	
Cost of Electricity:	16.0 ¢/kWh

Results			
Month	Solar Radiation ($kWh/m^2/day$)	AC Energy (kWh)	Energy Value ($)
1	4.46	22241	3558.56
2	5.18	22903	3664.48
3	6.60	32415	5186.40
4	7.82	36457	5833.12
5	8.02	37422	5987.52
6	8.31	36818	5890.88
7	8.05	36159	5785.44
8	7.65	34431	5508.96
9	7.01	31091	4974.56
10	5.90	27958	4473.28
11	4.69	22439	3590.24
12	4.08	20658	3305.28
Year	6.49	360991	57758.56

Output Hourly Performance Data * Output Results as Text

About the Hourly Performance Data

Saving Text from a Browser

Run PVWATTS v.1 for another US location or an International location
Run PVWATTS v.2 (US only)

Please send questions and comments regarding PVWATTS to Webmaster

RReDC Return to RReDC home page (http://rredc.nrel.gov)

PVWatts * * *

AC Energy & Cost Savings

Cautions for Interpreting the Results

(Type comments here to appear on printout; maximum 1 row of 80 characters.)

Station Identification	
City:	Daggett
State:	California
Latitude:	34.87° N
Longitude:	116.78° W
Elevation:	588 m
PV System Specifications	
DC Rating:	400.0 kW
DC to AC Derate Factor:	0.850
AC Rating:	340.0 kW
Array Type:	Fixed Tilt
Array Tilt:	15.0°
Array Azimuth:	180.0°
Energy Specifications	
Cost of Electricity:	16.0 ¢/kWh

Results			
Month	Solar Radiation ($kWh/m^2/day$)	AC Energy (kWh)	Energy Value ($)
1	4.46	44482	7117.12
2	5.18	45806	7328.96
3	6.60	64830	10372.80
4	7.82	72915	11666.40
5	8.02	74844	11975.04
6	8.31	73635	11781.60
7	8.05	72318	11570.88
8	7.65	68862	11017.92
9	7.01	62181	9948.96
10	5.90	55916	8946.56
11	4.69	44878	7180.48
12	4.08	41315	6610.40
Year	6.49	721982	115517.12

Output Hourly Performance Data * Output Results as Text

About the Hourly Performance Data

Saving Text from a Browser

Run PVWATTS v.1 for another US location or an International location
Run PVWATTS v.2 (US only)

Please send questions and comments regarding PVWATTS to Webmaster

RReDC Return to RReDC home page (http://rredc.nrel.gov)

Size (DC W installed)	Total Installed Cost	Cost $/w	Production kW·hr/yr	CPUC Incentive PBI ($/kW·hr)	CPUC Incentive Annual income	Power Cost SCE rate	Power Cost Rate Inflation
200,000	$1,000,000	$5.00	360,991	$0.19	$68,588	$0.140	2.5%

Cost/Payback Analysis						Lbs of Green House Gas Mitigated				
Year	PBI	Production	Equipment	Total annual cost	Cash Flow	Energy (MW-hr)	CO2	SO2	NO2	Total (Tons)
yr 1	$68,588	$50,538.74	($1,000,000)	($880,873)	($880,873)	361	261,357	217	289	119
yr 2	$68,588	$51,802.21	$0	$120,390	($760,482)	722	522,715	433	578	238
yr 3	$68,588	$53,097.26	$0	$121,686	($638,797)	1,083	784,072	650	866	357
yr 4	$68,588	$54,424.70	$0	$123,013	($515,784)	1,444	1,045,430	866	1,155	476
yr 5	$68,588	$55,785.31	$0	$124,374	($391,410)	1,805	1,306,787	1,083	1,444	595
yr 6		$57,179.95	$0	$57,180	($334,230)	2,166	1,568,145	1,300	1,733	714
yr 7		$58,609.44	$0	$58,609	($275,621)	2,527	1,829,502	1,516	2,022	833
yr 8		$60,074.68	($80,000)	($19,925)	($295,546)	2,888	2,090,860	1,733	2,310	952
yr 9		$61,576.55	$0	$61,577	($233,970)	3,249	2,352,217	1,949	2,599	1,071
yr 10		$63,115.96	$0	$63,116	($170,854)	3,610	2,613,575	2,166	2,888	1,190
yr 11		$64,693.86	$0	$64,694	($106,160)	3,971	2,874,932	2,383	3,177	1,309
yr 12		$66,311.21	$0	$66,311	($39,849)	4,332	3,136,290	2,599	3,466	1,428
yr 13		$67,968.99	$0	$67,969	$28,120	4,693	3,397,647	2,816	3,754	1,547
yr 14		$69,668.21	$0	$69,668	$97,789	5,054	3,659,005	3,032	4,043	1,666
yr 15		$71,409.92	$0	$71,410	$169,198	5,415	3,920,362	3,249	4,332	1,785
yr 16		$73,195.16	($80,000)	($6,805)	$162,394	5,776	4,181,720	3,466	4,621	1,904
yr 17		$75,025.04	$0	$75,025	$237,419	6,137	4,443,077	3,682	4,909	2,023
yr 18		$76,900.67	$0	$76,901	$314,319	6,498	4,704,435	3,899	5,198	2,143
yr 19		$78,823.19	$0	$78,823	$393,142	6,859	4,965,792	4,115	5,487	2,262
yr 20		$80,793.77	$0	$80,794	$473,936	7,220	5,227,150	4,332	5,776	2,381
yr 21		$82,813.61	$0	$82,814	$556,750	7,581	5,488,507	4,548	6,065	2,500
yr 22		$84,883.95	$0	$84,884	$641,634	7,942	5,749,865	4,765	6,353	2,619
yr 23		$87,006.05	$0	$87,006	$728,640	8,303	6,011,222	4,982	6,642	2,738
yr 24		$89,181.20	$0	$89,181	$817,821	8,664	6,272,580	5,198	6,931	2,857
yr 25		$91,410.73	$0	$91,411	$909,232	9,025	6,533,937	5,415	7,220	2,976

	Total Installed	Cost	Production	CPUC Incentive		Power Cost	
Size (DC W $_{installed}$)	Cost	$/w	kW·hr/yr	PBI ($/kW·hr)	Annual income	SCE rate	Rate Inflation
800,000	$6,400,000	$8.00	1,443,964	$0.19	$274,353	$0.140	2.5%

Cost/Payback Analysis						Lbs of Green House Gas Mitigated				
Year	PBI	Production	Equipment	Total annual cost	Cash Flow	Energy (MW-hr)	CO2	SO2	NO2	Total (Tons)
yr 1	$274,353	$202,154.96	($6,400,000)	($5,923,492)	($5,923,492)	1,444	1,045,430	866	1,155	476
yr 2	$274,353	$207,208.83	$0	$481,562	($5,441,930)	2,888	2,090,860	1,733	2,310	952
yr 3	$274,353	$212,389.05	$0	$486,742	($4,955,188)	4,332	3,136,290	2,599	3,466	1,428
yr 4	$274,353	$217,698.78	$0	$492,052	($4,463,136)	5,776	4,181,720	3,466	4,621	1,904
yr 5	$274,353	$223,141.25	$0	$497,494	($3,965,641)	7,220	5,227,150	4,332	5,776	2,381
yr 6		$228,719.78	$0	$228,720	($3,736,922)	8,664	6,272,580	5,198	6,931	2,857
yr 7		$234,437.78	$0	$234,438	($3,502,484)	10,108	7,318,010	6,065	8,086	3,333
yr 8		$240,298.72	($320,000)	($79,701)	($3,582,185)	11,552	8,363,439	6,931	9,241	3,809
yr 9		$246,306.19	$0	$246,306	($3,335,879)	12,996	9,408,869	7,797	10,397	4,285
yr 10		$252,463.84	$0	$252,464	($3,083,415)	14,440	10,454,299	8,664	11,552	4,761
yr 11		$258,775.44	$0	$258,775	($2,824,640)	15,884	11,499,729	9,530	12,707	5,237
yr 12		$265,244.83	$0	$265,245	($2,559,395)	17,328	12,545,159	10,397	13,862	5,713
yr 13		$271,875.95	$0	$271,876	($2,287,519)	18,772	13,590,589	11,263	15,017	6,189
yr 14		$278,672.85	$0	$278,673	($2,008,846)	20,215	14,636,019	12,129	16,172	6,666
yr 15		$285,639.67	$0	$285,640	($1,723,206)	21,659	15,681,449	12,996	17,328	7,142
yr 16		$292,780.66	($320,000)	($27,219)	($1,750,426)	23,103	16,726,879	13,862	18,483	7,618
yr 17		$300,100.17	$0	$300,100	($1,450,325)	24,547	17,772,309	14,728	19,638	8,094
yr 18		$307,602.68	$0	$307,603	($1,142,723)	25,991	18,817,739	15,595	20,793	8,570
yr 19		$315,292.75	$0	$315,293	($827,430)	27,435	19,863,169	16,461	21,948	9,046
yr 20		$323,175.06	$0	$323,175	($504,255)	28,879	20,908,599	17,328	23,103	9,522
yr 21		$331,254.44	$0	$331,254	($173,001)	30,323	21,954,029	18,194	24,259	9,998
yr 22		$339,535.80	$0	$339,536	$166,535	31,767	22,999,459	19,060	25,414	10,475
yr 23		$348,024.20	$0	$348,024	$514,559	33,211	24,044,889	19,927	26,569	10,951
yr 24		$356,724.80	$0	$356,725	$871,284	34,655	25,090,318	20,793	27,724	11,427
yr 25		$365,642.92	$0	$365,643	$1,236,927	36,099	26,135,748	21,659	28,879	11,903