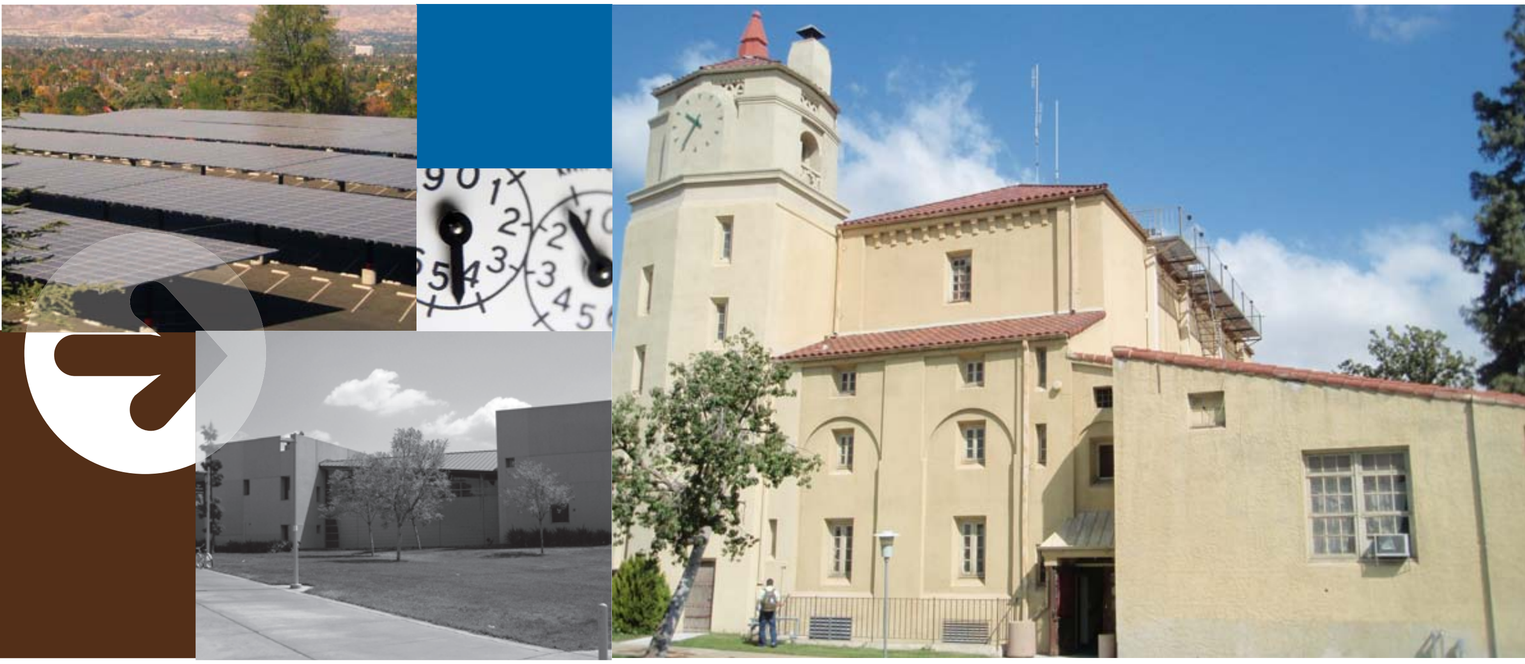

Alternative Energy Concept Plan

San Bernardino Valley College

Final Report—January 12, 2010

Submitted by:

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Executive Summary

Background and Scope

San Bernardino Community College District (SBCCD), one of 72 community college districts within the California Community College system, is comprised of San Bernardino Valley College, Crafton Hills 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 San Bernardino Valley 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 is an 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 San Bernardino Valley College 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 paybacks 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 and various 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 8.4 million kWh per year with a peak electrical demand of 2.3 MW. The current average costs for electricity and gas for SBVC are:

Electricity	$0.13/kWh
Gas	$0.81/therm

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

- A wide variety of heating and cooling systems comprising of package units, chilled water system, and split systems currently serve buildings on campus.
- Majority of the older buildings lack effective demand and occupancy controls and were found to have their HVAC systems operating on a continual basis.
- Majority of the buildings on campus are on the Automated Logic Controls (ALC) network except for the Planetarium. Some buildings are not completely electronic and have a hybrid control system containing both pneumatic and electronic controls.
- Several buildings were found to have electric DHW (Domestic Hot Water) heaters
- Lighting systems were found to be lacking effective occupancy controls in some cases and were equipped with inefficient lamps and ballasts.

A review and application of the various renewable technologies currently existing in the market place revealed that photovoltaic 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 at the campus were studied for locating these PV systems to maximize their efficiency and output. Parking Structure 1 located on the south side of the campus and newer buildings like Technology and Gymnasiums Arts were found to be ideal candidates for provision of this technology.

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.

Description	Energy in kWh
Energy Efficiency Measure Savings	665,000
Central Plant and TES Savings	960,000
Proposed PV Production	2,301,000

The following table summarizes the costs, potential rebates and annual energy cost reduction based on current electric rates ($0.13/kWh) for the various recommended energy efficiency measures and proposed PV systems.

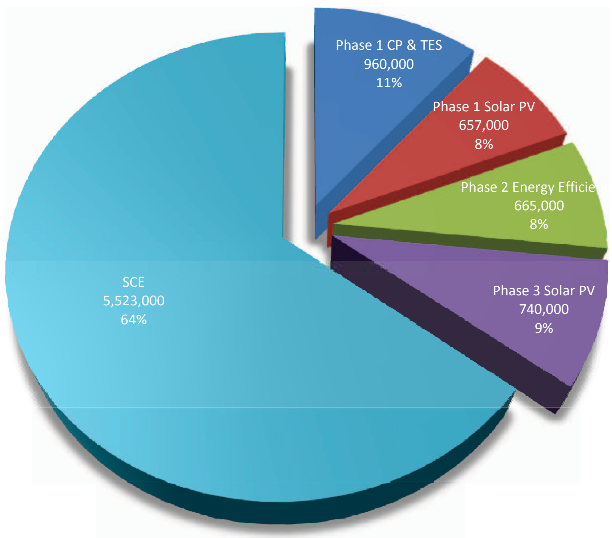
Phase	Description	Annual Energy Savings (kWh)	Cost	Rebates	Annual Energy Cost Reduction	Payback (Years)
1	Central Plant and Thermal Energy Storage	960,000	*	$243,000	$207,000	17
	Proposed PV Production 400 kW Parking Structure	657,000	**	$621,000	$85,000	25
2	Energy Efficiency Measures 2-9, 11-15	665,000	$752,000	$138,000	$93,000	7
3	Proposed PV Production 450 kW Building Rooftop	740,000	$2,250,000	$703,000	$95,000	17

* Included in Central Plant Budget
** Included in Parking Structure Budget

The implementation of the proposed energy conservation and renewable energy projects recommended above will help SBVC reduce reliance on the electrical grid by approximately 45% and reduce campus carbon emissions by approximately 1,270 tons. After implementation of the EEM and Centrsl Plant projects, the average Energy Utilization Index (EUI) for buildings on the SBVC campus would reduce from 87 kBtu/ft^2-yr to 76 kBtu/ft^2-yr. The two PV Phases would further reduce the average building EUI to 59 kBtu/ft^2-yr.

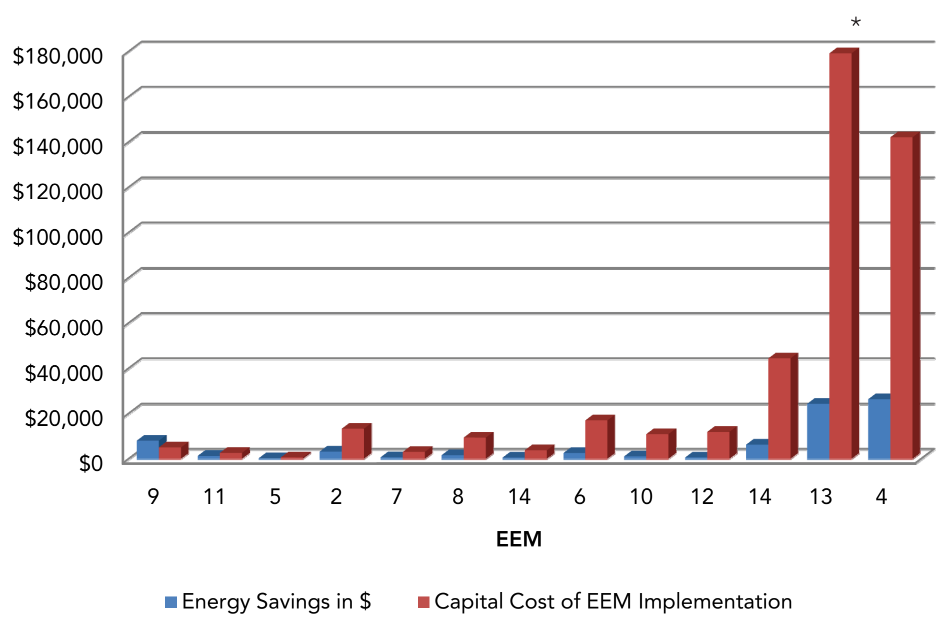
The following chart provides the percent of utility energy reliance that will be offset by the implementation of these energy efficiency measures and provision of recommended PV systems.

ANNUAL ENERGY DISTRIBUTION AFTER IMPLEMENTATION OF RECOMMENDED PROJECTS



The following chart provides the energy savings vs. capital costs in dollars for each EEM.

ENERGY EFFICIENCY MEASURE SAVINGS AND CAPITAL COSTS



* Costs are included in San Bernardino Valley College Infrastructure master Plan.

Baseline Energy Usage

This section establishes current electricity and natural gas consumption at SBVC Campus buildings. Blended cost of electricity and natural gas are computed based on monthly bills provided to us by the Program Manager.

Primary electrical utility is served to campus with SCE TOU-8B service connection. Exterior lighting is provided by a separate OL-1 All Night meter.

Natural gas is served to campus under GN-10 rate schedule from The Gas Company, at most of the locations. There are ten gas connections as outlined in Table-4 of this section

The following table provides the meter types and yearly usage data against each of them.

Utility	Type	Customer A/C #	Yearly Billing
SCE	GS-1	2-29-043-8126	$1,470
SCE	GS-1	097-721-3910-2	$200
SCE	OL-1 Allnight	3-003-4056-85	$2,400
Colton	EC3	55563545	$15,000
SCE	TOU-8B	3-000-2039-07	$1,101,003

Blended cost of electricity is calculated as $ 0.13/kWh and for natural gas as $ 0.81/therm.

Peak electrical demand experienced during 2009 was 2,371 kW. The billing demand usage statistic for electricity at SBVC is summarized in the table below:

TABLE 1 BILLING DEMAND VARIATIONS AT SBVC

Parameter	kW
Min	998
Max	2371
Mean	1628
Median	1584

Fifteen minute interval dates of service connection 3-000 - 2039-07 is summarized graphically in Figure 2.

After reviewing the electric consumption and natural gas consumption for twelve contiguous months, the current Energy Utilization Index (EUI) of SBVC buildings is estimated at 87 kBtu/ft^2-yr, as computed in Table 5 of this section.

TABLE 2 SUMMARY OF MONTHLY ELECTRIC BILLS OF SBVC

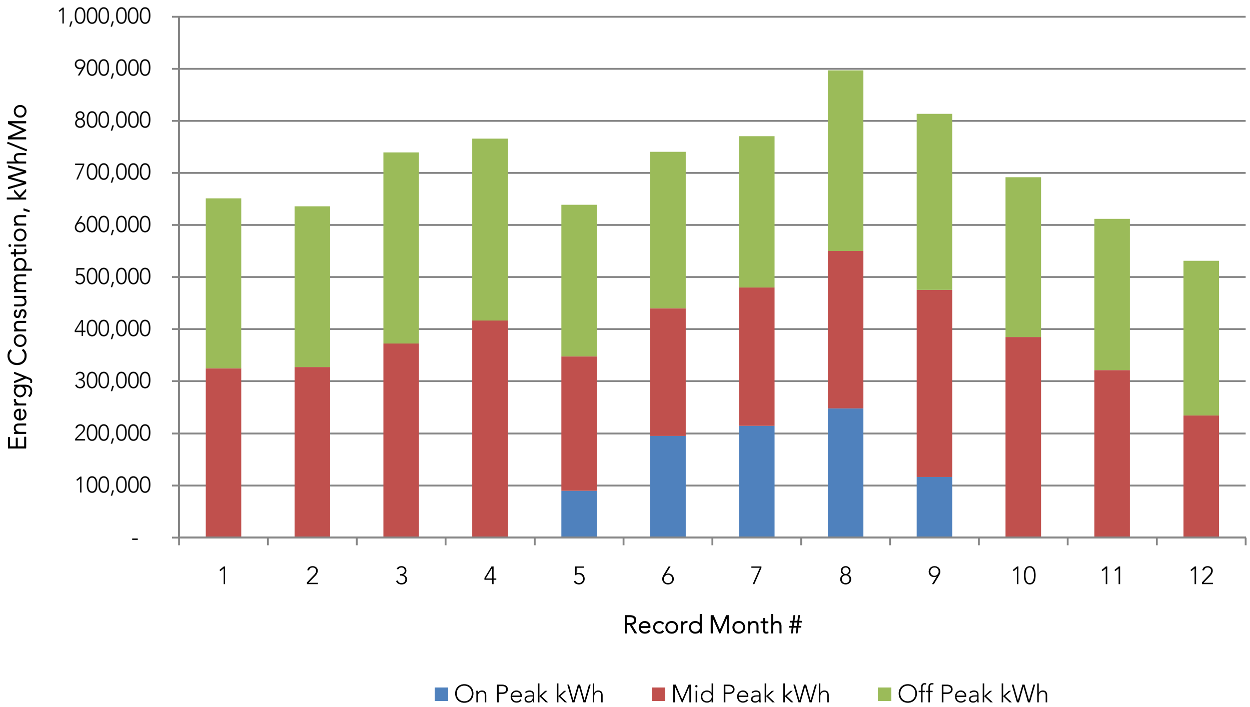
Service Connection: 3-000-2039-07 TOU-08										
Start Date	End Date	Charges	On Peak kWh	Mid Peak kWh	Off Peak kWh	Total kWh	On Peak KW	Mid Peak kW	Off Peak kW	$/kWh
1/19/2009	1/18/2009	$68,665.03		324,787	326,076	650,863		1,574	1,142	$0.11
2/18/2009	3/19/2009	$68,707.02		327,442	308,704	636,146		1,718	1,315	$0.11
3/19/2009	4/20/2009	$77,208.59		372,782	366,706	739,488		1,680	1,296	$0.11
4/20/2009	5/19/2009	$85,924.50		416,736	348,924	765,660		2,016	1,594	$0.11
5/19/2009	6/18/2009	$91,513.43	89,808*	116,683*	130,097*	638,806	1,536	1,402*	998*	$0.14
				141,526	160,692			1,776	1,478	
6/18/2009	7/20/2009	$126,652.18	195,264*	244,985*	300,149*	740,398	1,968	1,901*	1,459*	$0.17
7/20/2009	8/18/2009	$134,277.00	214,462*	265,414*	290,368*	770,244	2,102	2,064*	1,613*	$0.17
8/18/2009	9/17/2009	$153,215.00	247,673*	302,590*	346,418*	896,681	2,371	2,275*	1,584*	$0.17
9/17/2009	10/19/2009	$108,841.50	116,256*	141,406*	146,484*	813,651	2,179	2,122*	1,382*	$0.13
				217,807	191,698			1,795	1,430	
10/19/2009	11/18/2009	$72,480.59		384,631	307,356	691,987		1,968	1,296	$0.10
11/18/2009	12/18/2009	$61,948.30		321,650	290261	611,911		1,565	1,114	$0.10
12/18/2009	1/19/2010	$51,569.84		234,118	297,336	531,454		1,402	1,066	$0.10
1/19/2010	2/18/2010	$60,344.25		323,386	304,852	628,238		1,651	1,142	$0.10
Totals		$1,101,003	863,463	3,812,557	3,811,269	8,487,289				$0.13

*Indicates summer month.

TABLE 3 'TIME OF USE', MONTHLY ENERGY CONSUMPTIONS

Month #	On Peak kWh	Mid Peak kWh	Off Peak kWh
1	-	324,787	326,076
2	-	327,442	308,704
3	-	372,782	366,706
4	-	416,736	348,924
5	89,808	258,209	290,789
6	195,264	244,985	300,149
7	214,462	265,414	290,368
8	247,673	302,590	346,418
9	116,256	359,213	338,182
10	-	384,631	307,356
11	-	321,650	290,261
12	-	234,118	297,336

FIGURE 1 TIME OF USE, MONTHLY ENERGY CONSUMPTION



GAS CONSUMPTION AND COSTS

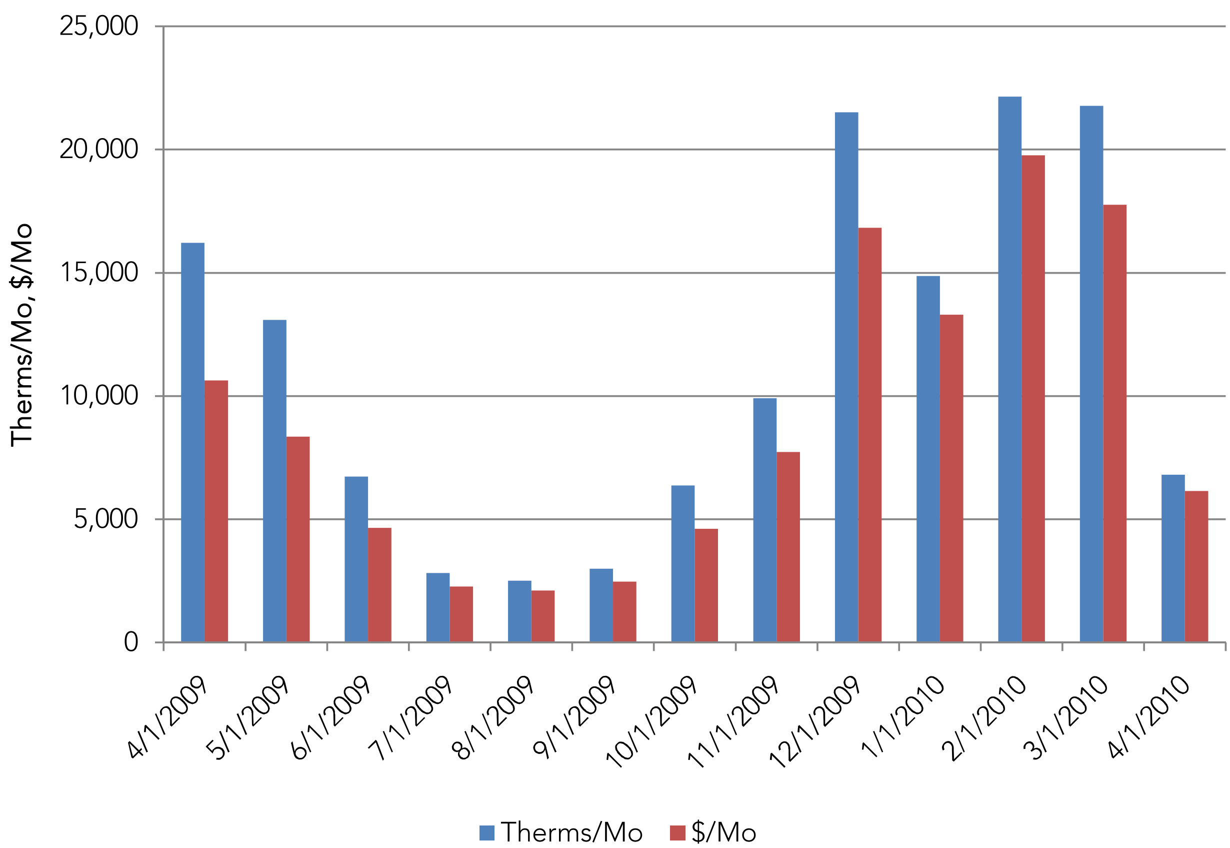


TABLE 4 NATURAL GAS SERVICE CONNECTIONS AT SBVC

Mtr #	Therms	$/Month	Therms	$/Month	Therms	$/Month	Therms	$/Month	Therms	$/Month	Therms	$/Month
	120-853-2403		116-692-8986		070-486-9649		099-835-2610		122-995-9019		051-587-6555	
4/14/2010	3,882	$3,244	177	$208	456	$456	18	$35	713	$665	254	$292
3/16/2010	3,574	$3,281	324	$376	787	$790	22	$48	699	$711	976	$959
2/12/2010	2,129	$2,177	463	$542	1,070	$1,138	54	$81	1,281	$1,345	1,348	$1,411
1/13/2010	2,417	$2,298	371	$428	843	$859	21	$37	694	$723	1,550	$1,506
12/10/2009	3,782	$3,286	313	$325	839	$774	21	$36	884	$812	1,247	$1,122
11/6/2009	3,329	$2,645	112	$130	271	$254	16	$27	397	$353	137	$150
10/9/2009	3,309	$2,331	101	$113	139	$139	13	$23	66	$79	0	$15
9/10/2009	720	$567	83	$99	100	$116	13	$24	64	$80	518	$420
8/11/2009	292	$258	75	$91	93	$110	11	$21	46	$62	524	$429
7/13/2009	72	$87	92	$107	122	$131	13	$24	121	$130	542	$429
6/12/2009	2,302	$1,557	106	$113	145	$139	15	$25	430	$326	587	$429
5/13/2009	4,473	$2,905	181	$162	378	$290	18	$27	707	$505	748	$532
4/13/2009	3,417	$2,462	258	$245	586	$475	18	$27	673	$536	941	$724

Mtr #	Therms	$/Month	Therms	$/Month	Therms	$/Month	Therms	$/Month	Therms	$/Month	Therms	$/Month
	051-587-6555		043-121-4171		030-021-8400		053-621-4100		099-845-9634		SBVC Total	
4/14/2010	254	$292	1054	$943	111	$126			144	$173	6,809	$6,142
3/16/2010	976	$959	1579	$1,498	198	$235	13301	$9,495	314	$367	21,774	$17,755
2/12/2010	1,348	$1,411	1739	$1,795	154	$194	13391	$10,490	521	$599	22,150	$19,772
1/13/2010	1,550	$1,506	1132	$1,124	142	$166	7429	$5,828	268	$334	14,867	$13,303
12/10/2009	1,247	$1,122	1354	$1,214	6	$17	12802	$8,964	261	$281	21,509	$16,831
11/6/2009	137	$150	739	$620	26	$35	4801	$3,414	86	$106	9,914	$7,7334
10/9/2009	0	$15	663	$501	11	$21	2022	$1,337	41	$55	6,365	$4,615
9/10/2009	518	$420	519	$421	9	$18	927	$666	39	$55	2,992	$2,466
8/11/2009	524	$429	343	$295	9	$18	1089	$784	27	$43	2,509	$2,110
7/13/2009	542	$429	373	$309	17	$25	1445	$994	25	$41	2,822	$2,277
6/12/2009	587	$429	490	$366	11	$20	2617	$1,639	28	$42	6,731	$4,656
5/13/2009	748	$532	869	$610	31	$37	5585	$3,174	99	$108	13,089	$8,349
4/13/2009	941	$724	1063	$810	70	$74	9033	$5,107	156	$170	16,215	$10,627
	Totals										131,531	$106,010
Blended Cost of Natural Gas												$0.81

FIGURE 2 15 MINUTE INTERVAL DATA FOR ELECTRICAL DEMAND

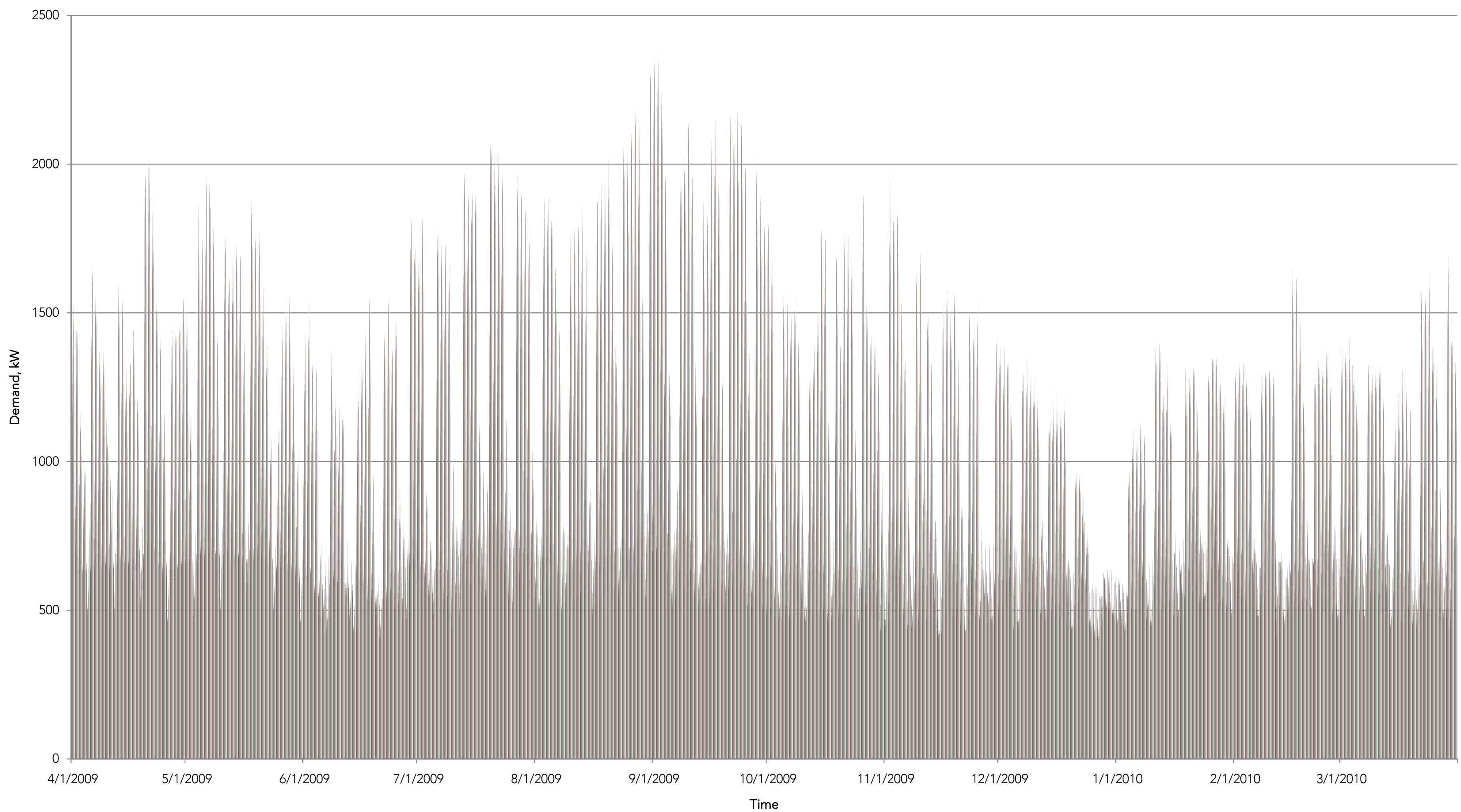
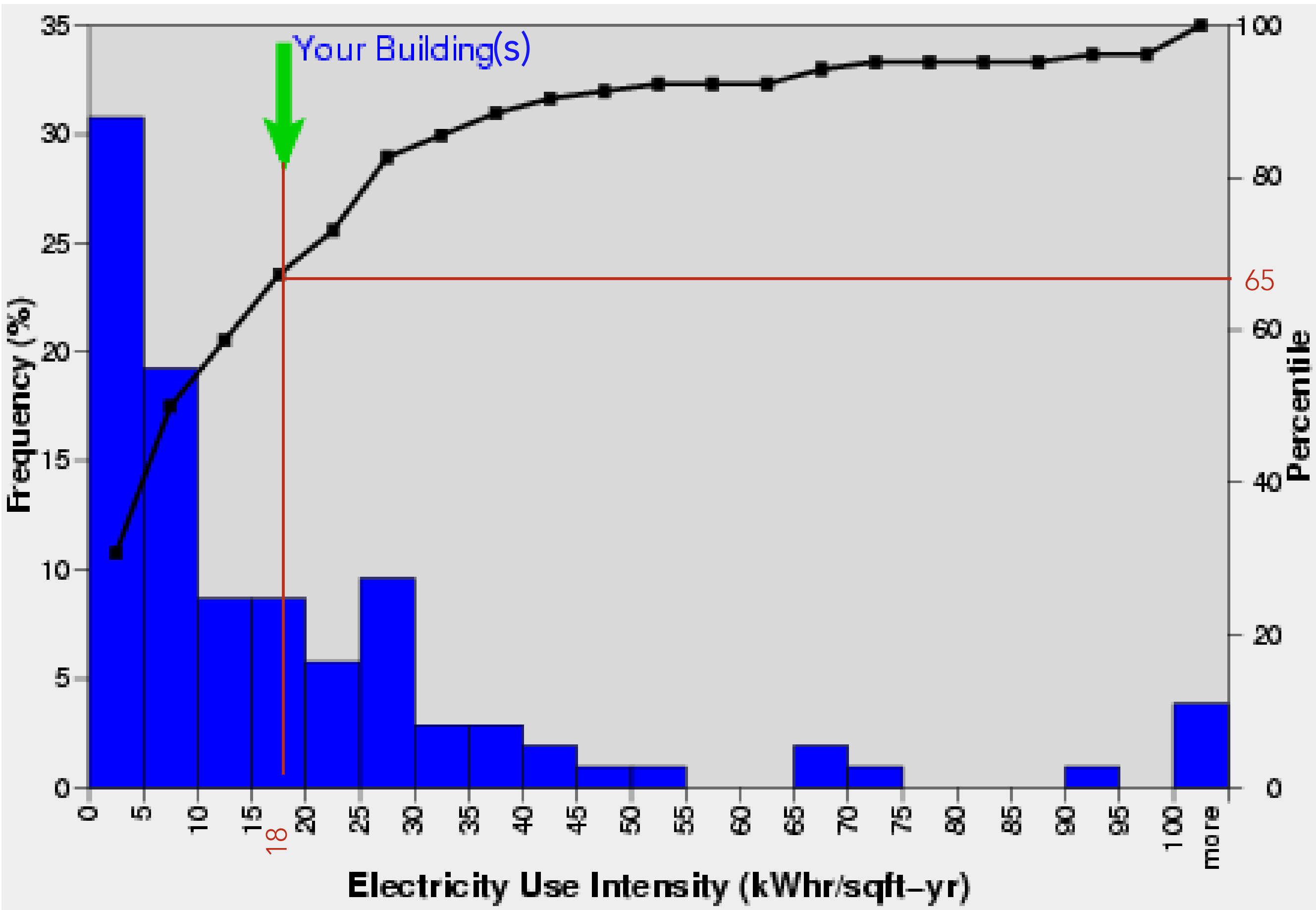


TABLE 5 EUI CALCULATION

Building Name	Conditioned Area, ft^2	Units
Admin/Student Services	26,016	ft^2
Art & Gallery	16,638	ft^2
Auditorium	26,200	ft^2
Business	36,000	ft^2
Liberal Arts	28,000	ft^2
Chemistry & Physical Science	57,000	ft^2
Planetarium	6,300	ft^2
Health & Life Science	37,685	ft^2
Library	36,700	ft^2
Media/Communications	18,300	ft^2
North Hall Bldg	20,000	ft^2
Campus Center	30,800	ft^2
Student Health Services	2,400	ft^2
Gymnasiums	75,000	ft^2
Observatory	200	ft^2
Technical Building	47,800	ft^2
Child Development Center	19,000	ft^2
Total Area of (E) Buildings	484,039	ft^2
Total Electricity Consumption	8,487,289	kWh/Yr
Street Lights Energy @ 10 kW	29,200	kWh/Yr
Total Natural Gas Consumption	131,531	Therms/Yr
Total energy consumption (Bldgs)	42,020,558	kBtu
EUI (Energy Utilization Index)	87	$kBtu/ft^2 \cdot Yr$

SBVC buildings EUI of 87 kBtu/ft²-yr is higher than all average EUI (80 87 kBtu/ft²-yr) buildings in the climate zone, per database of California Building Energy Reference Tool.

FIGURE 3 ELECTRIC USE INTENSITY COMPARISON



SBVC electric EUI is 18 kWh/ft²-yr is higher than 65% 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. Central Plant & TES (Thermal Energy Storage)
2. Tankless DHW Heaters
3. Low Flush Urinals
4. Lighting Retrofits
5. Piping Insulation
6. Campus Center Kitchen Dishwasher Retrofit
7. Campus Center Heat Pump Water Heater
8. Liberal Arts AHU Supply Fan VFDs
9. Auditorium AHU Supply Fan Wheel Retrofit
10. Planetarium Hydronic System
11. Planetarium AHU Supply Fan VFD
12. High SEER Split Condensing Units
13. Monitoring-Based Commissioning
14. Premium Efficiency Motors
15. Controls Retrofit

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

1. Admin and Student Service
2. Art Gallery
3. Health and Life Science
4. Campus Center
5. Planetarium
6. Technical Building
7. Library
8. Liberal Arts
9. Auditorium
10. Observatory

EEMs that had paybacks exceeding the remaining life of existing buildings were ruled out assuming the renovation or new construction would incorporate the energy efficient design features.

EEM 1 and EEM 10 were used to calculate annual energy savings and potential rebates from the Central Chilled Water Plant with Thermal Storage and the converting the Planetarium from electric reheat to heating hot water as recommended in the SBVC Utilities Infrastructure Report.

Individual EEMs with their description and recommendation are outlined in this section. The detailed backup for each ECM is shown in Appendix B. Implementation of the fifteen recommended EEMs would result in an 18.5% electrical energy reduction of current use.

Annual SBVC Baseline Electrical Energy Consumption	8,487,289 kWh
Annual Electrical Savings from EEMs 1-15	1,567,115 kWh
Overall Percent Electrical Reduction	18.5%

The following Table shows the EEMs sorted by payback periods.

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	9	Auditorium AHU Supply Fan Wheel Retrofit	63,121	15.8		$5,075	$5,075	$8,042	0.0
2	11	Planetarium AHU Supply Fan VFD	10,445	3		$2,655	$2,507	$1,331	0.1
3	5	Piping Insulation			211	$650	$211	$276	1.6
4	2	Tankless DHW Heaters	29,839	3.4	-	$13,350	$7,161	$3,209	1.9
5	7	Campus Center Heat Pump Water Heater	5,522	1.4		$3,099	$1,325	$704	2.5
6	4	Lighting Retrofits	202,804	50.7		$142,143	$48,673	$26,364	3.6
7	8	Liberal Arts AHU Supply Fan VFDs	12,736	3.2		$9,420	$3,057	$1,623	3.9
8	14	Premium Efficiency Motors	2,643	3.0	-	$2,116	$634	$337	4.4
9	15	Controls Retrofit	58,350	6.7	-	$50,000	$14,004	$7,586	4.7
10	6	Campus Center Kitchen Dishwasher Retrofit	9,772	13.6	1,151	$16,994	$2,419	$2,604	5.6
11	12	High SEER Split Condensing Units	4,625	1.9	-	$11,950	$2,994	$1,462	6.1
12	3	Low Flush Urinals				$44,400	$-	$6,311	7.0
13	10	Planetarium Hydronic System	11,570	5.8	(494)	*	$2,777	$1,074	
14	13	Monitoring-Based Commissioning	254,000	29.0	-	$450,000	$60,960	$33,020	11.8
15	1	Central Plant & TES (Thermal Energy Storage)	960,038	566.7	-	*	$243,208	$206,606	
		Totals	1,625,465	693	868	$751,852	$395,005	$300,549	

* Cost is included in the SBVC Utilities Infrastructure Master Plan Report

EEM 01—
Central Plant with TES (Thermal Energy Storage)

Construction Cost	*
Estimated Savings	$206,606
Potential Rebates	$243,208
Payback	

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

* Cost is included in the SBVC Utilities Infrastructure Master Plan Report.

Description

This EEM is included to calculate the savings and potential rebate associated with the installation of a new central chilled water plant with thermal energy storage on the SBVC campus. The EEM includes the installation of a 1,200 ton central chilled water plant with 10,000 ton-hour thermal energy storage, as described in the SBVC Utilities Infrastructure Master Plan report, and connecting the following buildings:

- Administration and Student Services (AD/SS)
- Art Center and Gallery (ART)
- Auditorium (AUD)
- Business (B)
- Campus Center (CC)
- Chemistry/Physical Science (SCI)
- Liberal Arts (LA)
- Planetarium (PL)
- North Hall Replacement (NHR)
- Future Gymnasiums 1 & 2 (G1 & G2)
- Future Technical (T)

Recommendation

This EEM provides an efficient means to air condition the campus, minimize maintenance expenses and substantially reduces energy expenses. This infrastructure project would also reduce future capital expenditures to provide air conditioning refrigeration equipment in new or renovated buildings if the central plant was not built.

We recommend this EEM be implemented to capture these savings.

EEM 02—Tankless DHW Heaters

Construction Cost	$13,350
Estimated Savings	$3,209
Potential Rebates	$7,161
Payback	1.9 years

Annual Utility Savings	
Electricity	29,839 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:

- Administration/Student Services
- Art
- Auditorium

EEM 03—No Flush and Low Flush Urinals

Construction Cost	$44,400
Estimated Savings	$6,311
Potential Rebates	N/A
Payback	7.0 years

Annual Utility Savings	
Electricity	N/A
Gas	N/A
Water	1,547 kGal

Description

SBVC has opportunity to retrofit 37 urinals in Buildings AD/SS, ART, AUD, CC, HLS, LA, LIB, PL, and TECH. This EEM includes the replacement of 37 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 1.5 gpf. Low (pint flush) 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.

EEM 04—Lighting

Construction Cost	$142,143
Estimated Savings	$26,364
Potential Rebates	$48,673
Payback	3.5 years

Annual Utility Savings	
Electricity	202,804
Gas	N/A
Water	N/A

Description

This EEM analyzes the lighting in the subject ten 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	Control interior light fixtures with occupancy sensors
ECM 2	Convert incandescent fixtures to compact fluorescent
ECM 3	Replace incandescent lamps with compact fluorescent lamps
ECM 4	Install daylighting controls for a group of fixtures
ECM 5	Replace lamp and ballast of a T8 - 32 W to T8 -25W
ECM 6	Replace MR-16 lamps with LED lamps
ECM 7	Replace ballast and lamps
ECM 8	Provide time clock control
ECM 9	Replace metal halide fixtures with multiple compact fluorescent fixtures

Recommendation

We recommend implementing the lighting efficiency measures shown in EEM-04 Table 18 shown in Appendix B.

EEM 05—Piping Insulation

Construction Cost	$650
Estimated Savings	$276
Potential Rebates	$211
Payback	1.6 years

Annual Utility Savings	
Electricity	N/A
Gas	211 Therms
Water	N/A

Description

This EEM evaluates the opportunity to reduce heat loss from un-insulated piping found at the campus. The two areas found were in the Auditorium and Liberal Arts buildings.

Heat losses through un-insulated surfaces are significant, especially when the hot/cold surfaces are operating continuously (24/7 basis). Although the analysis in this measure is representative of pipe insulation around the heating hot water pipe, there may be additional surfaces on the campus outside the ten buildings surveyed that could benefit from this EEM. A rigorous inventory of such surfaces needs to be prepared for insulation requirements. Generous rebates are also available from The Gas Company.

Recommendation

We recommend insulating the un-insulated hot water piping in the Auditorium and Liberal Arts buildings.

EEM 06—Campus Center Kitchen Dishwasher Upgrades

Construction Cost	$16,994
Estimated Savings	$2,604
Potential Rebates	$2,419
Payback	5.6 years

Annual Utility Savings	
Electricity	9,772 kWh
Gas	1,151 Therms
Water	100 kGal

Description

This EEM evaluates replacing the existing electric dishwasher with a gas dishwasher that is more energy and water efficient.

The SBVC kitchen in Campus Center building uses an electric heated dishwasher. Water is heated electrically in this dishwasher. The proposed champion dishwashing machine uses a gas heated hot water coil and uses less water. It is an Energy Star qualified product and was recommended by The Gas Company.

Recommendation

We recommend replacing the existing electric dishwasher with an Energy Star gas dishwasher.

EEM 07—Campus Center Heat Pump DHW Heater

Construction Cost	$3,079
Estimated Savings	$704
Potential Rebates	$1,325
Payback	2.5 years

Annual Utility Savings	
Electricity	5,522 kWh
Gas	N/A
Water	N/A

Description

This EEM evaluates the feasibility of replacing the electric DHW heater in the Campus Center Kitchen with an electric heat pump water heater.

The cold air from the heat pump will provide an additional benefit of 2.7 tons of cooling in the Kitchen. This EEM saves less energy when compared to tankless gas-fired DHW heater, but considering the desire to help SBVC Kitchen users with a cooler Kitchen, this EEM will save energy and provide cooling to the Kitchen as it heats up the domestic water.

Recommendation

We recommend replacing the electric DHW heater in the Campus Center Kitchen with an electric heat pump water heater.

EEM 08—Liberal Arts AHU Supply Fan VFDs

Construction Cost	$9,420
Estimated Savings	$1,623
Potential Rebates	$3,057
Payback	3.9 years

Annual Utility Savings	
Electricity	12,736 kWh
Gas	N/A
Water	N/A

Description

This EEM evaluates the feasibility of installing variable speed drives on the replaced supply fan premium efficiency motors in the Liberal Arts building.

The Liberal Arts building has two air-handling units with 28,260 CFM and 16,170 CFM capacities, respectively. Supply fans with motor sizes of 20 and 8 HP provide supply air to the building. The building has multiple supply zones with variable air volume dampers.

E-quest was used to simulate the building, to generate savings.

Recommendation

We recommend installing variable speed drives on the supply fan motors in the Liberal Arts building.

EEM 09—Auditorium AHU Supply Fan Wheel Retrofit

Construction Cost	$5,075
Estimated Savings	$8,042
Potential Rebates	$5,075
Payback	Immediate

Annual Utility Savings	
Electricity	63,121 kWh
Gas	N/A
Water	N/A

Description

This EEM evaluates the feasibility of installing a smaller fan wheel on the existing air handler sized for the proper airflow in the building.

The Auditorium building has one air-handling unit in the basement, manufactured by Energy Labs. There is a single supply fan with a VFD on this unit, which is manually controlled. The fan is oversized and is operating at 45% speed all the time to reduce the ventilation CFM. This causes existing fan to operate at lower efficiency than the design efficiency.

Recommendation

We recommend installing variable speed drives on the supply fan motors in the Liberal Arts building.

EEM 10—
Planetarium Electric Heating to Hydronic Heating Upgrades

Construction Cost	*
Estimated Savings	$1,074
Potential Rebates	$2,777
Payback	

Annual Utility Savings	
Electricity	11,570 kWh
Gas	N/A
Water	N/A

* Cost is included in the SBVC Utilities Infrastructure Master Plan Report

Description

This EEM evaluates the energy savings when replacing the existing electric reheat with hot water reheat as described

This EEM is included to calculate the savings and potential rebate associated with replacing the existing electric reheat with hot water reheat in the Planetarium. This work is described in the SBVC Utilities Infrastructure Master Plan report.

The air handler in the Planetarium has six zones and each zone uses electric reheat. This existing electric reheat is sized at 88 kW.

Recommendation

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

EEM 11—Planetarium AHU Supply Fan VFD

Construction Cost	$2,655
Estimated Savings	$1,331
Potential Rebates	$2,507
Payback	0.1 year

Annual Utility Savings	
Electricity	10,445 kWh
Gas	N/A
Water	N/A

Description

This EEM evaluates the feasibility of installing a variable frequency drive (VFD) on the Planetarium air handler.

The air handler in the Planetarium has six zones and each zone uses electric reheat. E-Quest was used to model the performance of the baseline and savings.

Recommendation

We recommend installing a variable frequency drive (VFD) on the Planetarium air handler.

EEM 12—High SEER Condensing Units

Construction Cost	$11,950
Estimated Savings	$1462
Potential Rebates	$2,994
Payback	6.1 years

Annual Utility Savings	
Electricity	4,625 kWh
Gas	N/A
Water	N/A

Description

This EEM evaluates the feasibility of replacing small split system condensing units and window AC units only in the following buildings:

- Auditorium CU-2
- Campus Center CU-1 & CU2
- Health & Life Sciences CU-1, CU-2 & CU-3
- Library CU-1

SBVC has eight condensing units with EER ratings in range of 8 to 12 within the ten buildings being analyzed for energy efficiency improvements. Cooling capacities of these condensing units vary from 9,000 Btu/h (0.751 Ton) to 24,000 Btu/h (2 Tons). Some of the units are relatively new. For smaller capacities the newer technology allows 21 SEER condensing units that generate room for energy conservation by energy efficient retrofit. Using Energy Star rated condensing units when choosing a retrofit will provide rebates and reliable energy efficiency. This EEM targets split system condensing units and window AC units only. Packaged Roof top units (RTUs) are not analyzed, since they will be retrofitted or replaced to AHU (Air Handling Unit)

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

Recommendation

We recommend replacing the small split system condensing units and window AC units with 21 SEER units in the following buildings:

- Auditorium CU-2
- Campus Center CU-1 & CU2
- Health & Life Sciences CU-1, CU-2 & CU-3
- Library CU-1

EEM 13—Monitoring Based Commissioning (MBCx)

Construction Cost	$450,000
Estimated Savings	$33,000
Potential Rebates	$60,960
Payback	11.8 years

Annual Utility Savings	
Electricity	254,000 kWh
Gas	N/A
Water	N/A

Description

This EEM evaluates the feasibility of implementing MBCx on the following buildings to reduce energy and operating costs:

- Administration and Student Services
- North Hall
- Media & Communications Building
- Chemistry/Physical Science Building

MBCx is a process through the CCC/IOU partnership that is performed over 7 phases and occurs during a course of a year. After the MBCx process is completed the partnership will pay $0.24 per kWh saved and $1.00 per therm saved that was verified up to the total amount that was estimated during the application period.

Recommendation

We recommend implementing MBCx on only the following buildings to reduce energy and operating costs:

- Administration and Student Services
- North Hall
- Chemistry/Physical Science Building

EEM 14—Premium Efficiency Motors

Construction Cost	$2,116
Estimated Savings	$337
Potential Rebates	$634
Payback	4.4 years

Annual Utility Savings	
Electricity	2,643 kWh
Gas	N/A
Water	N/A

Description

This EEM evaluates the feasibility of rewinding the standard efficiency motors in the Technical Building and Planetarium Building to premium efficiency motors.

- Technical Building lathes, CNC machines, and AHU-1 and 2
- Planetarium Building chilled water pump.

SBVC has over 100 motors in ten buildings being analyzed. It is recommended that SBVC 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. SBVC should mandate the use of premium efficiency motors for all future retrofits and new buildings. It is recommended that the replacement be coordinated with the OEM (Original Equipment Manufacturer), particularly for Lathes and CNC machines in the Technical building.

Recommendation

We recommend rewinding the following motors to premium efficiency:

- (12) 1.5 HP motors for lathes in Technical Building
- (4) 5 HP motors for CNC machines in Technical Building
- (1) 5 HP motor on CHW pump in Planetarium

EEM 15—Control Retrofit

Construction Cost	$50,000
Estimated Savings	$7,586
Potential Rebates	$14,000
Payback	4.7 years

Annual Utility Savings	
Electricity	58,350 kWh
Gas	N/A
Water	N/A

Description

This EEM evaluates the feasibility of replacing the control system from a mixture of pneumatics or obsolete DDC to the latest generation of current Automated Logic DDC controls (ALC) for the following buildings:

- Planetarium Building
- Health and Life Science Building
- Library Building

The Health and Life Science and Library buildings are shown in the SBVC Utility Master Plan Report as Priority 2 buildings for conversion to chilled water. This EEM would only be applicable if these buildings were converted to chilled water.

Recommendation

We recommend the campus replace the control system on the Planetarium Building.

The campus should consider replacing the controls on the Health and Life Science and Library Buildings in the future if the buildings are converted from DX to chilled water.

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	5000-8000 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

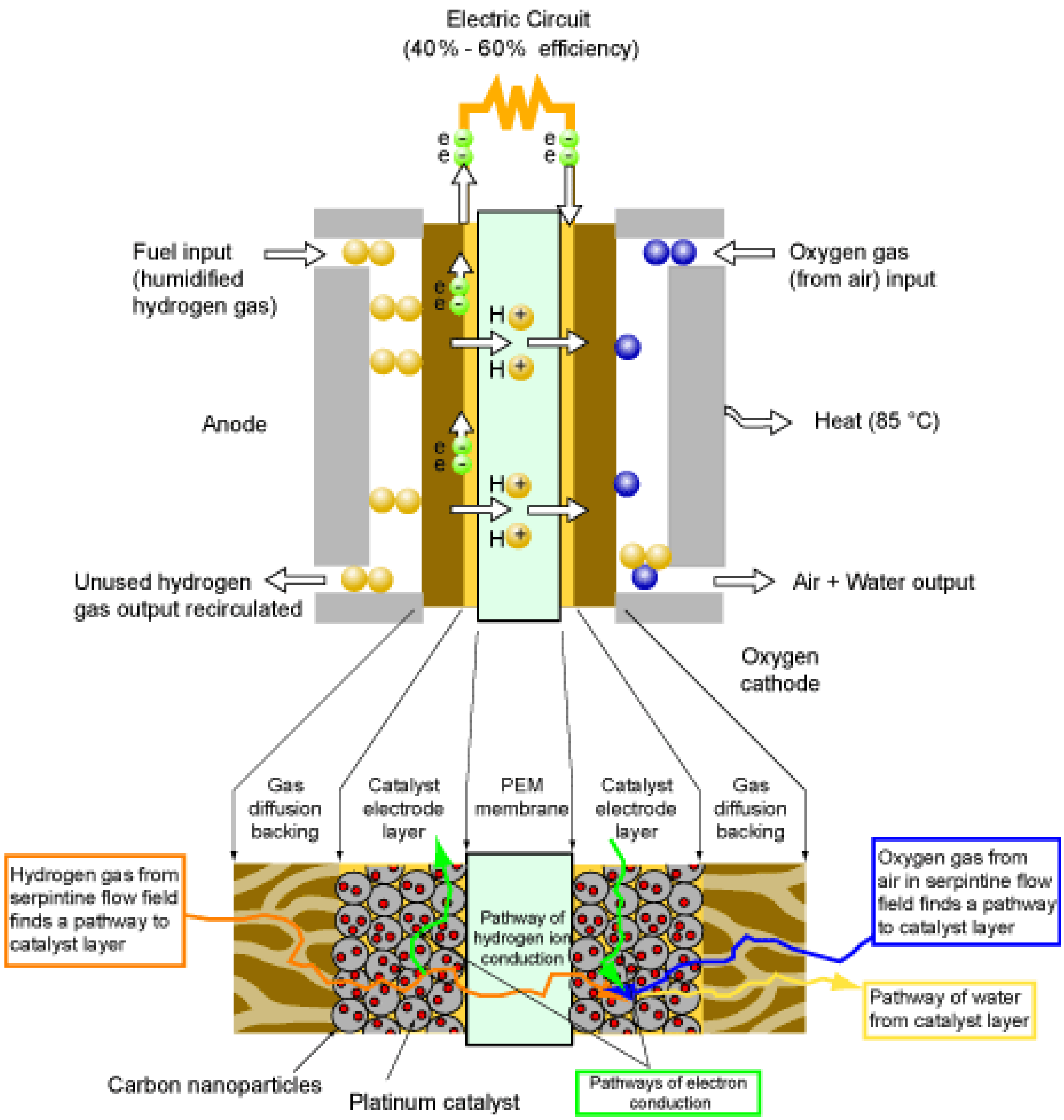

Electric Circuit
(40% - 60% efficiency)
Fuel input
(humidified
hydrogen gas)
Oxygen gas
(from air) input
Anode
Heat (85 °C)
Unused hydrogen
gas output recirculated
Air + Water output
Oxygen
cathode
Gas
diffusion
backing
Catalyst
electrode
layer
PEM
membrane
Catalyst
electrode
layer
Gas
diffusion
backing
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

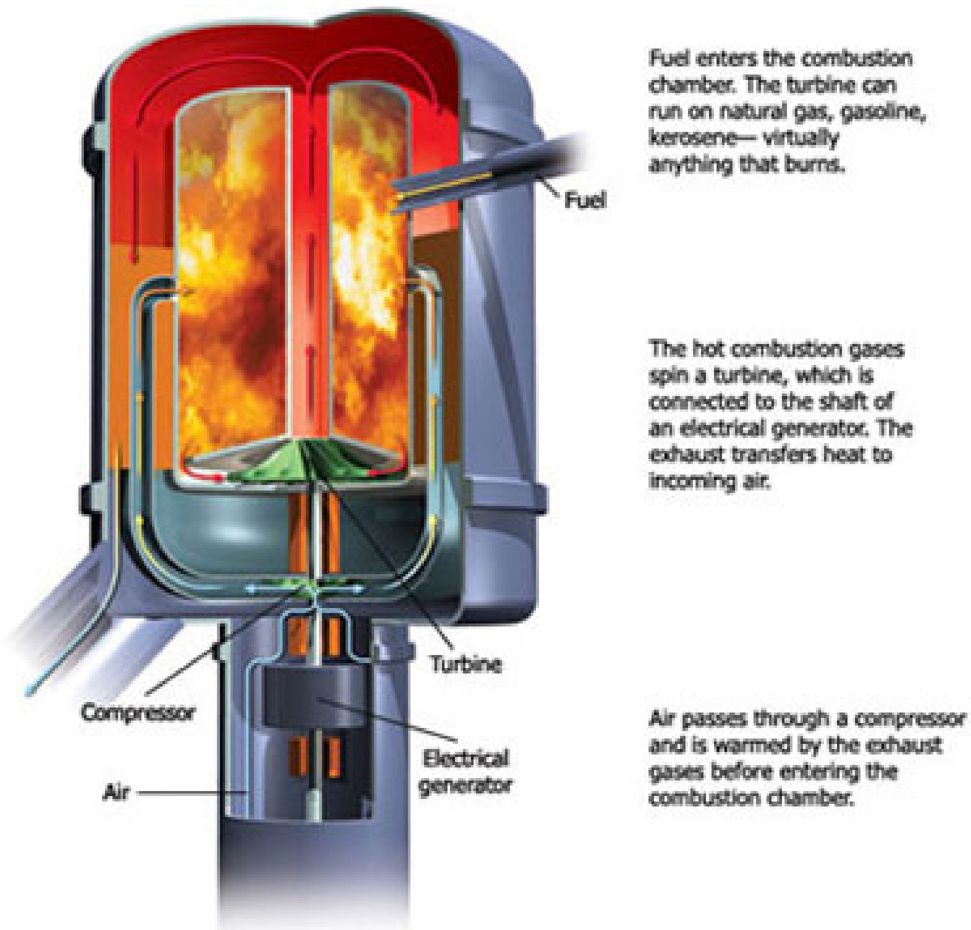


FIGURE 3—SERVICING MICROTURBINES

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/m^2 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.

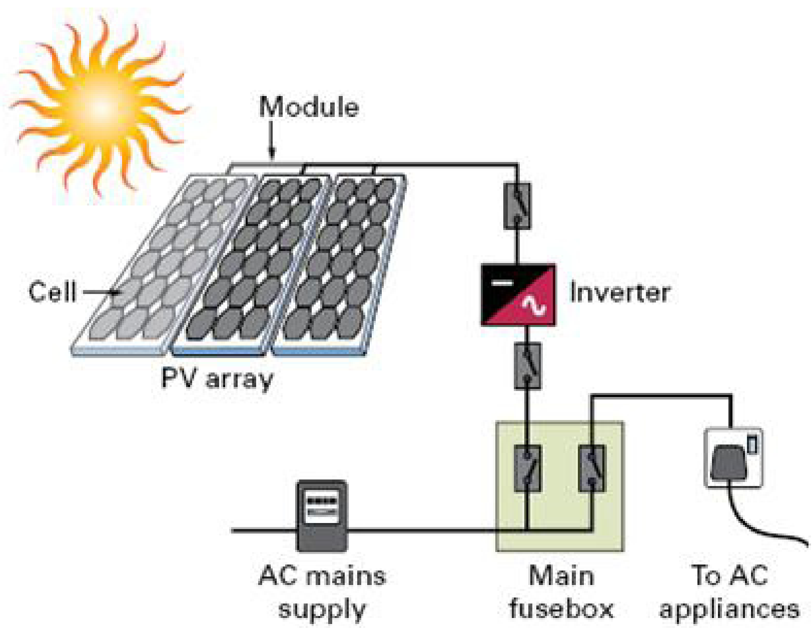
Grid-Connected Systems

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



There are three main parts of a grid connected system. The biggest element is the photovoltaic panels and their support structure. The second major component is the power inverter(s). The final part is the interconnecting equipment and metering to tie the system into the power grid.

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:

Cast 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.

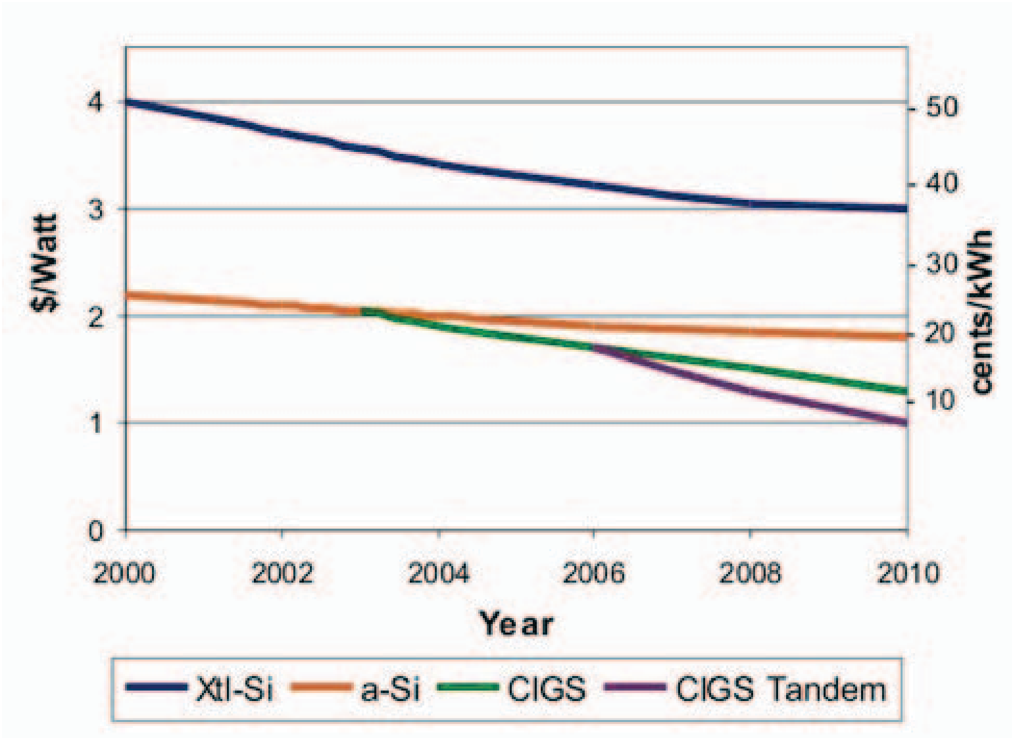
The primary advantages of thin-film panels lie in their low manufacturing costs and versatility. Because amorphous silicon and similar semiconductors do not depend on the long, expensive process of creating silicon crystals, they can be produced much more quickly and efficiently. As they do not need 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).

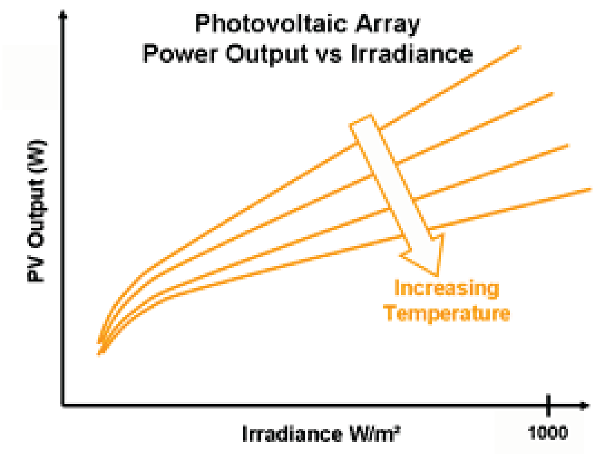
FIGURE 7—TYPICAL 250 KW PV INVERTER

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 $kWh/m^2/day$ at the campus.

FIGURE 9—SAN BERNARDINO SUN PATH

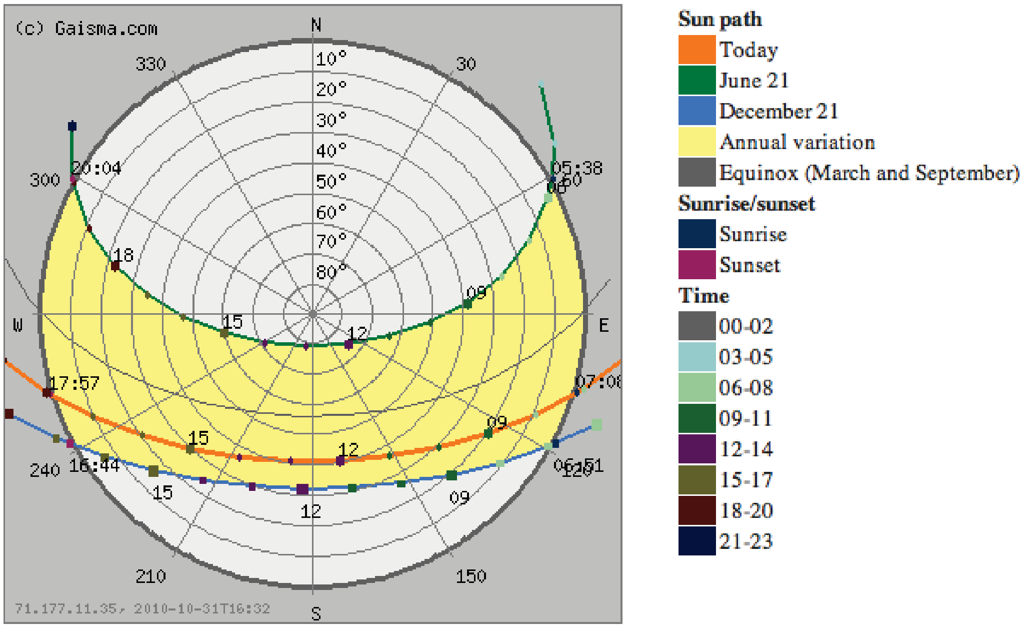
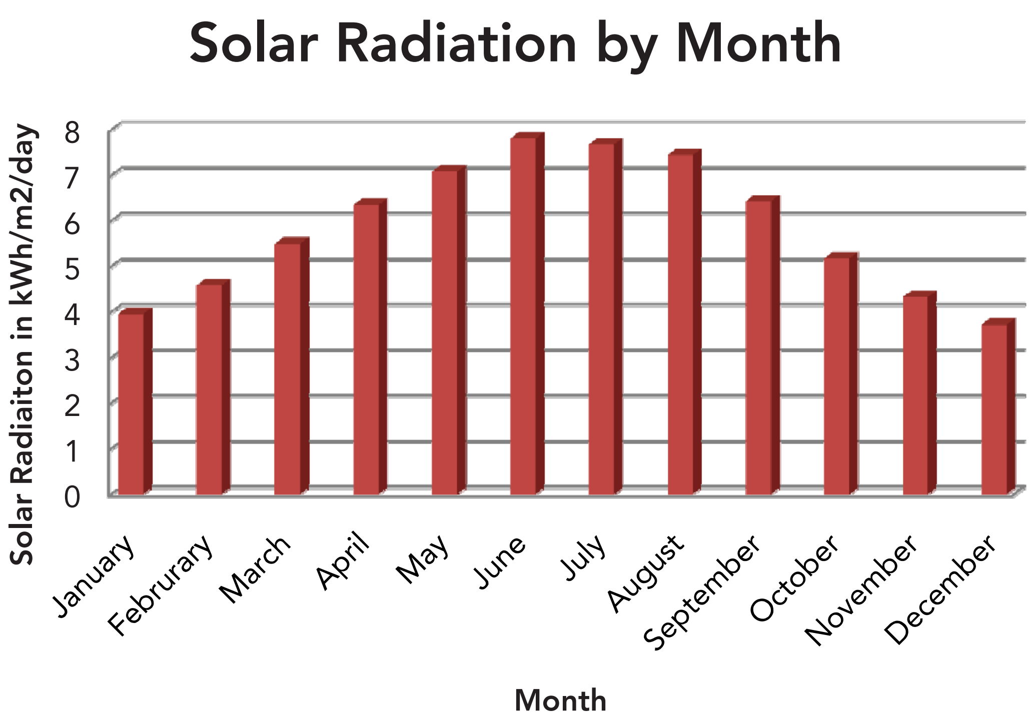


FIGURE 10—SAN BERNARDINO AVAILABLE AVERAGE SOLAR RADIATION IN $KWH/M^2/DAY$



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)		
		Residential	Non-Residential		Residential	Non-Residential	
			Commercial	Governmental / Non-Profit		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.

Solar Water Heating

Buildings

Solar water heating systems for buildings have two main parts: (1) a solar collector and (2) a storage tank. The most common collector used in solar hot water systems is the flat plate collector.

Solar water heaters use the sun to heat either water or a heat-transfer fluid in the collector. Heated water is then held in the storage tank ready for use, with a conventional system providing additional heating as necessary. The tank can be a modified standard water heater, but it is usually larger and very well insulated. Solar water heating systems can be either active or passive, but the most common are active systems.

Active Solar

Active solar water heaters rely on electric pumps, and controllers to circulate water, or other heat-transfer fluids through the collectors.

Passive Solar

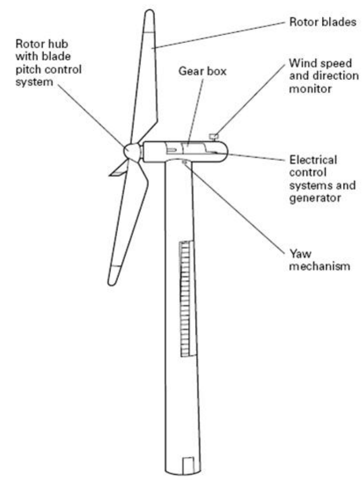
Passive solar water heaters rely on gravity and the tendency for water to naturally circulate as it is heated. Because they contain no electrical components, passive systems are generally more reliable, easier to maintain, and possibly have a longer work life than active systems.

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.

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

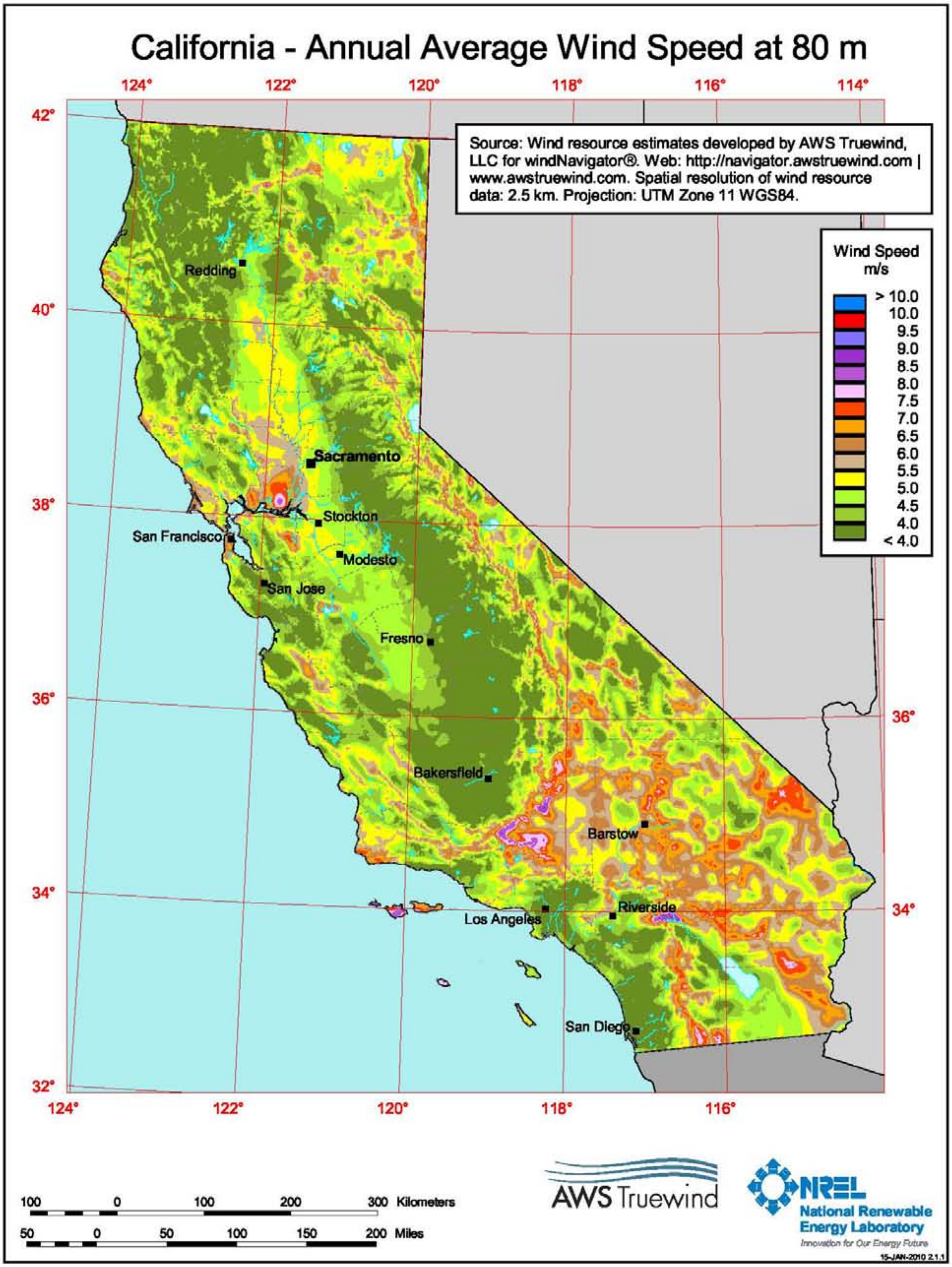


Generally, wind farms are located in areas with good winds and typically have annual capacity factors ranging from 20% to over 40%. A typical life of a wind turbine is 20 years. Maintenance is required at 6-month intervals.

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 California map below indicates that the wind speeds at the campus location (Latitude 34degrees, Longitude 117degrees) fall below 4-5 meters per second or Class 2 and below. Thus a wind turbine in a 4-5meter/sec 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 2-3cents/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—CALIFORNIA ANNUAL AVERAGE WIND SPEED



Recommendations and Costs

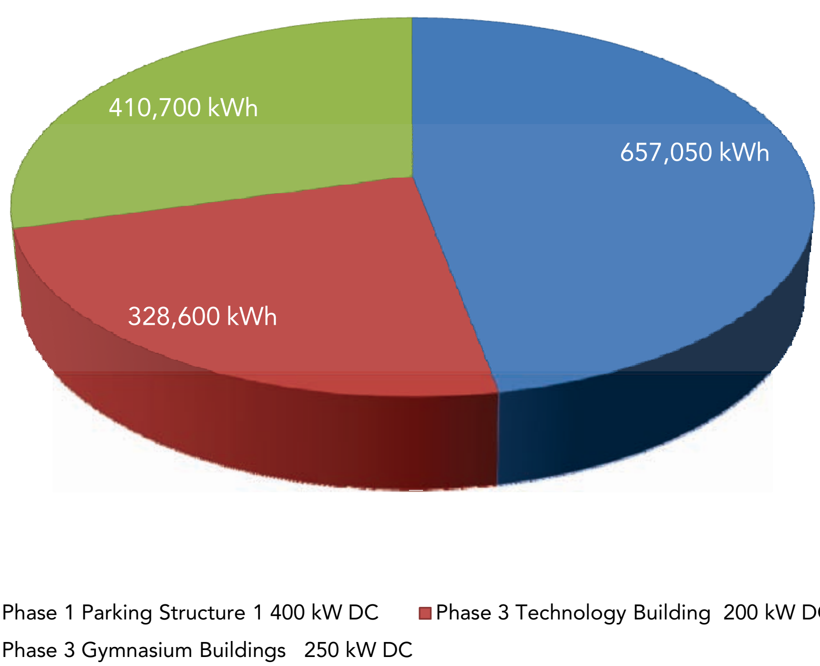
The total electrical consumption of the campus currently stands at 8.4 million kWh per year with a peak demand of 2.37 MW.

We recommend that the campus install photovoltaic power systems on the roofs of new buildings and proposed parking structures to limit dependence on non-renewable power sources, reduce greenhouse gas emissions and eliminate the impact of fluctuation of energy prices in the future. The new PV systems can be installed in phases. Phase 1 would include 400 kW (DC) of PV power. Phase 3 would include an additional 450 kW (DC) of PV power.

Phase 1	Parking Structure 1	400 kW (DC)
	Total	**400 kW (DC)**
Phase 3	Gymnasium Buildings	250 kW (DC)
	Technology Building	200 kW (DC)
	Total	**450 kW (DC)**

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

FIGURE 13—PV ENERGY PRODUCTION BY LOCATION



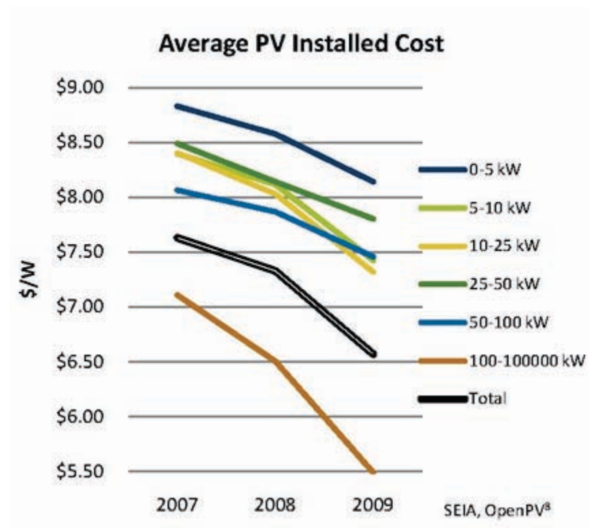
A photovoltaic system requires approximately 90 -115 ft^2 of footprint area per installed kW DC. In addition, this area should be free from solar shading from other buildings, trees, light poles, or other structures. Thus rooftops and parking lots are the preferred PV locations.

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.

PV 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 18 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.

PHASE 1 COSTS

Proposed Location	PV Capacity in kW	Unit Cost in $/watt	Total Costs
Parking Structure 1	400KW	$8/watt	$3,200,000*
Total Costs			$3,200,000

PHASE 3 COSTS

Proposed Location	PV Capacity in kW	Unit Cost in $/watt	Total Costs
Gymnasiums 1 and 2	250KW	$5/watt	$1,250,000
Technical Building	200kW	$5/watt	$1,000,000
Total Costs			$2,250,000

* Included in Parking Structure budget.

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	3,285,500	$0.19	$624,245
Total Incentives			$624,245

PHASE 3 INCENTIVES

Proposed Location	kWh for First 5 Yrs	Incentive $/kWh	Total Incentive
Gymnasiums 1 and 2	2,056,250	$0.19	$390,688
Technical Building	1,645,000	$0.19	$312,550
Total Incentives			$703,238

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 tak advantage of the 30% renewable energy federal tax credits.

Phase 1 PV resulted in a payback of 25 years
Phase 3 PV resulted in a payback of 17 years

Appendix A—Existing Conditions

Bldg	Conditioned Area (ft²)	Lighting Watts	Heating	MBtuh	Cooling	Tons	DHW
AD/SS T24	26,016	27,351	Central	1244.8	Central	120	4.5kW TL; 130MBH, 34 gal
ART T24L	16,638	14,719	Central	795	Central	75	6kW 20 gal;150MBH 100 gal
AUD	30,000	33,000	Boilers	950	Central	84	
CC T24L	30,800	29,073	RTU gas	2,537	RTU	130	4.5 kW, 65 gal, 500MBH, 220 gal
HLS T24L	37,685	45,878	RTU gas	3,294	RTU	201	100 MBH, 50 gal
LA DWG	28,000	36,400	Boiler	1,600	Chiller	119	40MBH, 50 gal
LIB T24	36,700	42,598	RTU gas	2,838	RTU	150	85MBH, 50gal
PL DWG	6,300	8,190	Electric	300	DX	25	9kW, 30 gal
T DWG	47,800	62,140					
Totals	259,939	299349		13,559		904	

Administration and Student Services (AD/SS)

Administration and Student Services Building is a two story building and is used for student services and administration. AD/SS has 26,016 ft^2 of conditioned floor area. The building has insulated corrugated sheet metal envelope with standing seam sheet metal sloped roof. Most of the occupancies are used for office activities. Building is seven years old.

Mechanical

<u>Cooling</u>: Thirty seven fan coils with chilled water cooling coils are used to provide cooling for AD/SS Building. Chilled water cooling coils are controlled by two-way control valves. Total installed cooling capacity is approximately 120 tons. Building AD/SS is supplied with chilled water from stand alone Central Plant.

<u>Heating</u>: Thirty seven 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 two way control valves. Total installed heating capacity is approximately 1244.8 MBH. Building AD/SS is supplied with heating hot water from stand alone Central Plant.

<u>Ventilation</u>: Outside air is provided to indoor spaces through exterior louvers installed on return ducts of fan coils. All fan coils operate during occupied hours on thermostat control settings. The south east building has air design issues, resulting in higher temperatures on the western facade office desks, which also have higher fenestration. The return air is collected from office desks and the supply air does not make its way in adequate quantities, with thermostat being on the eastern offices. Fan coils are approximately seven years old. According to ASHRAE, typical service life for this type of equipment is 20 years.

<u>List of Major Mechanical Equipment</u>

- Fan Coils (37)
- Exhaust fans (8) for Restrooms and Motor Room (about 13 years life remaining).

Administration and Student Services (AD/SS) (cont.)

Central Plant

Central Plant provides chilled and heating hot water to Administration and Student Services Building as well as to Art Center and Gallery Building.

- Chillers: 8x Clima Cool multistack chillers with EER=15.2. Total capacity is 232 tons.
- Cooling Towers: 1x500 gpm, 92/82 °F cooling tower and 1x256 gpm , 92/82 °F cooling tower. Cooling towers are provided with VFDs on the fans.
- Boilers: 1x 1500 MBH input/1275 MBH output Camus boiler and 1x 1000 MBH input/880 MBH output Lochinvar boiler. Lochinvar boiler is non operational.
- Pumps:

  Chilled water pump:

    Primary chilled water pump: 1x235 gpm at 15 ft and 141 gpm at 20 ft (about 8 years life remaining).

    Secondary chilled water pump: 1x600 gpm at 116 ft, with NEMA premium efficiency motor and VFD.

  Hot water pump: 1x100 gpm at 102 ft and 1x150 gpm at 102 ft (about 8 years life remaining).

  Condenser water pump: 1x430 gpm at 45 ft and 1x258 gpm at 45 ft (about 8 years life remaining).

  Cooling tower cleaning system 3HP, 81.5% efficient pump.

  Those cooling and heating plants were installed in 2004. The American Society of Heating, Refrigerating, and Air-Conditioning Engineers, (ASHRAE), suggests, with good and frequent service and maintenance repairs, a service life of approximatelly 20 years for this types of cooling and heating equipment, which equates to about 13 years of life remaining for those cooling and heating plant.

  Plumbing:

  Domestic hot water is heated by one 4.5kW tankless electric heater and one 130 MBH, 34 gallons tank gas water heater.

  Hot water heaters were installed in 2004. According to California Energy Commission the average life expectancy of a tank water heater is 13 years , and for tankless water heater is 20 years, which equates to about 6 and 13 years of life remaining accordingly for tank and tankless water heater.

Administration and Student Services (AD/SS) (cont.)

Lighting

Majority of building has fluorescent lighting with T8 lamps of 1st generation (32W). 22,355 Watts of fluorescent light fixtures are installed in the envelope. There are 715 Watts of fluorescent downlights in the building and 270 watts of strip fluorescent 28W T5 fixtures.

- 450 watts of recessed incandescent lamps were found operational in the envelope.
- There are pendant metal halide 175 Watt fixtures with total installed lighting of 5125 watts.

Controls

- Fan coils are operating all the times during occupied hours, either in heating or cooling mode. Lighting is on during occupied hours with no lighting controls in the building.
- Air temperature in the building is controlled by fan coil temperature sensors. Fan coils are controlled by thermostats, which were found locked with passwords protection.

Baseline Energy Consumption Observations

Exhaust fans are found operational round the clock.

Ventilation, Lighting, Cooling, Heating needs to be provided only during scheduled business hours of the building.

Other Observations

<u>Schedule</u>: Business requirement of the building is from 6:00 am to 6:00 pm, Monday through Friday. Custodians operate in the envelope from 6:00 pm to 02:00 am, Monday through Friday. Building has no week end utilization.

Building mechanical systems and lights are reported as power consuming during 6:00 PM to 2:00 AM for custodians.

All appliances (printers, monitors, microwaves) were not found to have EnrgyStar logo on them.

Art Center and Gallery Building (ART)

Art Center and Gallery Building is a single story building and it is used for art classrooms, laboratories, gallery and working studio spaces. ART Building has 16,638 ft^2 of conditioned floor area and has standing seam sheet metal sloped roof. Building is six years old.

Mechanical

Cooling: Twenty chilled water/heating hot water fan coils is used to provide cooling for ART Building. Chilled water cooling coils are controlled by two-way control valves. Total installed cooling capacity is approximately 75 tons. ART building is supplied with chilled water from stand alone Central Plant. Telecommunication and Electrical Room are served by DX system with two fan coils and two outside condensing units.

Heating: Twenty fan coils are provided with heating hot water coils which provide heating to building conditioned space during winter. Heating hot water coils of fan coils are controlled by two way control valves. Total installed heating capacity is approximately 795 MBH. ART Buildings is supplied with heating hot water from stand alone Central Plant. Additionally, Telecommunication Room DX system fan coil servers as a heat pump as well.

Ventilation: Outside air is provided to indoor spaces through exterior louvers installed on return ducts of fan coils. All fan coils operate during occupied hours on thermostat control settings. Fan coils are approximately seven years old. According to ASHRAE, typical service life for this type of equipment is 20 years.

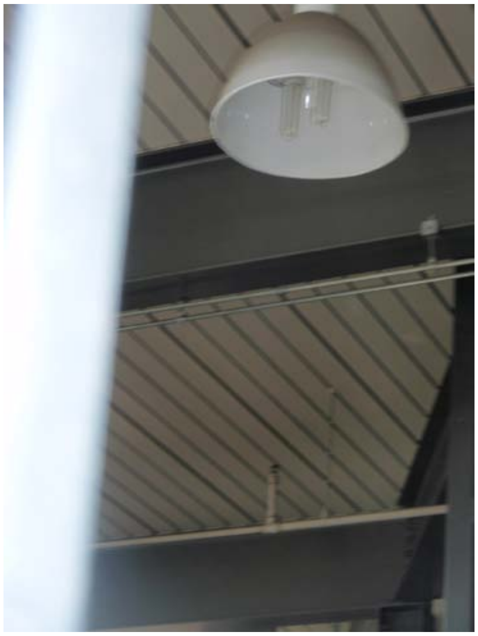
List of Major Mechanical Equipment

- Fan coils (20)
- Condensing units (2) (about 8 years life remaining).
- Exhaust fans (5) for Restrooms and Glass Blowing Studios (about 8 years life remaining).

Lighting

- Major spaces are lit by fluorescent first generationT8 (32W) fixtures. Installed lights have 3887 watts on 4' fluorescent lights.
- There are pendant and down lights with CFL (Compact Fluorescent Lamps). 6760 Watts of CFLs are reported on this building.
- There are dimmable CFLs of 2058 watts in this building.

Art Center and Gallery Building (ART) (cont.)



- There are 650 Watts of incandescent down lights in this building
- Total installed lighting on the building is 14719 watts.

Plumbing

Domestic hot water is heated by

- One 6kW, 20 gallons tank electric water heater, and
- One 150,000 BTUH, 100 gallons tank gas water heater with hot water circulation pump.

Hot water heaters were installed in 2004. According to California Energy Commission the average life expectancy of a tank water heater is 13 years , and for tankless water heater is 20 years, which equates to about 6 and 13 years of life remaining accordingly for tank and tankless water heater.

Controls

- Fan coils are operating all the times during occupied hours, either in heating or cooling mode on thermostat settings.
- Air temperature in envelope is controlled by fan coil temperature sensors and thermostats.
- All fan coils, exhaust fans and associated points are connected to campus wide network via the ALC control panel, located in electrical room.
- Lighting loads are connected to occupancy sensor relays.

Baseline Energy Consumption Observations

Ventilation, Lighting, Cooling, Heating needs to be provided only during scheduled business hours of the building. Mechanical systems and lighting were reported as energy consuming from 6:00 PM to 2:00 AM for custodians. Custodians have control to turn lights on/off during their hours of need.

Other Observations

Art building has gas furnace facility, which operates for 13 weeks in a year.

Auditorium (AUD)

Auditorium Building is a multiple story building, and serves as an auditorium building. AUD building has approximately 26,200 ft^2 of conditioned floor area. There are two mechanical rooms in the basement of the building. In one there is air handling unit and in another is boiler. Building is 35 years old and has slopped attic type tiled roof.

Mechanical

Cooling: Chilled water is supplied from chiller located in North Hall building. Chilled water is provided to AHU coil (54 tons cooling capacity). Chilled water is also provided to six fan coils which total capacity is approximate 30 tons. Actual total installed capacity capacity of the building is 84 tons. There is one split system and one window air conditioner serving offices of instructors.

Heating: Auditorium Building has 1,260 MBH input (1,080 MHB Parker steam boiler). The boiler provides steam to air handling unit coil (697 MBH) and six convectors. One fan coil is provided with 2kW electric heater.

Ventilation: Outside air is provided through air handling unit. Energy Labs air handling unit and Parker steam boiler were installed in 2003. ASHRAE suggests, with good and frequent service and maintenance repairs, a service life of approximately 20 years for these types of cooling and heating equipment, which equates to about 13 years of life remaining for these equipment.

List of Major Mechanical Equipment

- Energy Labs manufactured air handling unit(1)
- Fan coils (6),
- Steam boiler (1) (about 13 years life remaining),
- Steam radiators (4),

Auditorium (AUD) (cont.)

- Convectors (3)

Lighting

- Spaces are lit by compact fluorescent PL (42W) fixtures. Installed lights have 2,016 watts.
- There are dimmable down halogen light of 11,600 watts in this building.
- There are 3,628 Watts of incandescent lights in this building. Some of them are dimmable.
- Total installed lighting on the building is 14,504 watts.

Plumbing

- The building has bisexual restroom with one water closet and one flushed male urinal.
- A 4 kW electric water heater (instantaneous type) is installed below the sink in the restroom.
- Water fountains were found operational in this building.

Controls

- Air handling unit (AHU) is operating all the times during occupied hours, either in heating or cooling mode. AHU is connected to central control system via the ALC controller.
- Air temperature in envelope is controlled by AHU's temperature sensors and thermostats. Convection heaters are also controlled by thermostats.
- There is lighting control panel for lights in theater.

Baseline Energy Consumption Observations

Ventilation, Lighting, Cooling, Heating needs to be provided only during scheduled business hours of the building. This building has occupancies which have high diversity factor for utilization.

Other Observations

Windows at Auditorium building, mostly on eastern facade, are single clear with wooden frame and are in poor conditions.

Campus Center (CC)

Campus Center (CC) Building is a two story building and it is used for offices, bookstore, dinning and kitchen spaces (Culinary & for students). Campus Center Building has 30,800 ft^2 of conditioned floor area. Building is six years old.

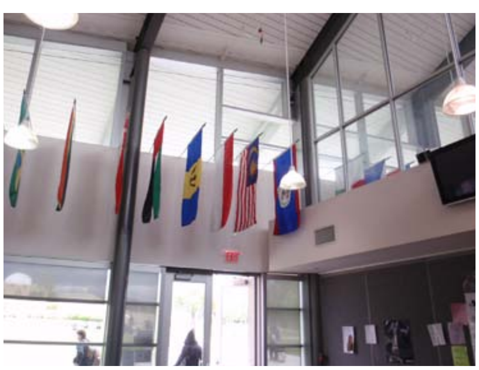
Mechanical

Cooling: Campus Center building has installed cooling coil capacity of approximately 130 tons. There are sixteen Trane rooftop DX (Direct Expansion)/Gas heating packaged units (capacity from 3 to 12.5 tons and EER 11.3-12.5). The building is also served by one 2 tons Carrier split system with outside condensing unit, one 1.5 tons Carrier heat pump with outside condensing unit, and seven Logic Air make-up air units with evaporative cooling which serve kitchen area. Make-up in summer months creates a higher than normal space temperature in kitchen areas. Kitchen areas are not designed to have conditioned air. The walk in coolers and freezers in the kitchen have the air cooled condensing unit on the roof. Cooling capacity of 30 Tons is approximated from drawings.

Heating: Campus Center Building has installed heating coil capacity of approximately of 2,537 MBH. Sixteen Trane roof top units are equipped with 81% Annual Fuel Utilization Efficiency (AFUE) gas heating coils. Seven each of make-up air units (manufactured by HUNTAIR) with exhaust fan are equipped with 80% efficient gas heating coils. There is one 17.6 MBH Carrier heat pump unit.

Ventilation: Outside air is provided by supply air from rooftop packaged units and by make-up air units. Rooftop packaged units are provided with variable air volume (VAV) boxes with bypass damper. Rooftop equipment DX equipment are 6 years old. ASHRAE suggests a useful life of 15 years for this type of air cooled DX equipment, which would yield over 9 years of life remaining.

Campus Center (CC) (cont.)



<u>List of Major Mechanical Equipment</u>

- Trane rooftop packaged units (17),
- Logic Air make-up units (7) (about 9 years life remaining),
- Exhaust fans (5) (about 13 years life remaining),
- Gravity intake ventilator (1) (about 13 years life remaining),
- Split system condensing units (2) (about 9 years life remaining),
- Split system fan coils units (2) (about 9 years life remaining).

Lighting

- Spaces are lit by fluorescent T8 (32W) fixtures. Installed lights have 12,352 watts.
- There are metal halide lights of 11,375 watts in this building.
- There are 3,898 Watts of other fluorescent lights in this building.
- There are 1,450 watts of incandescent lights in this building.
- Total installed lighting on the building is 29,073 watts.
- There is a lighting control panel with global north photo cell wired in to this panel. Override switches for custodians are wired in to this electrical panel.

Plumbing

Domestic hot water is heated by one 4.5kW, 65 gallons tank electric water heater and one 500,000 BTUH, 220 gallons tank gas water heater. There are two hot water circulation pumps.

There is one each male and female restroom with water closets, lavatories and male urinals as plumbing fixtures equipped in the restrooms. Male Urinals are water consuming components.

Hot water heaters were installed in 2004. According to California Energy Commission the average life expectancy of a tank water heater is 13 years, which equates to about 6 years of life remaining for tank water heaters.

Campus Center (CC) (cont.)

Controls

- Rooftop units are operating all the times during occupied hours, either in heating or cooling mode based on thermostat settings.
- Metal Halide Lights in the building are operated on time clocks.
- Most of the lights are operated on clock schedule. There is a lighting control panel for this building and lighting loads are connected to occupancy sensors.
- All the roof top units, split system condensing units, exhaust fans and thermostats are wired in to the campus wide control network via the ALC controller, located in the electrical room.

Baseline Energy Consumption Observations

Daylight harvesting controls should be deployed using dimming ballasts on metal halide.

The kitchen hoods are operated all the times irrespective of cooking activities.

Other Observations

Temperature in the kitchen spaces are outside comfort zone for summer months.

Health and Life Science (HLS) Building

Health and Life Science Building is a two story building and its usage range from offices and classroom to lab spaces. Health and Life Science Building has 37,685 ft^2 of conditioned floor area. HLS building is eight years old.

Mechanical

Cooling: Health and Life Science Building has installed cooling coil capacity of approximately 201 tons. There are thirty-four Trane DX/Gas heating packaged units (capacity from 2 to 12 tons and EER 10.5-11.2), two split system with two outside condensing units, and one heat pump with outside condensing unit.

Heating: Health and Science Building has installed heating coil capacity of approximately 3,294 MBH. Thirty-four Carrier roof top units are equipped with 81-82% AFUE gas heating coils. Additionally, there is one 17.6 MBH heat pump unit.

Ventilation: Outside air is provided by supply air from rooftop packaged units. Eight of rooftop packaged units are provided with variable air volume (VAV) boxes with bypass damper. This building's rooftop DX equipment appears to have about 7 years of life remaining.

List of Major Mechanical Equipment

- Carrier rooftop packaged units (34),
- Exhaust fans (17) (about 13 years life remaining),
- Split system condensing units (2) (about 7 years life remaining),
- Split system fan coils units (2) (about 7 years life remaining).

Health and Life Science (HLS) Building (cont.)

Lighting

- Major spaces are lit by fluorescent first generationT8 (32W) fixtures. Installed lights have 22,176 watts on 4' fluorescent lights.
- There are pendant and down lights with CFL (Compact Fluorescent Lamps). 6760 Watts of CFLs are reported on this building.
- There are dimmable CFLs of 2058 watts in this building.
- There are 1,500 Watts of incandescent down lights in this building
- Total installed lighting on the building is 45,878 watts. There is a lighting control panel with global north photo cell wired in to this panel. Override switches for custodians are wired in to this electrical panel

Plumbing

Domestic hot water is heated by 100,000 BTUH, 50 gallons tank gas water heater. There is hot water circulation pump.

The building has male and female rest rooms, and lab sinks as DHW consuming components. Water closets and lavatories are part of rest rooms with male urinals in men's restroom having flushing urinal fixtures.

Controls

- Rooftop units are operating all the times during occupied hours, either in heating or cooling mode with thermostat settings.
- Air temperature in the building is controlled by rooftop temperature sensors. Rooftops are controlled by thermostats.
- Most of the lights are operated on clock schedule. There is a lighting control panel for this building and lighting loads are connected to occupancy sensors.

Other Observations

The labs have odor issue when in session. The air distribution and exhaust system components need relocation.

There is potential for MBCx on this building due to higher variation in utilization of labs and classrooms.

Liberal Arts (LA)

Liberal Arts Building is a two story building and is used mainly for classrooms and lecture rooms. Liberal Arts Building has approximately 28,000 ft^2 of conditioned floor area and the structure is approximately 40 years old. The building appears to have retrofitted for mechanical and lighting systems.

Mechanical

Cooling: Liberal Arts Building is cooled by supplied chiller water from 120 tons McQuay turbo-core chiller, which has performance issues. Chiller was installed in 2006 and if operated correctly appears to have 18 years of life remaining. There are two Trane air handling units (77 tons and 42 tons) with cooling coils (controlled by three-way valves) that date back to 1969 that appear to be in poor condition and in need of replacement. The American Society of Heating, Refrigeration and Air-Conditioning Engineers (ASHRAE) suggests, with good and frequent service and maintenance repairs, a service life of approximately 20-25 years for this type of equipment. The air handlers are well beyond their life span and are in need of replacement for performance and energy efficiency purposes. Total installed cooling capacity is approximately 119 tons. Existing cooling tower was installed in 2000 and appears to have about 10 years life remaining.

Heating: Liberal Arts Building has one 2,000MBH input/1,600MBH output, 80% efficient Ajax heating hot water boiler which serves preheating coil in one of the air handling units and zone terminal reheat coils in the building. Control on the air handling unit heating hot water coil is provided by low ambient three-way bypass valve. Two-way terminal reheat coils control valves at the zones are controlled by thermostats located in the zones. Existing boiler appear to be in good condition and have about 13 years of life remaining.

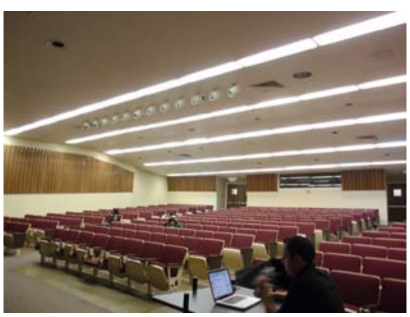
Ventilation: Outside air is provided to indoor spaces through economizer on the air handling units. Both air handling units are equipped with return fans.

List of Major Mechanical Equipment

- Chiller: 120 tons McQuay VFD turbo core chiller (1),
- Cooling Tower: 360 GPM, 95/85oF BAC cooling tower (1),
- Air handling units:

  Trane AHU 77 tons, approximately 1,700 MBH heating hot water coil capacity, and 20 HP motor,

Liberal Arts (LA) (cont.)



Trane AHU 42 tons and 10 HP motor,

- Boiler: 1x2,000 input/1,600MBH output, 80% efficient Ajax Boiler Co. heating hot water boiler (1),
- Pumps:

  Chilled water pump: 1x288 gpm at 53 ft with NEMA premium efficiency motor,

  Heating hot water pump: 1x170 gpm at 80 ft??

  Condenser water pump: 1x360 gpm at 40 ft and 1x258 gpm at 45 ft with NEMA premium efficiency motor,
- Exhaust fan (5).

Lighting

- The building occupancies are lit 2x4 florescent fixtures with 1st generation T-8 lamps. Each fixture has 3 lamps. These fixtures are flush mount. The building hallways and non class room occupancies have pendant style two lamp fixtures.
- There are incandescent lights in the open air shell, which appeared to be replaced with CFLs.
- There are incandescent down lights in many parts of the buildings with on/off switches.
- Total installed lighting of the building is estimated at 34,000 watts, in absence of drawings.
- Override switches for custodians were found on both the floors of the building.
- Occupancy sensors were verified to be operational turning off the lighting loads in instructor's offices and other office occupancies. Some task lights were observed to be of incandescent type in instructor's offices.

Plumbing

Domestic hot water is heated by 40,000 BTUH, 50 gallons tank gas water heater. There is hot water circulation pump. Gas water heater appears to have about 8 years of life remaining.

The restrooms for men and women are the consumers of DHW and cold water. Restrooms are equipped with water closets, lavatories, and automatic flushing urinals in men's restrooms.

Controls

- Air handling units are operating all the times during occupied hours.
- Chiller and Boilers come on and off automatically to meet the supply air temperature requirements. Air is reheated at VAV boxes and reheat is controlled by thermostat also.
- Chiller, Air Handlers and exhaust fans are tied in the campus wide network through the ALC controller in the building.
- The control action is conveyed by pneumatic signal of compressed air.

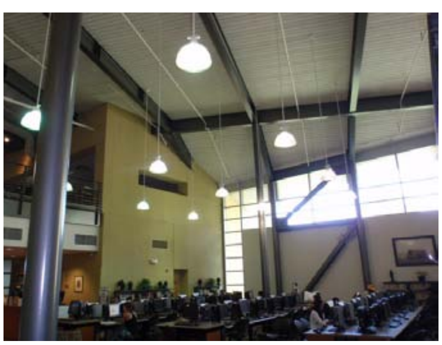
Baseline Energy Consumption Observations

Ventilation, Lighting, Cooling, Heating needs to be provided only during scheduled business hours of the building. MBCx has a great potential in this building. The large lecture hall was found open all the times during both the site visits with no scheduled classes. Lighting and air conditioning energy consuming components were on both the times. Classrooms were also observed to be not in session with air conditioning and lighting loads to be operational.

Other Observations

Three vending machines are operating in the conditioned envelop of this building. One vending machine on first floor does have SCE energy miser controls installed on it.

Library (LIB) Building



Library Building is a two story building and is mainly used as library, study area, and computer lab. Library Building has 36,700 ft^2 of conditioned floor area. Building LIB is approximately seven years old.

Mechanical

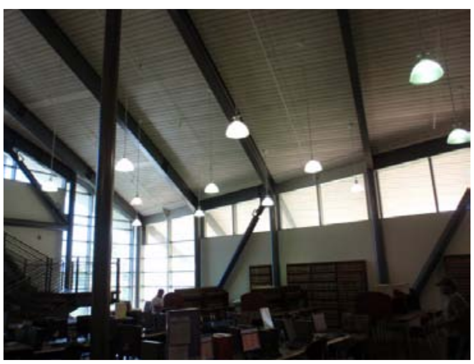
Cooling: Library Building has installed cooling coli capacity of approximately 150 tons. There are seventeen Trane DX/Gas heating rooftop packaged units (capacity from 2 ton to 42, EER 10-13), and one split system with outside condensing unit.

Heating: Library Building has installed heating coil capacity of approximately 1,466 MBH. Seventeen Carrier roof top units are equipped with 80% AFUE gas heating coils.

Ventilation: Outside air is provided by supply air from rooftop packaged units. Rooftop packaged units are provided with zone and bypass dampers. This building's rooftop DX equipment appears to have about 8 years of life remaining.

List of Major Mechanical Equipment

- Carrier rooftop packaged units (17),
- Exhaust fans (5) (about 13 years life remaining),
- Split system condensing units (1) (about 8 years life remaining),
- Split system fan coils units (1) (about 8 years life remaining).



Lighting

- Building has fluorescent lighting with T8 lamps of 1st generation (32W). 24,851 Watts of T8 fluorescent light fixtures are installed in the envelope. There are 3,776 Watts of fluorescent downlights in the building.
- 1,100 watts of recessed incandescent lamps were found operational in the envelope.
- There are pendant metal halide 175 Watt fixtures with total installed lighting of 6,125 watts.
- Total installed lighting on the building is 42,598 watts.
- The building has lighting control relay panel in the electrical room, with override switches and global north photo sensor mounted on roof.

Plumbing

Domestic hot water is heated by 85,000 BTUH, 50 gallons tank gas water heater. There is hot water circulation pump. Gas water heater appears to have about 6 years of life remaining.

The restrooms for men and women are the consumers of DHW and cold water. Restrooms are equipped with water closets, lavatories, and automatic flushing Urinals in men’s restrooms.

Library (LIB) Building (cont.)

Controls

- Rooftop units are operating all the times during occupied hours, either in heating or cooling mode based on thermostat settings.
- Most of the lights are operated on clock schedule. There is a lighting control panel for this building and lighting loads are connected to occupancy sensors.
- All the roof top units, split system condensing units, exhaust fans and thermostats are wired in to the campus wide control network via the ALC controller, located in the electrical room.

Baseline Energy Consumption Observations

Ventilation, Lighting, Cooling, Heating needs to be provided only during scheduled business hours of the building.

Other Observations

Schedule: Business requirement of the building is from 7:00 am to 6:00 pm, Monday through Friday. Custodians operate in the envelope from 6:00 pm to 02:00 am, Monday through Friday. Building has no week end utilization and the am utilization of the building systems is scheduled at 6:00 AM.

Building mechanical systems and lights are reported as power consuming during 6:00 PM to 2:00 PM for custodians.

All appliances (Printers, monitors, microwaves) were not found to have energystar logo on them.

Planetarium (PL) Building

Planetarium Building is a two storey building. Planetarium Building has approximately 6,300 ft^2 of conditioned floor area. Building is approximately thirty-five years old and appears to have retrofitted for mechanical and lighting in past.

Mechanical

<u>Cooling</u>: Planetarium Building is cooled by supplied chiller water from 25 tons Carrier air cooled chiller. There is a multi-zone Trane air handler unit serving six zones with electric heating that appears to be original and date back to 1976. The air handler is well beyond its ASHRAE recommended life span of 20-25 years and in need of replacement for performance and energy efficiency. The chiller has approximately eight years of life remaining.

<u>Heating</u>: There are six electric duct heaters, one each for one zone. Total installed electric heaters capacity is 300 MBH. The electric heating is very energy efficient. There is no gas connection to this building.

Ventilation: Outside air is provided to indoor spaces through multi zone air handling unit.

<u>List of Major Mechanical Equipment</u>

- Chiller: 25 tons Carrier air cooled chiller (1),
- Trane multi zone air handling unit (1),
- Pumps:

  Chilled water pump: 1x40 gpm at 40 ft.
- Exhaust fan (2).

Planetarium (PL) Building (cont.)

Lighting

The building spaces are lit by fluorescent lighting fixtures. There are few instances of incandescent light fixtures, but they do not have significant utilization.

Approximately 7,560 watts of interior lighting is installed in the building.

Occupancy sensors were found installed, but the lighting circuits do not seem to be connected via relays to the occupancy sensors.

Plumbing

There is no active plumbing system in the building. DHW heater is installed, but decommissioned.

Controls

- Air temperature in zones is controlled by temperature sensors.
- Lighting controls are through on/off switches.
- This building does not have connection to the campus wide network.
- The control signals are pneumatic and air compressor serves the needs for compressed air. The controls are localized via a local controller.
- Exterior lights were found be on timer circuits.

Baseline Energy Consumption Observations

Ventilation, Lighting, Cooling, Heating needs to be provided only during scheduled business hours of the building. Since this building relies on thermostats and on/off switches, there appears a good opportunity for MBCx.

Other Observations

Two of the first floor zones have no occupancy, most of times, and the air conditioning to these spaces can be turned off most of times.

Technical Building (T)

Technical Building is a one story building. Technical Building has approximately 47,800 ft^2 floor area. Technical Building is approximately forty-five years old.

Mechanical

<u>Cooling</u>: There is one multi zone air handling unit with 42 ton DX cooling coils and 700MBH gas heating coil. DX coil is served by three 14 tons Carrier air cooled condensing units. There are also three 7.5 tons electric cooling, 125MBH input/102MBH output gas heating Carrier roof top packaged unit with EER (Energy Efficiency Ratio)=10. There is one 3.5 tons electric cooling, 60MBH input/ 48.6MBH output gas heating Carrier root top packaged unit with SEER=10, and there is one 5 tons electric cooling, 80MBH input/ 64.8MBH output gas heating Carrier root top packaged unit with SEER=10.

<u>Heating</u>: There are 125MBH input/102MBH output gas heating Carrier roof top packaged unit, 60MBH input/ 48.6MBH output gas heating Carrier root top packaged, and 80MBH input/ 64.8MBH output gas heating Carrier root top packaged unit.

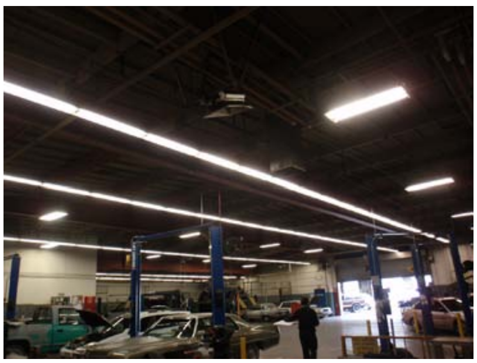
There are radiant heaters, suspended unit heaters, and make-up air suspended unit heaters installed in the Technical building.

Ventilation: Outside air is provided to indoor spaces through multi zone air handling units. Shop area of the building is designed for heating only and has swamp coolers on roof.

<u>List of Major Mechanical Equipment</u>

- Condensing Units 14 Tons (3)
- Condensing Units 7.5 Tons (3)
- Air Handling Unit(2)
- Air compressor (1)
- Swamp Coolers (18)
- Roof top Units (2)
- Exhaust Fans (7)

Technical Building (T) (cont.)



Lighting

The building spaces are lit by fluorescent lighting fixtures. There are few instances of incandescent light fixtures, but they do not have significant utilization.

Approximately 7560 watts of interior lighting is installed in the building.

Occupancy sensors were found installed, but the lighting circuits do not seem to be connected via relays to the occupancy sensors.

Plumbing

There is no active plumbing system in the building. DHW heater is installed, but decommissioned.

Controls

- Air temperature in zones is controlled by temperature sensors.
- Lighting controls are through on/off switches.
- This building does not have connection to the campus wide network.
- The control signals are pneumatic and air compressor serves the needs for compressed air. The controls are localized via a local controller.
- Exterior lights were found be on timer circuits.

Baseline Energy Consumption Observations

Ventilation, Lighting, Cooling, Heating needs to be provided only during scheduled business hours of the building. Since this building relies on thermostats and on/off switches, there appears a good opportunity for MBCx.

Other Observations

Two of the first floor zones have no occupancy, most of times, and the air conditioning to these spaces can be turned off most of times.

Appendix B—
Energy Efficiency Measures Calculations

TABLE 1 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	9	Auditorium AHU Supply Fan Wheel Retrofit	63,121	15.8		$5,075	$5,075	$8,042	0.0
2	11	Planetarium AHU Supply Fan VFD	10,445	3		$0	$2,507	$1,331	
3	5	Piping Insulation			211	$650	$211	$276	1.6
4	2	Tankless DHW Heaters	29,839	3.4	-	$13,350	$7,161	$3,209	1.9
5	7	Campus Center Heat Pump Water Heater	5,522	1.4		$3,099	$1,325	$704	2.5
6	4	Lighting Retrofits	202,804	50.7		$142,143	$48,673	$26,364	3.5
7	8	Liberal Arts AHU Supply Fan VFDs	12,736	3.2		$9,420	$3,057	$1,623	3.9
8	14	Premium Efficiency Motors	2,643	3.0	-	$2,116	$634	$337	4.4
9	15	Controls Retrofit	58,350	6.7	-	$50,000	$14,004	$7,586	4.7
10	6	Campus Center Kitchen Dishwasher Retrofit	9,772	13.6	1,151	$16,994	$2,419	$2,604	5.6
11	12	High SEER Split Condensing Units	4,625	1.9	-	$11,950	$2,994	$1,462	6.1
12	3	Low Flush Urinals				$44,400	$0	$6,311	7.0
13	10	Planetarium Hydronic System	11,570	5.8	(494)	$10,926	$2,777	$1,074	7.6
14	13	Monitoring-Based Commissioning	254,000	29.0	-	$450,000	$60,960	$33,020	11.8
Totals			852,250	316	3,438	$2,381,074	$207,978	$194,225	

TABLE 2 SAVINGS IN PERCENTAGE OF BASELINE ENERGY CONSUMPTION

#	Parameter	Value	Units	% of Baseline
1	Σ Savings from ECMs without TES & CP	665,427	kWh/Yr	7.8%
2	Σ Savings With TES and Central Plant	1,625,465	kWh/Yr	19.2%
3	Baseline Energy Consumption	8,487,289	kWh/Yr	100%
4	Central Plant Savings	960,038	kWh/Yr	11.3%

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

EEM 01—
Central Plant with TES (Thermal Energy Storage)

Currently there are several buildings with roof top units (RTUs) for SBVC campus. There are few buildings, which are served by modular stacked chillers. A central plant four pipe systems is desired by SBCCD at SBVC. This EEM quantifies the savings for central plant on cooling side with thermal energy storage. No efficiency improvement on heating side is expected and/or calculated from the proposed central boiler installation. Energy consumption is reduced for improved efficiency of central plants and cost savings are realized by load shifting from peak load to off peak.

This analysis is done for peak load and is hence limited at 1,600 hrs/yr of annual cooling operations. These 1,600 hours include 480 hrs/yr for 16 weeks of summer peak energy consumption. Operational efficiency of new central chiller plant at standard conditions (95˚F condenser temperature) is designed at 0.55 kW/ton. With TES, the chiller is expected to operate during non-peak hours. Average nigh temperature is 62˚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 at lower condenser temperatures, they will operate more efficiently than design efficiency of 0.55 kW/ton. For calculation purposes, this is conservatively estimated at 0.5 kW/ton, as outlined in Table-1. Savings for central plant are resulting from improved efficiency compared to current efficiencies of chillers and RTUs, Load shifting energy cost savings, and demand savings for improved energy efficiency. Load shift energy cost savings are the savings from lower cost of energy at night then during peak and mid-peak conditions. Table-1 defines these charges from the utility bills of SBVC.

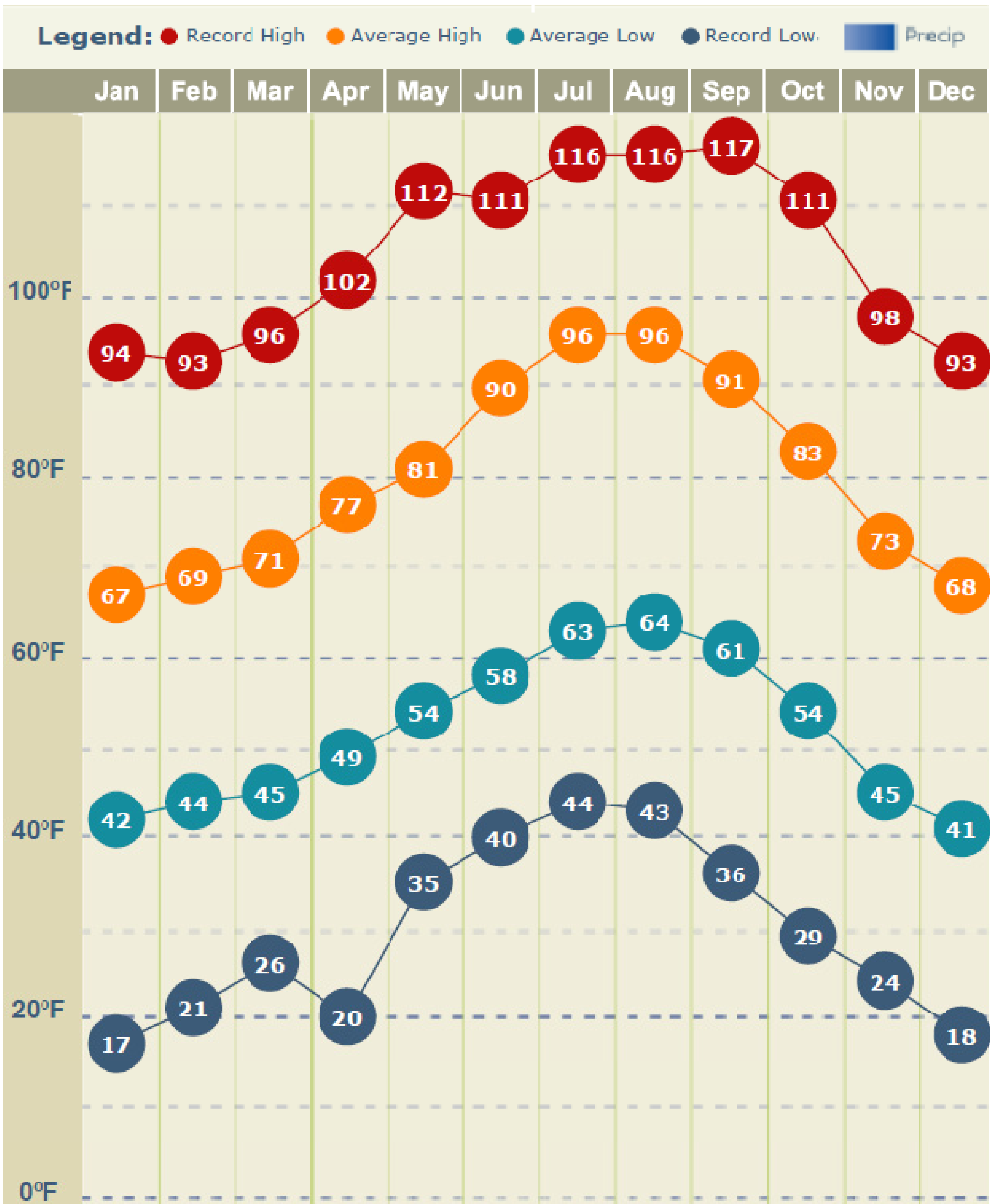
Inputs and Assumptions

The inputs and assumptions in performing calculations for this measure are tabulated below. New buildings are assumed to have 13 SEER or 0.92 kW/Ton for analysis and calculations of savings, which is current Title-24 standard. Roof Top Units on existing buildings are computed to be operating at 1.2 kW/ton.

Savings

Savings for new buildings and existing buildings are summarized in tables of 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 in analysis. New energy consumption is computed at night time operations of chiller at 0.5 kW/ton (0.05 kW/Ton savings, for Night time Operations). Operating chillers at night 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 Consumption kWh/yr (N)' and 'kWh/Yr (N)' respectively. These numbers are used for computing cost savings resulting from differential energy charges from tariff/Utility Bills.

AMBIENT TEMPERATURES FOR SAN BERNARDINO



INPUTS AND ASSUMPTIONS

#	Parameter	Value	Comments
1	Operating Hrs/Yr	1600	Reasonable Assumption for equivalent full load hours (Source: www. energyexperts.org)
2	Peak Load Operating Hrs/Yr	480	16 Summer Weeks*5 days/Week * 6 Peaks Hrs/Day
3	New Central Plant Efficiency	0.6	kW/Ton (0.55 Designed)
4	Baseline Cost of Energy	$0.13	$/kWh, from Utility Bills
5	Peak Summer Demand Cost	$15.45	$/kW, from Utility Bills
6	Peak Summer Energy Surcharge	$0.1005	$/kWh, from Utility Bills
7	Mid Peak Summer Energy Surcharge	$0.0729	$/kWh, from Utility Bills
8	Off Peak Summer Energy Surcharge	$0.0367	$/kWh, from Utility Bills
9	TES Load Shifting Savings	$0.0638	$/kWh (Peak Summer-Off Peak Summer)
10	TES Load Shifting Savings	$0.0362	$/kWh (Mid-Peak Summer-Off Peak Summer)
11	Utility Inflation Rate	4%	Reasonable Assumption
12	CCC-IOU Rebates	0.24	$/kWh
13	Demand Savings Rebate	300	$/kW
14	Plant Efficiency for 80˚F condenser temperature	0.55	kW/Ton (Conservative, for 75-80˚F Condenser Temperatures)
15	Savings in kW/Ton for Night Operations	0.05	Conservative estiamte for 65-70˚F conderser temperatures

CALCULATION OF SAVINGS FOR EXISTING BUILDINGS

Building Phase 1	Tons (E)	kW/ Ton(E)	kW (E)	kW (N)	kWh/Yr (E)	Peak Consumption kWh/Yr (E)	kWh/Yr (N)	Peak Consumption kWh/Yr (N)	Demand Savings (kW)	Demand Cost Savings	Peak Summer Load Shift Savings	Mid Peak Load Shift Savings	Cost of Efficiency Improvement for Night Operations	Rebates for Efficient Night time Operations	TES Savings
Admin/Student Services	69	1.09	76	38	121,091	36,327	61,050	18,315	38	$2,358	$836	$1,107	$396	$733	$4,301
Art & Gallery	75	1.09	82	41	130,909	39,273	66,000	19,800	41	$2,549	$904	$1,197	$428	$792	$4,650
Auditorium	84	0.9	76	46	120,960	36,288	73,920	22,176	29	$2,855	$1,012	$1,341	$479	$887	$5,208
Business	75	1	75	41	120,000	36,000	66,000	19,800	34	$2,549	$904	$1,197	$428	$792	$4,650
Liberal Arts	82	0.9	74	45	118,200	35,460	72,233	21,670	29	$2,790	$989	$1,310	$469	$867	$5,089
North Hall (N)	104	0.92	96	57	153,231	45,969	91,300	27,390	39	$3,526	$1,250	$1,656	$592	$1,096	$6,433
Planetarium	25	1.26	31	14	50,240	15,072	22,000	6,600	18	$850	$301	$399	$143	$264	$1,550
Technical Building (N)	150	0.92	138	83	221,538	66,462	132,000	39,600	56	$5,099	$1,808	$2,394	$856	$1,584	$9,300
Gymnasiums (N)	140	0.92	129	77	207,000	62,100	123,338	37,001	52	$4,764	$1,689	$2,237	$800	$1,480	$8,690
Chemistry & Physical Science (N)	119	0.92	110	65	175,385	52,615	104,500	31,350	44	$4,036	$1,431	$1,895	$678	$1,254	$7,363
Totals	923		887	508	1,418,554	425,566	812,341	243,702	379	$31,377	$11,125	$14,732	$5,269	$9,748	$57,234

Total savings are computed as arithmetic sum of TES Savings and Cost of Efficiency Improvements for Night Operations

TES Savings are savings due to TES (Thermal Energy Storage), which is arithmetic sum of

a) Demand Cost Savings. kW (N) is assumed to be switched to night operations and is turned off during Peak Billing duration for calculations.
b) Peak Summer Load Shift Savings, and
c) Mid Peak Load Shift Savings

CALCULATIONS OF SAVINGS FOR NEW BUILDINGS

Buildings (Future Conversions)	Tons (E)	kW/ Ton (E)	kW (E)	kW (N)	kWh/Yr (E)	Peak Consumption kWh/Yr (E)	kWh/Yr (N)	Peak Consumption kWh/Yr (N)	Demand Savings (kW)	Demand Cost Savings	Peak Summer Load Shift Savings	Mid Peak Load Shift Savings	Cost of Efficiency Improvement for Night Operations	Rebates for Efficient Night time Operations	TES Savings
Health & Life Science	84	1.2	101	46	160,800	48,240	73,700	22,110	54	$2,847	$1,009	$1,337	$478	$884	$5,193
Library	83	1.2	100	46	160,000	48,000	73,333	22,000	54	$2,833	$1,004	$1,330	$476	$880	$5,167
Media	50	1.2	59	27	95,160	28,548	43,615	13,085	32	$1,685	$597	$791	$283	$523	$3,073
Campus Center	72	1.2	87	40	138,800	41,640	63,617	19,085	47	$2,457	$871	$1,154	$413	$763	$4,482
	289		347	159	554,760	166,428	254,265	76,280	188	$9,821	$3,482	$4,611	$1,649	$3,051	$17,914

Energy savings resulting from improved efficiency (kWh/Yr) is reported as 'Energy η savings (kWh/yr)'. This energy savings is computed at blended cost of energy at $ 0.13/kWh, to stay on conservative side. Actual summer cost of electricity is calculated as $ 0.17/kWh and peak summer energy cost is as high as $ 0.24/kWh.

CAPITAL COSTS, SAVINGS, REBATES AND SIMPLE PAYBACKS

Full Build-out

#	Cost Element	Cost	Comments
1	SBVC- TES Tank Costs	$1,269,500	
2	Rebates-Energy Efficiency Savings	$12,799	@$0.24/kWh
3	Net Project Costs	$1,256,701	Cost After Rebates
4	Annual Savings (Calculated)	$82,066.40	=Demand Savings+Load shift Savings+Night Operations Efficiency Savings
5	Simple Payback	15.3	Years

Phase 1 Buildings

#	Cost Element	Cost	Comments
1	SBVC- TES Tank Costs	$1,269,500	
2	Rebates-Energy Efficiency Savings	$9,748	@$0.24/kWh
3	Net Project Costs	$1,259,752	Cost After Rebates
4	Annual Savings (Calculated)	$62,503	=Demand Savings+Load shift Savings+Night Operations Efficiency Savings
5	Simple Payback	20.16	Years

CENTRAL PLANT STATISTICS

Parameter	Value @ FBO	Value in 2011	Units
Central Plant & TES Energy Savings	960,038	646,830	kWh/Yr
Central Plant & TES Demand Savings	567	379	kW
Central Plant Rebate	$230,409	$155,239	$
Central Plant Savings	$124,540	$83,909	$/Yr
Central Plant Cost	$8,600,000	$8,600,000	$
Total Savings for Central Plant & TES	$206,606	$146,412	$/Yr

EEM 02—Tankless DHW Heaters

Background

Domestic Hot Water (DHW) is heated by electric and gas heaters with storage in buildings of SBVC. Electric heating of DHW is three times more expensive at SBVC 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 Efficiency Measure (EEM) attempts to replace high efficiency tankless water heaters with high energy factors.

Assumptions

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

Capital Cost Estimate

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

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 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. It should be noted that the tank losses are not included in this calculations, but the DHW consumption of 1.5 GPD/occupation is taken higher to compensate for baseline. There are few buildings that were analyzed in e-quest for other EEM's and baseline energy consumption reported in those models is higher than the baseline reported here, keeping the savings conservative.

ASSUMPTIONS

#	Parameter	Value	Units	Comments
1	Cost of Natural Gas	$0.81	$/Therm	From Utility Bills
2	Cost of Electricity	$0.13	$/kWh	From Utility Bills
3	Gas Rebate	$1.00	$/Therm	CCC-IOU Rebates
4	Electricity Rebate	$0.24	$/kWh	CCC-IOU Rebates
5	DHW Consumption	1.5	GPD/Person	
6	Average # of Occupants & Visitors	375	People	Assumption, including Students
7	Hydronic Heating Costs	$8,857	$/Yr	The Gas Co. Data
8	Hydronic Heating Energy Consumption	9,625	Therms/yr	From Utility Bills
9	Hydronic Heater Efficiency	85%	%	Existing Boiler Efficiency
10	Existing Pump Work = New Pump Work		kWh/Yr	
11	Utilization	250	days/yr	
12	Kitchen DHW Use	1000	GPD	
13	Occupant/Sq. ft	100		
14	Average ΔT, 60˚F	60	˚F	
15	Baseline Tanked Energy Factor	0.65		DOE Published data
16	Tankless Energy Factors	0.9		

CAPITAL COST ESTIMATE

#	CBS Description	Unit Cost	Qty	Units	Item Cost	Notes/ Comments
1	Heater	$1,950	1	Ea	$1,950	
2	Piping	$22	30	LF	$660	
3	Insulation	$5	30	LF	$159	
4	Electrical Conduit, 1”	$22	10	Ea	$220	
5	Flue Duct	$4.44	25	LF	$111	
6	Duct Accessories	$450	1	LOT	$450	
7	Demolition	$500	1	Ea	$500	
8	Contingency				$400	
Total Installed Cost of Installation					$4,450	

BASELINE, SAVINGS, REBATES AND PAYBACK ANALYSIS

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)	Life Remaining (Yrs)	End of Life Replacement (ELR)/ Immediate Replacement (IR)
AD/SS	4.5kW TL;	16,638	166	250	14,073	kWh/yr	$1,793	347	Therms/Yr	$280	$4,450	$1,513	$3,378	1	13	IR
	130MBH, 34 gal	26,016	260	390	751	Therms/Yr	$605	542	Therms/Yr	$437	$4,450	$168	$209	25	6	ELR
ART	6kW 20 gal	8,638	86	130	7,307	kWh/yr	$931	180	Therms/Yr	$145	$4,450	$786	$1,754	3	13	IR
	150MBH 100 gal	8,000	80	120	231	Therms/Yr	$186	167	Therms/Yr	$134	$4,450	$52	$64	85	6	ELR
AUD	4 kW Electric	30,000	100	150	8,459	kWh/yr	$1,078	209	Therms/Yr	$168	$4,450	$910	$2,030	3	13	IR
HLS	100 MBH, 50 gal	37,685	377	565	1,088	Therms/Yr	$877	786	Therms/Yr	$633	$4,450	$244	$302	17	5	ELR
LA	40MBH, 50 gal	28,000	280	420	808	Therms/Yr	$652	584	Therms/Yr	$471	$4,450	$181	$225	23	8	ELR
LIB	85MBH, 50gal	36,700	367	551	1,060	Therms/Yr	$854	765	Therms/Yr	$617	$4,450	$237	$294	18	6	ELR
	Totals	191,677		2,575	33,776		$6,975	$3,579		$2,885	$35,600	$4,090	$8,255	7		
	Electric Heating			529	29,839		$3,801.44	$735.50	Therms/Yr	$592.80	$13,350	$3,209	$7,161	1.93		IR
	Tanked Gas			2,046	3,938		$3,173.76	$2,843.96	Therms/Yr	$2,292.16	$22,250	$882	$1,094	24.00		ELR

BASELINE DHW ENERGY CONSUMPTIONS

Electric	29,839	kWh/Yr
Tanked Water	3,938	Therms/Yr

PROPOSED DHW ENERGY CONSUMPTION

Tankless	3,579	Therms/Yr

EEM 03—No Flush and Low Flush Urinals

Background

San Bernardino has opportunity to retrofit 37 urinals in Buildings AD/SS, ART, AUD, CC, HLS, LA, LIB, PL, and TECH. This analysis is for 37 urinals on the San Bernardino Valley College Campus. This EEM analyzes and reports costs, savings and paybacks for both. Water-free and Low flush technologies available in market for water conservation.

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

FIGURE 3 INSTALLATIONS OF FLUSHED MALE URINALS AND WATER-FREE URINALS

Assumptions

Inputs and assumptions for this EEM are tabulated below.

Calculations

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

Capital Cost Estimate

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

Payback Analysis

Calculations for payback are summarized in the table below.

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 San Bernardino, CA. Even though simple payback is better on water-free urinals, due to housekeeping related problems (cartridges replacement), it is recommended that existing urinals be replaced with low flush urinals.

ASSUMPTIONS

#	Parameter	Value	Comments
1	Cost of Water & Sewer ($/1000 Gallons)	$4.08	From Utility Bills
2	Male Urinals	37	From Plumbing Plans
3	Urinal's Flush Rate (Existing)	1.5	Gallons/flush
4	Male Population of Buildings	1500	50% of 3000 Occupants @ 100 ft^2/occupant density
5	Flushes/day/Occupant	3	From ASPE Handbook
6	Academic Usage (days/Yr)	250	50 Weeks * 5 days/Year
7	Rebate	$-	No 2010 Rebates Available
9	Cost of Cartridges	$30.00	Manufacturer's Quote
10	Flushes/Cartridge	8000	Average Flushes/cartridge
11	New Flush Rate (Low Flush Option)	0.125	1/8th Gallon Flush

SAVINGS CALCULATIONS

#	Parameter	Value	Notes/Comments
1	Flushes/Day	4500	=Assumption 4 * Assumption 5
2	Days/Yr	250	Assumption-6
3	Flushes/Yr	1,125,000	=flushes/day * Days/yr
4	Annual Water Usage (MG)	1687.50	=Flushes -/Yr * Assumption-3 / 1000
5	Cost of Water & Sewer	$4.10	Assumption-1
6	Cost of Flushing Male Urinals ($/Yr)	$6,885	Operating Costs (Baseline Water Costs)
7	Number of Replacement Cartridges/Yr	141	=Flushes/Yr/Assumption-9
8	Cost of Cartridges ($/Yr)	$4,230	=Annual Water Consumption * Assumption-10
9	Net Savings	$2,655	Baseline - Cost of Cartridges
10	Low Flush Urinals Annual Water Usage	140.625	=flushes/yr * Assumption-11
11	Water Savings for Low Flush Urinals	1,546.88	MG/Yr
12	Cost Savings for Low Flush Urinals	$6,311	

INSTALLATION COSTS FOR WATER-FREE URINALS

#	Parameter	Unit Cost	Qty	Item Cost	Notes/Comments
1	Installation cost per Waterfree urinal	235	37	$8,695	
2	Waterfree Urinal cost	316	37	$11,692	Falkon F-4000 (Discounted Price from Dealer)
3	Total Installed Cost/Ea	$551		$20,387	

INSTALLATION COSTS FOR LOW FLUSH URINALS

#	Parameter	Unit Cost	Qty	Item Cost	Notes/Comments
1	Low flush urinal cost	750	37	$27,750	www.plumbingsupply.com
2	Installation cost per low flush urinal	450	37	$16,650	CSI # 224213303140
3	Total Installed Cost/Ea	$1,200		$44,400	

PAYBACK ANALYSIS FOR LOW FLUSH AND WATER-FREE URINALS

#	Parameter	Value	Notes/Comments
1	Capital Cost (Water-free Option)	$20,387	
2	Rebates	$-	
3	Water-free Option, Savings $/ Yr	$2,655	$/ Yr
4	Simple Payback(Yrs)	7.7	=(Capital costs-Rebates)/Savings
5	Low flush Urinals Capital Costs	$44,400	
6	Low flush Option, Savings $/Yr	$6,311	$/ Yr
7	Simple Payback(Yrs)	7.0	=(Capital costs-Rebates)/Savings

EEM 04—Lighting

Background

This EEM analyzes the lighting in the subject ten 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.

EEMs listed in the table 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 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.

LEEM-1

Control interior light fixtures with occupancy sensors.

Occupancy sensors react to motion/sound using passive infrared and ultrasonic technologies. The application determines what type to use and some require dual or both of the technologies. Generally sensors are ceiling mounted to maximize the coverage areas. Time delays are also used to limit on/off operations of lights which can be obtrusive. The ballast type must be selected to coincide with the anticipated on/off operations.

There are also wireless occupancy sensors and wall switches. These may be useful where ceilings are not easily accessible.This is offered by Lutron and the product is the Radio Powr Savr.

LEEM-2

Convert incandescent fixtures to compact fluorescent.

Please see EEM5 for the benefits of CFL’s. Sometimes the fixture loses some of its appeal depending on the shape of the CFL and space available for the lamp in the fixture.

LEEM-3

Replace halogen/incandescent lamps with CFL's

Compact Fluorescent Lamps (CFLs) are five times as efficient as incandescent bulbs. They also last eight to ten times as long, and produce much less heat than incandescent lamps do when they are on. This, in turn, can help to reduce the cost to cool your building.

Although the most common types are the exposed spiral-tube models shown above, many have a plastic cover and look similar to incandescent lamps. There are even models that look and perform similar to parabolic reflector (PAR) lamps.

Today CFLs come in many shapes and sizes to accommodate the needs of the marketplace.

LEEM-4

Install day lighting controls for a group of fixtures with astronomical time clock and photocells.

A time clock can be used to automatically program when equipment turns on and off. This reduces energy waste and ultimately saves money.

Different times of the year have different amounts of daylight, thus it is important that a time clock adjusts for this; an astronomic time clock is suggested for these applications. This type of time clock compensates for daylight savings time and is programmed for a specific geographic location. Even through astronomic time clocks are more expensive we recommend these be used to minimize maintenance department's time in adjusting standard time clocks throughout the year.

A photocell is another device used to automatically turn equipment on and off. The difference is that a photocell is activated by the presence and absence of daylight. Generally you want lights not operating when natural daylight is present. This too reduces energy waste and ultimately saves money.

A time clock is often used in conjunction with a photocell and vice versa.

LEEM 4-5

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

The advancement in offerings of T8 lamp and ballast technology continues to provide more offerings. There are now 32W as well as 28W and 25W ballast/lamp combinations.

The lighting standards particularly CEC, Title 24 pushes for lower watts per square foot for various type occupancies and tasks. The IES standards also give sizable ranges of lighting. We are tending to move to the lower parts of the range to meet the pressure to reduce energy usage and the carbon footprint.

This EEM is usually used with older buildings where the lighting design levels were at the high ends of the general practices of IES and the lighting profession. The ability to reduce wattage is possible and still being in acceptable lighting range.

LEEM-6

Replace MR-16 lamp with LED lamp.

The advancement in offerings of LED lamps continues to provide more offerings. There are now numerous offerings and the price continues to come down.

LEEM-7

Replace ballast and lamp.

This energy conservation method involves replacement of ballast and lamp with new electronic ballast and third generation T8 lamps.

LEEM 4-8

Provide time clock control.

This conservation measures puts the power circuits of identified fixtures on timer to achieve set back savings.

LEEM 4-9

Replace metal halide fixtures with multiple compact fluorescent fixtures.

The advancement in offerings of compact fluorescent lamps has been integrated into high bay fixtures. These fixtures offer enhanced control capability over high intensity discharge lamps which need restrike time to turn back on after being shut off. The use of multiple compact fluorescent lamps with or without dimming allows daylighting and occupancy sensor control.

CALCULATIONS FOR CAPITAL COSTS, SAVINGS, AND PAYBACKS

			Existing Conditions						Post-Retrofit Conditions									Cost, Rebate & Payback Analysis				
Item #	Building	Location	Type	Fixture	Fixture Qty	Watts per fixture	Total kWatts	Total kWh	Replacement Fixture	LEEM#	New Watts/ fixture	Total kW	kW Demand Reduction	Total kW Demand Reduction	Operating Hours	kWh saved (kWh)/yr	Annual Cost Savings ($) at $.13/kWh	Installation Cost/fixture	Total Installed Cost ($)	Rebate	Simple Payback (Yrs)	Comments
1	Life Science	Balcony 2nd Floor	MH	Downlight	17	128	2.2	9,531		4	128	2.2	0.0	0.0	4,380	4,765	$620		$300	$1,144	Immediate	Add photocell to circuit 11a,11b.
2	Technology	Rm 116A	Fluor	Pendant	126	74	9.3	68,065		4	74	9.3	0.0	0.0	7,300	29,949	$3,893		$43,200	$7,188	9.2	Cut skylights in roof and provide photocell control.
3	Planetarium	Supply Rm 204	Fluor	Surface Wrap	6	93	0.6	4,073		1	93	0.6	0.0	0.0	7,300	280	$36		$126	$67	1.6	4 lamp ballast serves 2 fixtures. 502 kWh/kW deemed savings per SCE workpaper. There will need to be two sensors to cover area.
4	Planetarium	Stage	Inc	Downlight	12	150	1.8	1,800	CFL	2	23	0.3	0.1	1.5	1,000	904	$117		$18	$217	Immediate	Replace lamps when incandescents burn out.
5	Campus Center	Sunroom Dining 1 & 2, Main Dining Room, Student Lounge	MH	Pendant	39	215	8.4	36,726	CFL	4,8	230	9.0	0.0	-0.6	4,380	10,796	$1,403	$610	$23,790	$2,591	15.1	Retrofit MH 175W - 11200 lumens, 215 W. With 42W TRT CFL 2670 lumens/lamp. Five CFL needed to get equivalent lumens or 230W per fixture. The retrofit will allow 'ab' control based on daylight levels. Assumed 8 hrs per day fixtures off.
6	Learing Resource Center/Library	Online Reference - 128 and Computer Lab 136	MH	Pendant	35	215	7.5	54,933	CFL	4,8	230	8.1	0.0	-0.5	7,300	12,912	$1,678		$15,781	$3,099	7.6	Retrofit MH 175W - 11200 lumens, 215 W. With 42W TRT CFL 2670 lumens/lamp. Five CFL needed to get equivalent lumens or 230W per fixture. The retrofit will allow 'ab' control based on daylight levels. Currently on manual control through a relay. 3680 ft^2.
7	Auditorium	Dressing Rm 2	Inc	Globe	43	60	2.6	2,580	CFL	2	14	0.6	0.0	2.0	1,000	1,978	$257	$20	$860	$475	1.5	
8	Learning Resource Center	Bookstacks 200	MR-16	Downlight	22	50	1.1	8,030	LED	6	7	0.2	0.0	0.9	7,300	6,906	$898	$75	$1,650	$1,657	Immediate	
9	Technology	Paint Booth	Fluor	Flush	22	118	2.6	2,596		7,1	99	2.2	0.0	0.4	1,000	1,721	$224		$1,420	$413	4.5	Replace with 28W T8. CRI to 85 from 75-78. Provide 3000 K lamps. Also add occupancy sensor with glass cover so paint can be removed.
10	Technology	Restroom 137	Fluor	Surface Wrap	2	71	0.1	1,244		7,1	58	0.1	0.0	0.0	8,760	299	$39		$190	$72	3.0	Replace magnetic ballast and install ceiling occupancy in main part of bathroom.
11	Technology	Auto Shop - Private Office - Long Building	Fluor	2x4	4	74	0.3	1,296		1					4,380	149	$19		$63	$36	1.4	
12	Technology	Back Welding Shop - Long Building	Fluor	Pendant	34	59	2.0	14,644		1					7,300	1,007	$131		$252	$242	0.1	
13	Technology	Classroom - Long Building (Next to Welding)	Fluor	2X4 Surface	6	59	0.4	2,584		1					7,300	178	$23		$126	$43	3.6	Hard lid.
14	Technology	Auto Shop - Long Building	Fluor	Pendant	24	59	1.4	10,337		1					7,300	711	$92		$189	$171	0.2	

			Existing Conditions						Post-Retrofit Conditions									Cost, Rebate & Payback Analysis				
Item #	Building	Location	Type	Fixture	Fixture Qty	Watts per fixture	Total kWatts	Total kWh	Replacement Fixture	LEEM#	New Watts/ fixture	Total kW	kW Demand Reduction	Total kW Demand Reduction	Operating Hours	kWh saved (kWh)/yr	Annual Cost Savings ($) at $.13/kWh	Installation Cost/fixture	Total Installed Cost ($)	Rebate	Simple Payback (Yrs)	Comments
15	Technology	Auto Shop - Classroom - Long Bldg	Fluor	Pendant	12	74	0.9	3,889		1					4,380	446	$58		$126	$107	0.3	
16	Technology	Auto Shop - Main Bldg North Side	Fluor	General Purpose Industrial	43	64	2.8	20,090		1					7,300	1,382	$180		$600	$332	1.5	Need to add office switch with occupancy sensor. Also need to separate the fan from the light switch. There will need to be three switches rather than two in shop and one switch in the office.
17	Technology	Classroom Rm 138	Fluor	Surface Mtd	16	64	1.0	7,475		1					7,300	514	$67		$126	$123	0.0	
18	Technology	Computer Lab E5	Fluor	2x4	15	64	1.0	4,205		1					4,380	482	$63		$126	$116	0.2	
19	Technology	Front Welding Lab	Fluor	Pendant	61	59	3.6	26,273		1					7,300	1,807	$235		$500	$434	0.3	
20	Technology	Aeronautic Hanger - Offices 114C and 114B	Fluor	2x4	16	64	1.0	4,485		1					4,380	514	$67		$126	$123	0.0	
21	Technology	Aeronautic Hanger - T114	Fluor	Pendant	16	148	2.4	10,372		1					4,380	1,189	$155		$1,000	$285	4.6	Common area with item 22 below. Need to setup override switches for custodial to pickup garbage. Fixtures at 13' mounting height. Mount photocells at 12'.
22	Technology	Aeronautic Hanger - T114	Fluor	Pendant	64	74	4.7	4,736		1					1,000	2,377	$309		$1,000	$571	1.4	
23	Liberal Arts	1st and 2nd floor walkways	Inc	Cans	28	100	2.8	12,264	CFL	2	23	0.6	0.1	2.2	4,380	9,443	$1,228	$30	$840	$2,266	Immediate	
24	Liberal Arts	Rooms 237,238	Fluor	2x4	5	59	0.3	1,292		1					4,380	148	$19		$126	$36	4.7	
25	Liberal Arts	LA-100 Auditorium	Inc-Dimmable	Recessed Cans	37	150	5.6	11,100	CFL-Dimmable	2	42	1.6	0.1	4.0	2,000	7,992	$1,039	$60	$2,220	$1,918	0.3	
26	Liberal Arts	LA-100 Auditorium	Fluor	Recessed 1x4	59	59	3.5	25,411		1					7,300	1,747	$227		$2,000	$419	7.0	Need passageway lights from elevator. Lights at 20'MH. Need overrides. Requires further study.
27	Liberal Arts	LA-108 (111 Drwg)	Fluor	Recessed 2x4	24	51	1.2	8,935		1					7,300	614	$80		$176	$147	0.4	4 lamp ballast serves 2-2 lamp fixtures(102W). 502 kWh/kW deemed savings. There will need to be two sensors to cover area. Wall switches do not seem to work.
28	Liberal Arts	Other 1st Floor(Classrooms)	Fluor	Recessed 2x4	84	51	4.3	31,273		1					7,300	2,151	$280		$1,408	$516	3.2	Rooms not accessible, assume 'ab' switching only and no occupancy sensors. 4 lamp ballast serves 2-2 lamp fixtures(102W). 502 kWh/kW deemed savings per SCE workpaper. There will need to be two sensors to cover area. Wall switches do not seem to work. 8 rooms at $176 each to install.
29	Liberal Arts	1st & 2nd Floor (Small Offices)	Fluor	Recessed 4x4	65	162	10.5	76,869		1					7,300	5,286	$687		$4,095	$1,269	4.1	Add occupancy sensor to each room. 502 kWh/kW deemed savings per SCE workpaper.
30	Liberal Arts	1st Floor (Corridors)	Fluor	Recessed 2x4/1x4	44	59	2.6	22,741		8					8,760	7,502	$975		$2,000	$1,801	0.2	Assume shutoff 6PM-2AM, 365 days per year. Install time clocks for each circuit. Assume 4 circuits.
31	Liberal Arts	1st and 2nd Floor (Restrooms)	Inc	Cans	12	162	1.9	17,029	CFL	2	23	0.3	0.1	1.7	8,760	14,612	$1,900	$20	$240	$3,507	Immediate	8 bathrooms inside area, not entry.
32	Liberal Arts	1st and 2nd Floor (Restrooms)	Fluor	CFL after retrofit	12	23	0.3	2,418		1					8,760	139	$18		$252	$33	12.1	Add occupancy sensor to each of the 8 bathrooms inside area lights after retrofit. Combined with 33. Four bathrooms investment shown.
33	Liberal Arts	1st and 2nd Floor (Restrooms)	Fluor	1x4	8	32	0.3	2,243		1					8,760	129	$17		$252	$31	13.2	Add occupancy sensor to each of the 4 bathrooms inside area lights after retrofit. Combined with 32. Four bathrooms investment shown.
34	Liberal Arts	2nd Floor (Room 205)	Fluor	2x4	152	59	9.0	65,466		5	44	6.7	0.0	2.3	7,300	4,502	$585	$60	$9,120	$1,080	13.7	Add occupancy sensor to each room. 502 kWh/kW deemed savings per SCE workpaper.

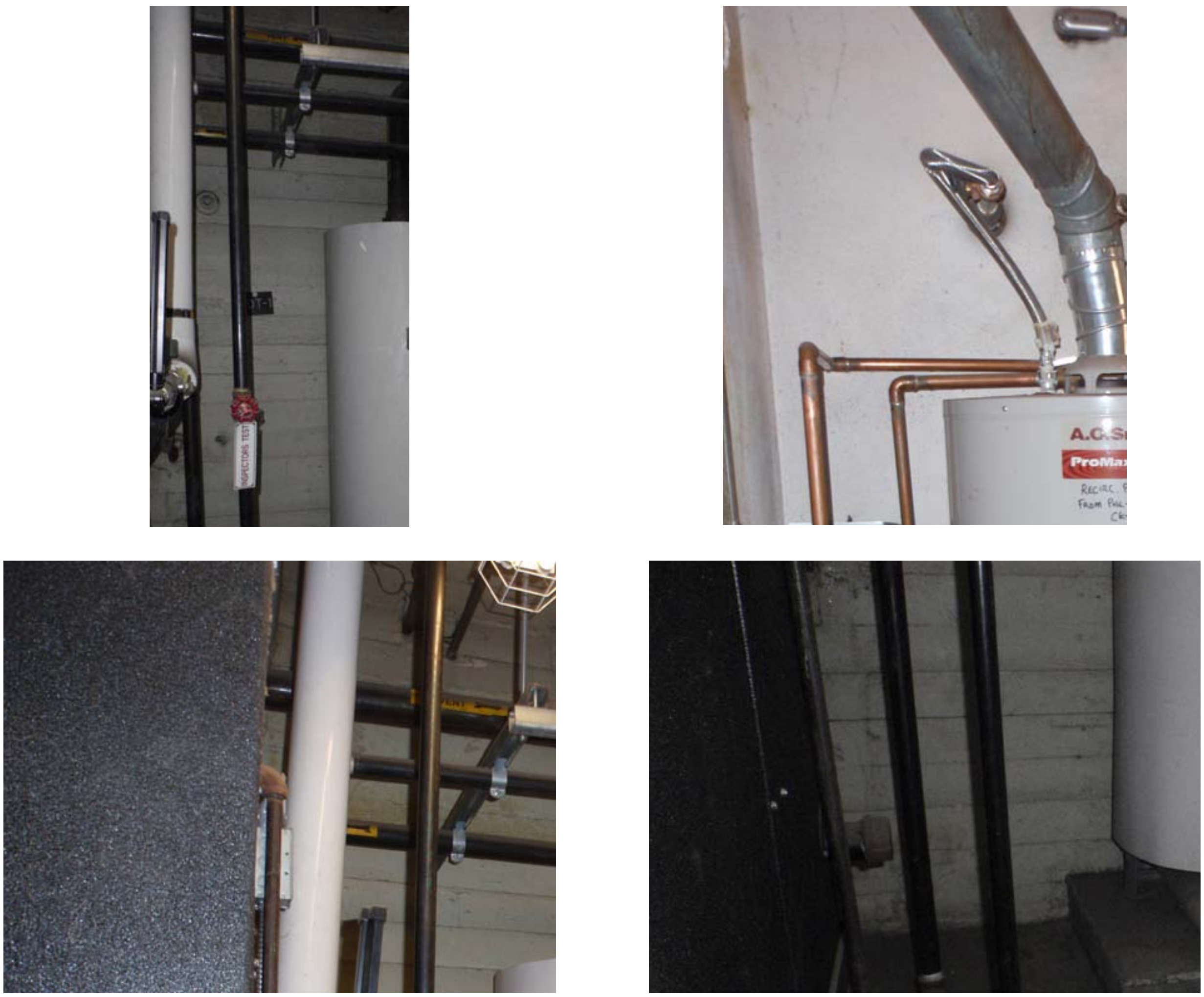
			Existing Conditions						Post-Retrofit Conditions									Cost, Rebate & Payback Analysis				
Item #	Building	Location	Type	Fixture	Fixture Qty	Watts per fixture	Total kWatts	Total kWh	Replacement Fixture	LEEM#	New Watts/ fixture	Total kW	kW Demand Reduction	Total kW Demand Reduction	Operating Hours	kWh saved (kWh)/yr	Annual Cost Savings ($) at $.13/kWh	Installation Cost/fixture	Total Installed Cost ($)	Rebate	Simple Payback (Yrs)	Comments
35	Liberal Arts	2nd Floor (Corridor)	Fluor	1x4 hard lid and surface	36	59	2.1	18,606		5	44	1.6	0.0	0.5	8,760	1,066	$139	$60	$2,160	$256	13.7	Corridor is lite to 33 footcandle at the floor stairway next to room 228. IES only need 10-20 footcandle at floor.
36	Liberal Arts	2nd Floor (Office225)	Inc	Table	2	95	0.2	1,387	CFL	2	23	0.0	0.1	0.1	7,300	95	$12	$12	$24	$23	0.1	
37	Liberal Arts	Other 2nd Floor (Classrooms)	Fluor	Recessed 2x4	107	51	5.5	39,836		1					7,300	2,739	$356		$2,640	$657	5.6	Rooms not accessible, assume 'ab' switching only and no occupancy sensors. 4 lamp ballast serves 2-2 lamp fixtures(102W). 502 kWh/kW deemed savings. There will need to be two sensors to cover area. Wall switches do not seem to work. 15 rooms at $176 each to install.
38	Auditorium	Room 111	Inc	Sconces	10	80	0.8	7,008	CFL	2	18	0.2	0.1	0.6	8,760	5,431	$706	$12	$120	$1,303	Immediate	2 lamps per fixture.
39	Auditorium	Room 111	Inc	Sconces	8	100	0.8	7,008	CFL	2	23	0.2	0.1	0.6	8,760	5,396	$702	$9	$72	$1,295	Immediate	
40	Auditorium	Passage 117 1st floor	Fluor	2x4	5	89	0.4	3,898	25W T8	5	66	0.3	0.0	0.1	8,760	1,007	$131	$60	$300	$242	0.4	Current lighting level is 16 footcandles at floor. This retrofit will still provide 13 footcandles.
41	Auditorium	Room 116	Fluor	1x4 Pendant	12	59	0.7	5,168		1					7,300	355	$46		$300	$85	4.6	Hard lid. Mount occupancy sensor at 12' maximum.Use wiremold to match walls or go with wireless occupancy sensor.
42	Auditorium	Green Rm Closet	Fluor	1x4 Pendant	4	59	0.2	1,723		1					7,300	118	$15		$126	$28	6.3	Hard lid.
43	Life Science	1st and 2nd Floor Classrooms	Fluor	Recessed 2x4	295	89	26.3	191,662		1					7,300	13,180	$1,713	$126	$11,214	$3,163	4.7	31 rooms
44	Art Center & Gallery	Misc Offices/Studios	Fluor	Linear	80	59	4.7	34,456		1					7,300	2,369	$308		$904	$569	1.1	Mount occupancy sensors 12' maximum.
45	Art Center & Gallery	Misc Offices/Studios	Fluor	Linear	12	89	1.1	7,796		1					7,300	536	$70		$252	$129	1.8	Some ceiling mounted layin ceiling.
46	Art Center & Gallery	Misc Offices/Studios	Fluor	Downlight	121	42	5.1	37,099		1					7,300	2,551	$332		$800	$612	0.6	Mount occupancy sensors 12' maximum.
47	Planetarium	Misc Offices	Fluor	1x4	15	50	0.8	5,475		1					7,300	377	$49		$652	$90	11.5	Add ab switching if possible.
48	Planetarium	Misc Offices	Fluor	2x4	18	100	1.8	13,140		1					7,300	904	$117		$489	$217	2.3	Add ab switching if possible.
49	Campus Center	Misc Offices	Fluor	2x4	155	59	9.1	66,759		1					7,300	4,591	$597		$2,394	$1,102	2.2	38 rooms/sensors.
50	Learing Resource Center/Library	Misc Offices	Fluor	2x4	13	89	1.2	8,446		1					7,300	581	$76		$189	$139	0.7	
51	Learing Resource Center/Library	Misc Offices	Fluor	1x4	69	59	4.1	29,718		1					7,300	2,044	$266		$452	$490	Immediate	
52	Learing Resource Center/Library	Room 200 - Bookstacks	MR-16	Recessed Downlight	22	50	1.1	8,030	Relamp	6	7	0.2	0.0	0.9	7,300	6,906	$898	$80	$1,760	$1,657	0.1	This is a retrofit for a 40W MR16 to 7W LED. The current lamps are 50W.
53	Administration Student Services	Rooms 220/219	Par 38	Downlight	7	150	1.1	7,665	Relamp	3	42	0.3	0.1	0.8	7,300	5,519	$717	$30	$210	$1,325	Immediate	
54	Administration Student Services	Room 200 - Bookstacks and Restrooms (6)	MR-16	Recessed Downlight	25	50	1.3	9,125	Relamp	6	7	0.2	0.0	1.1	7,300	7,848	$1,020	$80	$2,000	$1,883	0.1	This is a retrofit for a 40W MR16 to 7W LED. The current lamps are 50W.
55	Administration Student Services	Misc	Fluor	2x4	72	89	6.4	46,778		1					7,300	3,217	$418		$661	$772	Immediate	
56	Administration Student Services	Misc	Fluor	1x4	15	59	0.9	6,461		1					7,300	444	$58		$126	$107	0.3	
		Total Savings:														202,804	$26,364		$142,143	$48,673	3.5	

EEM 05—Piping Insulation

Heat losses through un-insulated surfaces are significant, especially when the hot/cold surfaces are operating continuously (24*7 basis). Although the analysis in this measure is representative of hot pipe insulation around the heating steam pipe, there may be several surfaces that are not analyzed and listed here. A rigorous inventory of such surfaces needs to be prepared for insulation requirements. Generous rebates are also available from the gas company.

Background

FIGURE 4 EXPOSED HEATING STEAM AND HOT WATER PIPING SURFACES



Assumptions

Savings

Cost Estimate

Payback Analysis

Observations and Comments

USDOE (United States Department of Energy) approved '3E Plus' software tool is used to analyze the information. Reports of 3E-Plus are attached for further considerations. 3E Plus is a free tool and SBVC is encouraged to prepare an inventory of hot/cold surfaces eligible for insulation for more detailed analysis. As trivial and insignificant this EEM may appear, this type of tools utilization is encouraged to develop good working practices for maintaining energy efficiency of its systems for longer period of times.

Attachments

The following reports from '3E Plus' are attached for back calculations.

- Attachment 5-1 Cost of Energy for 2" Pipe
- Attachment 5-2 Cost of Insulation
- Attachment 5-3 Emissions Report
- Attachment 5-4 Insulation thickness and energy losses for 2" tube

ASSUMPTIONS

#	Parameter	Value	Comments
1	Blended cost of electricity ($/kWh)	$0.13	From Utility Bills
2	Cost of Natural Gas ($/Therm)	$0.81	From Utility Bills
3	Temperature of pipe (˚F)	140	Heating Hot Water Supply
4	None		
5	2010 Rebate = 2009 Rebate ($/Therm)	$1.00	CCC-IOU Rebates
6	1 kW = 3412.14 Btu/h	3,413	Conversion Factor

CALCULATIONS OF SAVINGS

Bldg	LF Exposed	Pipe Size	Therms Saved	Savings, $/ft/Yr	Savings, $/Yr
Auditorium	40	2"	210.52	6.90	276
Totals			210.52		$276

COST ESTIMATE

Bldg	LF Exposed	Pipe Size	Cost, $/ft	Cost, $
Auditorium	40	2"	16.25	650
Totals				650

PAYBACK ANALYSIS

Bldg	LF Exposed	Pipe Size	Cost ($)	Savings ($/Yr)	Rebates ($)	Simple Payback (Yrs), Without Rebates	Simple Payback (Yrs), With Rebates
Auditorium	40	6"	$650	$276	$211	2.4	1.6
Totals			$650	$276	$211	2.4	1.6

ATTACHMENT 5-2 COST OF INSULATION

Source	Line Number	Description	Crew	Daily Output	Labor Hours	Quantity	Unit	Ext. Material
Unit	220719104304	Insulation, pipe (price copper tube one size less than I.P.S.), cellular glass, closed cell foam, all service jacket, sealant, 0 water vapor transmission, working temperature (-450 Deg.F to +900 Deg.F), 1-1/2" wall, 2-1/2" iron pipe size, includes sealant	Q14	90.00	0.178	40.00	L.F.	$192.40
								$192.40

Source	Line Number	Ext. Labor	Ext. Equipment	Ext. Total	Ext. Total Incl O&P	Zip Code Prefix	Type	Release	Notes
Unit	220719104304	$282.00		$474.40	$649.87	908	Union	2010	
		$282.00		$474.40	$649.87				

NAIMA 3E Plus 4.0

P2S Engineering, Inc
5000 E. Spring St.
Long Beach, CA, 90815
+1 (562) 497 2999

Item Description = SBVC Auditorium
Calculation Type = Cost of Energy
Geometry Description = Copper Pipe - Horizontal
System Units = ASTM C585
Bare Surface Emittance = 0.6
Nominal Pipe Size = 2 in.
Process Temperature = 140 °F
Ave. Ambient Temperature = 75 °F
Ave. Wind Speed = 0 mph
Fuel Name = Natural Gas
Heat Content = 1026 Btu/cuft
Fuel Cost = 10.00 $/Mcf
Efficiency = 75%
Hours Per Year = 8760
Outer Jacket Material = PVC Jacketing
Outer Surface Emittance = 0.9
Insulation Layer 1 = Cellular Glass,Type I,BLOCK, C552-07, Varied

Variable Insulation Thickness	Cost ($/ft/yr)	Heat Loss (BTU/ft/yr)	Savings ($/ft/yr)
Bare	8.09	622400	
0.5	2.67	205100	5.418
1.0	1.80	138200	6.288
1.5	1.41	108300	6.678
2.0	1.19	91760	6.898
2.5	1.06	81670	7.028
3.0	0.97	74460	7.118
3.5	0.90	69010	7.188
4.0	0.83	64240	7.258
4.5	0.79	60860	7.298
5.0	0.75	58050	7.338
5.5	0.72	55130	7.368
6.0	0.69	53150	7.398
6.5	0.67	51420	7.418
7.0	0.65	49900	7.438
7.5	0.63	48540	7.458
8.0	0.61	47320	7.478
8.5	0.60	46210	7.488
9.0	0.59	45210	7.498
9.5	0.58	44290	7.508
10.0	0.56	43440	7.528

NAIMA 3E Plus 4.0

P2S Engineering, Inc
5000 E. Spring St.
Long Beach, CA, 90815
+1 (562) 497 2999

Item Description = SBVC Auditorium
Calculation Type = Pollutant Reduction
Geometry Description = Copper Pipe - Horizontal
System Units = ASTM C585
Bare Surface Emittance = 0.6
Nominal Pipe Size = 2 in.
Process Temperature = 140 °F
Ave. Ambient Temperature = 75 °F
Ave. Wind Speed = 0 mph
Fuel Name = Natural Gas
Heat Content = 1026Btu/cuft
Fuel Cost = 10.00 $/Mcf
Efficiency = 75%
Hours Per Year = 8760
Outer Jacket Material = PVC Jacketing
Outer Surface Emittance = 0.9
Insulation Layer 1 = Cellular Glass,Type I,BLOCK, C552-07, Varied

Variable Insulation Thickness	CO2 (lb/ft/yr)	NOx (lb/ft/yr)	CE (lb/ft/yr)
Bare	96.700	0.194	26.350
0.5	31.860	0.064	8.681
1.0	21.470	0.043	5.849
1.5	16.820	0.034	4.583
2.0	14.260	0.029	3.885
2.5	12.690	0.025	3.458
3.0	11.570	0.023	3.152
3.5	10.720	0.022	2.922
4.0	9.981	0.020	2.720
4.5	9.456	0.019	2.577
5.0	9.020	0.018	2.458
5.5	8.566	0.017	2.334
6.0	8.258	0.017	2.250
6.5	7.990	0.016	2.177
7.0	7.753	0.016	2.112
7.5	7.541	0.015	2.055
8.0	7.351	0.015	2.003
8.5	7.180	0.014	1.956
9.0	7.024	0.014	1.914
9.5	6.881	0.014	1.875
10.0	6.750	0.014	1.839

NAIMA 3E Plus 4.0

P2S Engineering, Inc
5000 E. Spring St.
Long Beach, CA, 90815
+1 (562) 497 2999

Item Description = SBVC Auditorium
Calculation Type = Heat Loss Per Year Report
Geometry Description = Copper Pipe - Horizontal
System Units = ASTM C585
Bare Surface Emittance = 0.6
Nominal Pipe Size = 2 in.
Process Temperature = 140 °F
Ave. Ambient Temperature = 75 °F
Ave. Wind Speed = 0 mph
Relative Humidity = N/A
Dew Point = N/A
Condensation Control Thickness = N/A

Hours Per Year = 8760
Outer Jacket Material = PVC Jacketing
Outer Surface Emittance = 0.9
Insulation Layer 1 = Cellular Glass,Type I,BLOCK, C552-07, Varied

Variable Insulation Thickness	Surface Temp (°F)	Heat Loss (BTU/ft/yr)	Efficiency (%)
Bare	140.0	622400	
0.5	90.6	205100	67.05
1.0	83.9	138200	77.80
1.5	81.0	108300	82.60
2.0	79.4	91760	85.26
2.5	78.5	81670	86.88
3.0	77.9	74460	88.04
3.5	77.4	69010	88.91
4.0	77.1	64240	89.68
4.5	76.8	60860	90.22
5.0	76.6	58050	90.67
5.5	76.4	55130	91.14
6.0	76.3	53150	91.46
6.5	76.2	51420	91.74
7.0	76.1	49900	91.98
7.5	76.0	48540	92.20
8.0	75.9	47320	92.40
8.5	75.9	46210	92.57
9.0	75.8	45210	92.74
9.5	75.8	44290	92.88
10.0	75.7	43440	93.02

EEM 06—Campus Center Kitchen Dishwasher Upgrades

Background

SBVC kitchen in campus center building uses electric heated dish washer. Water is heated electrically in this dishwasher. The proposed champion dishwashing machine uses gas heated hot water coil and uses less water. It is Energy Star qualified product and was recommended by The Gas Company.

Assumptions

Assumptions and inputs for the EEM-06 are tabulated below

Savings

Savings for EEM-06 are summarized in the table below, using vendor proposal giving side by side comparison of existing consumption and proposed consumptions of utilities.

Capital Costs

Capital cost for the machine is estimated using list price and 15% distributor discount. Actual discounts may vary.

The capital costs does not include installation labor because this is an equipment replacement involving electrical connection, water hoses and gas hoses, which can be done by Maintenance staff.

Payback

Using the capital costs, savings and rebates established in this EEM, the payback summary is tabulated below.

ASSUMPTIONS

#	Parameter	Value	Units	Comments
1	Cost of Natural Gas	$0.81	$/Therm	From Utility Bills
2	Cost of Electricity	$0.13	$/kWh	From Utility Bills
3	Gas Rebate	$1.00	$/Therm	CCC-IOU Rebate
4	Electricity Rebate	$0.24	$/kWh	CCC-IOU Rebate
5	Water and Sewer Costs	4.08	$/MG	From Utility Bills
6	Annual Washer Operating Hours	720	Hrs/Yr	Assumption

FIGURE 5 CHAMPION 44DR ENERGY CONSUMPTION AND OLD HOBART ENERGY CONSUMPTIONS

Measured	Old Hobart C44A	Champion 44DR
Racks per hour (determined using NSF Standard 3 for rack conveyor machines)	201	208
Gallons per hour listed in current NSF Standard 3 Listing	300	112
Kilowatts tank specified	15	18
Kilowatts booster heater required	45	12
Water used per rack (calculated via data entered)	1.491	0.537
Total electrical (Watts) per rack (tank heat on 60% of the time; booster heat 90%)	172.22	72.56
Water cost per Rack	$0.0043	$0.0016
Sewage cost per rack	$0.0040	$0.0015
Building hot water cost if electric/rack	$0.0000	$0.0000
Building hot water cost if gas per rack	$0.0103	$0.0037
Electrical cost per rack	$0.0224	$0.0094
Total Water and Utility cost/rack	**$0.0411**	**$0.0162**
Total sewage gallons per year based on days and hours in operation stated above	156,600	56,448
Total gallons water per year based on days and hours in operation stated above	156,600	56,448
Total kWh per year based on days and hours in operation stated per above, including idle energy	17,701	7,929
Total therm per year based on days and hours in operation stated above, not including idle energy	1,240	89
For every hour the Champion runs, Old Hobart C44A runs (in hours)	1.04	1.00

CALCULATIONS FOR SAVINGS AND REBATES

#	Parameter	Value	Units	Comments
1	Baseline Water Consumption	156.60	kGal	
2	Baseline Electricity Consumption	17,701	kWh	
3	Baseline Gas Consumption	1,240	Therms	
4	Proposed Water Consumption	56.45	kGal	Vendor Proposal
5	Proposed Electricity Consumption	7,929	kWh	Vendor Proposal
6	Proposed Gas Consumption	89	Therms	Vendor Proposal
7	Water & Sewer Savings	100.15	kGal/Yr	
8	Electricity Savings	9,772	kWh	
9	Gas Savings	1,151.00	Therms	
10	Water & Sewer Savings	$409	$/Yr	
11	Electricity Savings	$1,268	$/Yr	
12	Gas Savings	$928	$/Yr	
13	Total Savings	$2,604	$/Yr	
14	Electricity Rebates	$1,268	$	
15	Gas Rebates	$1,151	$	
16	Total Rebates	$2,419	$	

CAPITAL COST ESTIMATES

#	CBS Description	Unit Cost	Qty	Units	Item Cost	Notes/Comments
1	44 DR List Price	$19,640	1	Ea	$19,640	
2	Discount Factor	15%	1	%	$2,946	Average Discount
3	Price after Discount	$16,694	1	LF	$16,694	
4	Shipping & Handling	$300	1	Ea	$300	
8	Contingency					
	Total Purchased Cost of 44DR				$16,994	No Sales Tax for CC

SIMPLE PAYBACK

#	Parameter	Value	Units
1	Total Equipment Cost	$16,994	$
2	Rebates	$2,419	$
3	Net Installed Cost	$14,575	$
4	Savings	$2,604	$
5	Simple Payback	5.6	Years

EEM 07—Campus Center Heat Pump DHW Heater

Background

This EEM attempts to replace the electric DHW heater with electric heat pump. The cold air from the heat pump will provide 2.7 Tons of cooling in kitchen. This EEM has less energy conservation compared to tankless gas fired DHW heater, but considering the desire to help SBVC kitchen users, this EEM will save energy and provide cooling effect to kitchen envelope to some extent (2.7 Tons).

It is intent of this EEM to replace existing EWH-1 in the Boiler Room with the electric heat pump tank mounted water heater. It is further recommended that the location of this tank mounted heat pump be adjacent to or behind E-81, on the kitchen floor to take full advantage of cooling effect and to supply the hot water to E-81 promptly from this new DHW heater. The recirculation pump in the boiler room and the GWH-1 will continue to distribute DHW as usual. Existing tankless gas DHW heater will be piped in series and used as a back up to the heat pump water heater.

FIGURE 6 EXISTING DHW HEATER

FIGURE 8 ENERGY STAR HEAT PUMP DHW HEATER

Assumptions

Inputs and assumptions made in this calculation are tabulated below for this EEM.

Savings

Savings from this EEM are summarized in the table below. Rebate is also calculated for CCC-IOU program in the table below.

Capital Cost & Simple Payback

Capital Costs and the payback statistic for this EEM is summarized in the table below.

The table below lists the currently qualified Energy Star products that can be used for this application.

ASSUMPTIONS FOR HEAT PUMP DHW HEATER

#	Parameter	Value	Units	Comments
1	Cost of Natural Gas	$0.81	$/Therm	From Utility Bills
2	Cost of Electricity	$0.13	$/kWh	From Utility Bills
3	Gas Rebate	$1.00	$/Therm	CCC-IOU Rebate
4	Electricity Rebate	$0.24	$/kWh	CCC-IOU Rebate
5	Water and Sewer Costs	$4.08	$/MG	From Utility Bills
6	Kitchen and Building Operational Days/Yr	250	Days/yr	50 Wks/Yr * 5 Days/Wk
7	Heating of DHW from supply temperature	60	˚F	135˚F DHW supply temp
8	Energy Factor of tanked DHW heaters	0.92		DOE Data
9	COP of new Hybrid water heater	3.10		
10	Input Power of new Hybrid Water Heater	4.5	kW	
11	Hybrid Mode Energy Factor	2.30		Energy Star & MFR Data

SAVINGS

#	Parameter	Value	Units	Comments
1	DHW Usage to be replaced	231	GPD	
2	Baseline Energy Consumption	9,203	kWh/Yr	261 GPD heated with El. Htg
3	Proposed Energy Consumption	3,681	kWh/Yr	261 GPD heated with heat pump
4	Savings	5,522	kWh/Yr	=Baseline - Proposed
5	Cost Savings	$703	$/Yr	=Savings(kWh) * $/kWh
6	Rebate	$1,325	$/Yr	=Savings(kWh) * 0.24 $/kWh
7	Cooling Effect as Bonus	2.7	Tons	When DHW is used

CAPITAL COSTS, AND SIMPLE PAYBACK

#	Parameter	Value	Units	Comments
1	Cost of New Heater	$1,599	$	Source: Sears.com
2	Demolition Cost	$500	$	Lumpsum
3	Electrical Costs	$500	$	26 Amp New ckt
4	Installation Costs	$500	$	
5	Total Installed Cost	$3,099	$	
6	Rebate	$1,325	$	
7	Net Installed Cost	$1,774	$	=Total Installed Costs-Rebates
8	Savings	$704	$/Yr	
9	Simple Payback	2.5	Yrs	

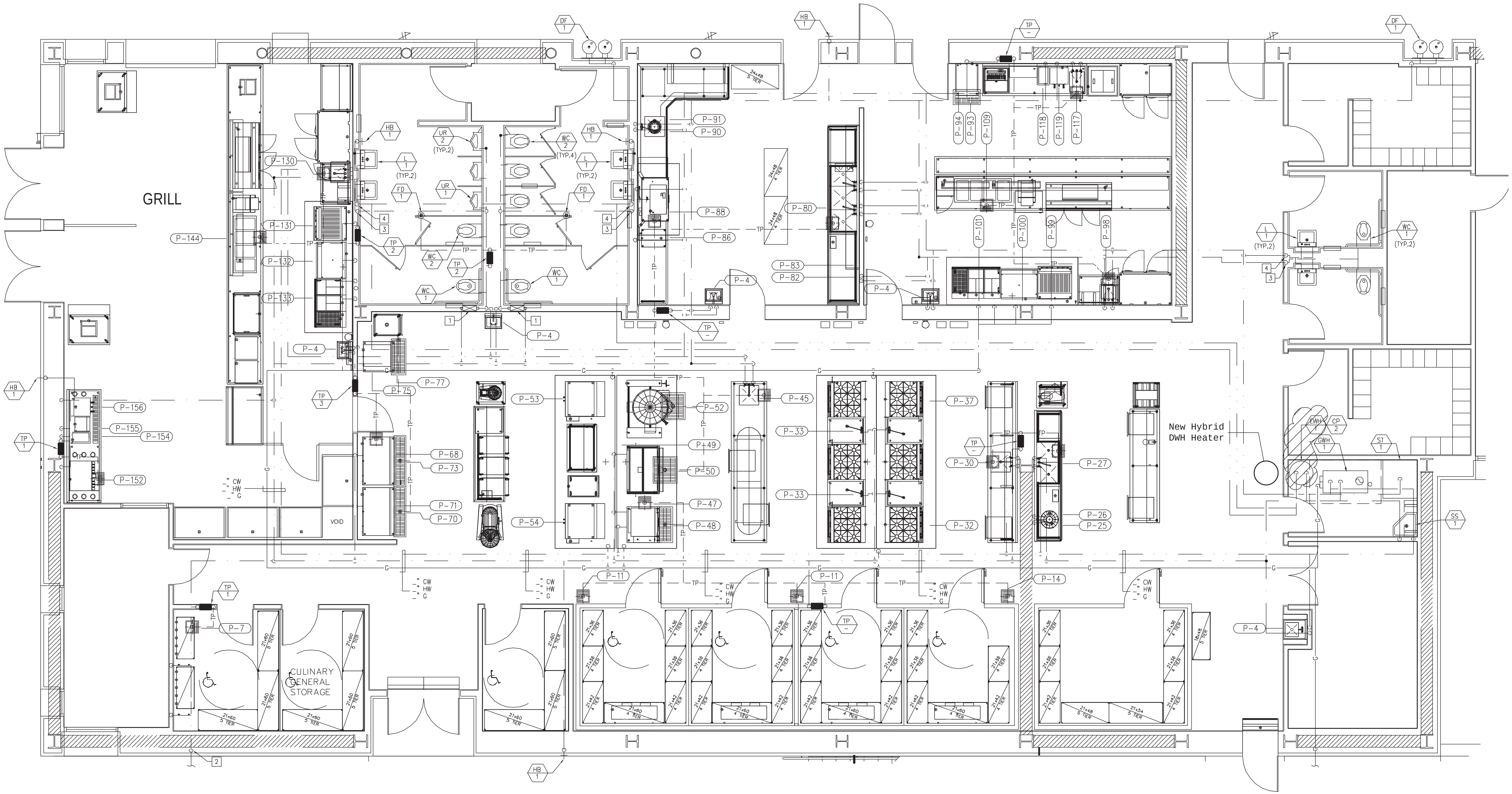

GRILL
CULINARY GENERAL STORAGE
VOID
New Hybrid DWH Heater

TABLE 1 LIST OF ACTIVE ENERGY STAR MODELS

Brand	Model	Volume (gallons)	Tank Height (inches)	Tank Diameter (inches)	Input (kW)	Volts	Energy Factor	kWh/ year	First Hour Rating (gallons per hour)	Min Warranty- Tank (years)	Min Warranty- Parts (years)	Active	Active Date
A.O. Smith	PHPT-80	80	80.9	25.2	4.5	240	2.3	1909	71	10	10	Yes	3/25/2010
AirGenerate	ATI1266	66	82.2	22.5	4.5	240	2.2	1950	60	6	6	Yes	10/7/2009
American	HPE10280H045DV	80	80.9	25.2	4.5	240	2.3	1909	71	10	10	Yes	3/25/2010
GE	GEH50DNSR***	50	60.5	21.8	4.5	240	2.35	1856	63	10	10	Yes	8/24/2009
GE	GEH50DXSR***	50	60.5	21.8	4.5	240	2.35	1856	63	10	10	Yes	8/24/2009
Reliance	10 80 DHPT	80	80.9	25.2	4.5	240	2.3	1909	71	10	10	Yes	3/25/2010
Rheem	HP50RH	50	75.5	21	4	240	2	2195	67	10	10	Yes	9/3/2009
Rheem EcoSense	HP50ES	50	75.5	21	4	240	2	2195	67	10	10	Yes	9/3/2009
Richmond	HP50RM	50	75.5	21	4	240	2	2195	67	10	10	Yes	9/3/2009
Ruud	HP50RU	50	75.5	21	4	240	2	2195	67	10	10	Yes	9/3/2009
State	EPX 80 DHPT	80	80.9	25.2	4.5	240	2.3	1909	71	10	10	Yes	3/25/2010
Stiebel Eltron	ACCELERA 300	80	73.8	26	2.2	240	2.51	1739	78	6	6	Yes	9/8/2009
USCraftmaster	HPE2K80HD045V (USC)	80	80.9	25.2	4.5	240	2.3	1909	71	10	10	Yes	3/25/2010
USI Green Energy	Green Star WH1360	65	82.5	22.5	4.5	240	2.2	1950	60	6	6	Yes	1/6/2010
Whirlpool	HPE2K80HD045V (WP)	80	80.9	25.2	4.5	240	2.3	1909	71	10	10	Yes	3/25/2010

EEM 08—Liberal Arts AHU Supply Fan VFDs

Background

Liberal Arts building has two air handling units (AHU) with 28,260 CFM and 16,170 CFM capacities respectively. Air is displaced by supply fan with motor sizes of 20 and 8 HP respectively. The building has multiple supply zones with variable air volume dampers. This EEM attempts to calculate the savings and payback performance of installing a variable speed drive on the replaced premium efficiency motors. E-quest was used to simulate the building, to generate savings.

FIGURE 9 MOTOR OF 28260 CFM AHU

Assumptions

The following inputs were used in to E-quest.

Savings

Savings are calculated in the table below by E-quest Model results, establishing baseline and proposed EEM.

Capital Costs & Simple Payback

Capital cost is estimated as cost of replacing existing motors with premium efficiency motors (Class F Insulation) and installing VFDs on them.

ASSUMPTIONS AND INPUTS TO E-QUEST

#	Parameter	Value	Units	Comments
1	Cost of Electricity	$0.13	$/kWh	From Utility Bills
2	Gas Rebate	$1.00	$/Therm	CCC-IOU Rebate
3	Electricity Rebate	$0.24	$/kWh	CCC-IOU Rebate

SAVINGS AND REBATES

#	Parameter	Value	Units	Comments
1	AHU-1 CFM	16,170	CFM	From Data Sheet
2	AHU-1 Fan BHP	8.00	BHP	From Data Sheet
3	AHU-2 CFM	28,260	CFM	From Data Sheet
4	AHU-2 Fan HP	20.00	HP	From Data Sheet
5	Baseline Ventilation Fans Energy Consumption	19,606	kWh/yr	From E-Quest Preliminary Model
6	Proposed Ventilation Fans Energy Consumption	6,870	kWh/yr	From E-Quest Preliminary Model
7	Energy Savings	12736.0	kWh/yr	=Baseline-Proposed
8	Rebate	$3,057	$	@ 0.24$/kWh CCC-IOU Rebate
9	Cost Savings	$1,623	$/Yr	@ Calculated cost of Electricity

CAPITAL COSTS AND SIMPLE PAYBACK

#	Parameter	Value	Units	Comments
1	Cost of 20 BHP VFD	$3,975	$	26292 310 0150
2	Cost of 7.5 BHP VFD	$2,450	$	26292 310 0120
3	Premium Efficiency Motor-20HP	$2,000	$	26711 320 1750
4	Premium Efficiency Motor-7.5HP	$995	$	26711 320 1600
5	Total Installed Cost	$9,420	$	
6	Rebate	$3,057	$	
7	Net Installed Cost	$6,363	$	=Total Installed Costs-Rebates
8	Savings	$1,623	$/Yr	
9	Simple Payback	3.9	Yrs	

E-QUEST OUTPUT (ANNUAL ELECTRIC CONSUMPTION, BY ENDUES)

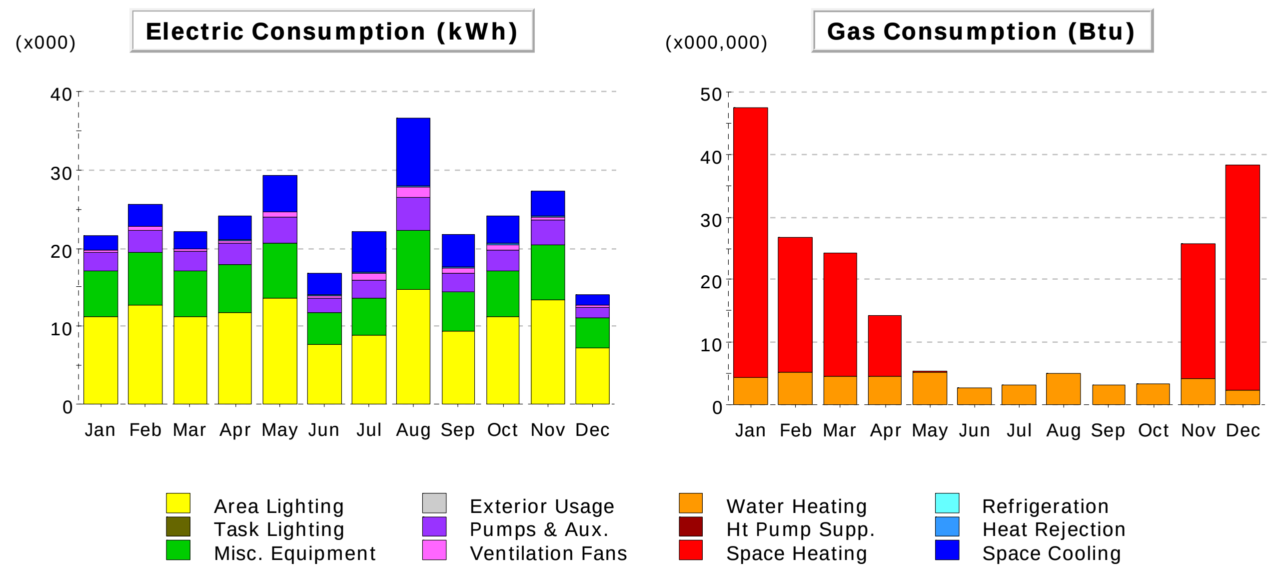
		Ambient Lights	Task Lights	Misc Equip	Space Heating	Space Cooling	Heat Reject	Pumps & Aux	Vent Fans	Dom Ht Wtr	Exterior Usage	Total
Annual Energy USE (kWh)												
0	Base Design	132,680	0	69,627	0	44,823	685	32,229	19,606	0	0	299,650
1	0+Fan Power & Ctrl EEM	132,680	0	69,627	0	43,298	648	31,851	6,870	0	0	284,974

Incremental SAVINGS (MWh) (values are relative to previous measure (% savings are relative to base case use), negative entries indicate increased use)

		Ambient Lights	Task Lights	Misc Equip	Space Heating	Space Cooling	Heat Reject	Pumps & Aux	Vent Fans	Dom Ht Wtr	Exterior Usage	Total
1	0+Fan Power & Ctrl EEM	0.00 (0%)	--	0.00 (0%)	--	1.52 (3%)	0.04 (5%)	0.38 (1%)	12.74 (65%)	--	--	14.68 (5%)

Cumulative SAVINGS (MWh) (values (and % savings) are relative to the Base Case, negative entries indicate increased use)

		Ambient Lights	Task Lights	Misc Equip	Space Heating	Space Cooling	Heat Reject	Pumps & Aux	Vent Fans	Dom Ht Wtr	Exterior Usage	Total
1	0+Fan Power & Ctrl EEM	0.00 (0%)	--	0.00 (0%)	--	1.52 (3%)	0.04 (5%)	0.38 (1%)	12.74 (65%)	--	--	14.68 (5%)



Electric Consumption (kWh x000)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Cool	1.80	2.75	2.16	3.05	4.62	2.68	5.16	8.67	4.24	3.65	3.23	1.30	43.30
Heat Reject.	0.01	0.01	0.01	0.03	0.06	0.04	0.14	0.19	0.07	0.04	0.03	0.01	0.65
Refrigeration	-	-	-	-	-	-	-	-	-	-	-	-	-
Space Heat	-	-	-	-	-	-	-	-	-	-	-	-	-
HP Supp.	-	-	-	-	-	-	-	-	-	-	-	-	-
Hot Water	-	-	-	-	-	-	-	-	-	-	-	-	-
Vent. Fans	0.37	0.53	0.39	0.43	0.65	0.39	0.78	1.28	0.71	0.67	0.48	0.21	6.87
Pumps & Aux.	2.38	2.88	2.45	2.72	3.34	1.82	2.38	4.17	2.42	2.71	3.10	1.48	31.85
Ext. Usage	-	-	-	-	-	-	-	-	-	-	-	-	-
Misc. Equip.	5.87	6.64	5.87	6.13	7.05	4.08	4.70	7.63	4.95	5.88	7.00	3.82	69.63
Task Lights	-	-	-	-	-	-	-	-	-	-	-	-	-
Area Lights	11.19	12.73	11.19	11.70	13.50	7.66	8.89	14.65	9.39	11.20	13.42	7.16	132.68
Total	21.62	25.53	22.08	24.05	29.21	16.67	22.05	36.59	21.79	24.15	27.25	13.98	284.97

Gas Consumption (Btu x000,000)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Cool	-	-	-	-	-	-	-	-	-	-	-	-	-
Heat Reject.	-	-	-	-	-	-	-	-	-	-	-	-	-
Refrigeration	-	-	-	-	-	-	-	-	-	-	-	-	-
Space Heat	43.13	21.63	19.77	9.60	0.31	-	-	-	-	-	21.51	36.05	151.97
HP Supp.	-	-	-	-	-	-	-	-	-	-	-	-	-
Hot Water	4.42	5.20	4.53	4.71	5.22	2.73	3.05	5.05	3.16	3.37	4.25	2.32	48.01
Vent. Fans	-	-	-	-	-	-	-	-	-	-	-	-	-
Pumps & Aux.	-	-	-	-	-	-	-	-	-	-	-	-	-
Ext. Usage	-	-	-	-	-	-	-	-	-	-	-	-	-
Misc. Equip.	-	-	-	-	-	-	-	-	-	-	-	-	-
Task Lights	-	-	-	-	-	-	-	-	-	-	-	-	-
Area Lights	-	-	-	-	-	-	-	-	-	-	-	-	-
Total	47.55	26.83	24.30	14.30	5.52	2.73	3.05	5.05	3.16	3.37	25.76	38.37	199.99

EEM 09—Auditorium AHU Supply Fan Wheel Retrofit

Background

Auditorium building has one air handling unit in the basement, manufactured by Energy Labs. There is one supply fan with VFD on this unit which is manually controlled. The fan is oversized and is operating at 45 % all the time to reduce the ventilation CFM. This causes existing fan to operate at lower efficiency then the design efficiency. This EEM attempts to quantify the savings and payback performance by installing the smaller impeller on the existing setup.

Assumptions and Inputs

Inputs, observations and assumptions for EEM-09 are tabulated below.

Savings

Savings are calculated by calculating the difference in operating power at 7200 CFM (7500 CFM), which is the flow of air through existing AHU fan at 45% speed.

Capital Costs

Simple Payback

Payback performance of the EEM-09 is summarized in Table below. Rebate will pay for the replacement costs. This is zero year payback, which is instantaneous payback.

INPUTS AND ASSUMPTIONS

#	Parameter	Value	Comments
1	Blended cost of electricity ($/kWh)	$0.13	From Utility Bills
2	kW/Ton for Chiller	0.8	North Hall Chiller
3	η-Belt	97%	Reasonable Assumption
4	2010 Rebate = 2009 Rebate ($/kWh)	$0.24	CCC-IOU Rebate
5	1 kW = 3412.14 Btu/h	3413	Conversion Factor
6	VFD output	45.0%	Observation
7	Power Factor of Existing Motor+VFD set-up	0.75	Observation
8	VFD Current, Amps	62	Observation
9	Specific Heat of Air	0.24	Btu/Lbm-°F
10	Standard Density of Air	0.075	Lbm/ft3
11	CFM of the AHU	16,000	Name Plate Data
12	Retail Cost of Natural Gas Fuel ($/MMBTU)	0.73	$/Therm, Utility Bills
13	Annual Operation (16 hrs/ day* 5 days/wk * 50 wks/yr)	4,000	Hrs/Yr
14	Motor Efficiency	93%	Assumption

FIGURE 1 PERFORMANCE CURVE OF EXISTING FAN IN AHU

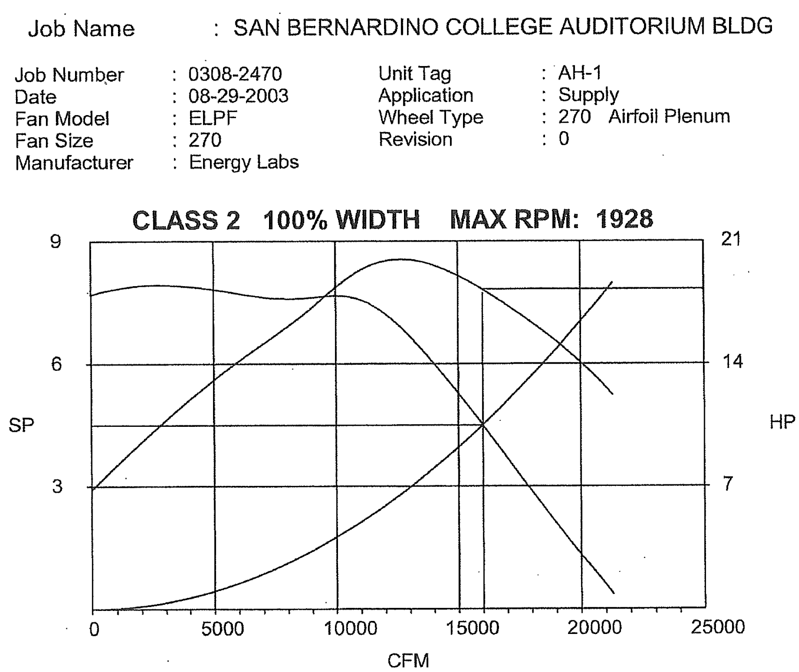
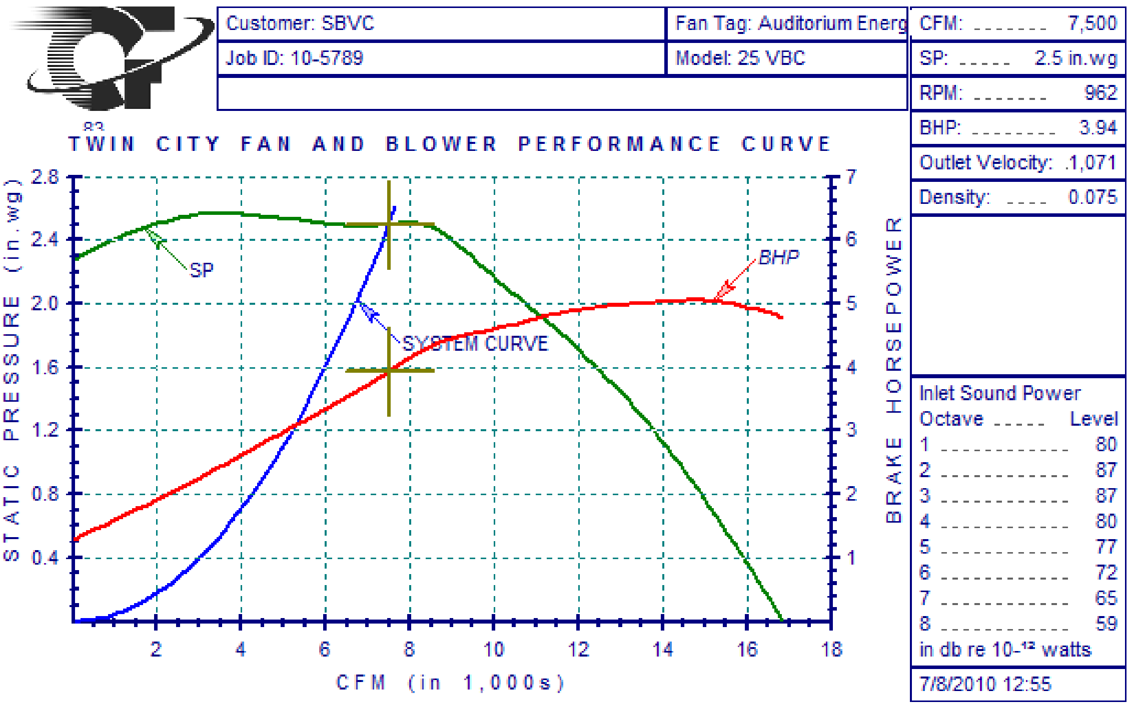


FIGURE 2 PERFORMANCE OF SMALLER FAN IN THE SAME AHU



SAVINGS

#	Parameter	Value	Units	Notes/Comments
1	Fan Motor Rating	25.00	hp	From Submittal
2	Observed Power Consumption	18.50	kW	with 0.75 PF
3	New Fan HP	3.94	hp	=Fan Input Power/□-belt
4	Power of New Fan Wheel	4.33	kW	From Temtrol Submittal
6	ΔkW, Energy Savings	14	kW	kW savings adjusted for 77.9% speed
7	Annual Hrs	4,000	Hr/Yr	Assumption-13
8	Energy Savings, Fan Motor	56,674	kWh/Yr	
9	Reduced Cooling Load (Btuh)	48,358	Btu/hr	
10	Reduced Chiller Load, Tons	4.03	Tons	
11	kW/Ton for Existing Chiller	0.80		Assumption-2
12	Reduced Chiller Load, kW	3.22		kW/ton*Reduced Chiller Load
13	Chiller Energy Savings, kWh/Yr	6,448		=Reduced Chiller Load * Annual Hrs * 0.5
14	Σ Savings, kWh/Yr	63,121		= Chiller Savings+Fan Motor Savings
15	Blended cost of electricity ($/kWh)	$0.13		Based on Utility Data
16	2010 Rebate = 2009 Rebate ($/kWh)	$0.24		CCC-IOU Rebates
17	Savings, $/Yr	$8,042		
18	Rebate, $	$15,149		

FIGURE 3 MANUFACTURER'S PRICE FOR SELECTED OPTIONS

Twin City Fan & Blower

A Twin City Fan Company

5959 Trenton Lane · Minneapolis, MN 55442-3238
Phone (763) 551-7600 · Fax (763) 551-7601 · www.tcf.com

ISO 9001 CERTIFIED

Customer: SBVC
Job Name: SBVC
Job ID: 10-5789

July 08, 2010
Page: 1

Fan tag: Auditorium Ener CFM: 7,500 SP (in.wg): 2.5
Temperature (°F): 70 Altitude (ft): 0 Density (lb/ft³): 0.075

#	Type	Size	Cl.	% peak	Drive	RPM	Max RPM	Std. BHP	Op. BHP	OV	S.E.	M.E.	FanSelectionID	Price	TipSpeed	Di
1	VBC	12	K	26.46	BD	3734	4000	9.36	9.36	4401	31.49	46.70	1	529.00	12432	12
2	VBC	14	K	37.20	BD	2810	3800	6.97	6.97	3395	42.28	54.43	1	637.00	10485	10
3	VBC	16	R	52.39	BD	2093	2400	5.38	5.38	2711	54.80	64.84	1	611.00	8758	87
4	VBC	18	R	66.32	BD	1660	2200	4.66	4.66	2152	63.26	70.56	1	788.00	7785	77
5	VBC	20	R	79.77	BD	1353	2000	4.28	4.28	1712	68.92	73.96	1	908.00	7098	70
6	VBC	22	R	91.51	BD	1128	1800	4.12	4.12	1363	71.61	74.93	1	1066.00	6627	66
7	VBC	25	R	99.73	BD	962	1700	3.94	3.94	1071	74.81	76.95	1	1250.00	6336	63
8	VBC	28	R	99.99	BD	855	1400	4.17	4.17	864	70.62	71.94	1	1756.00	6327	63

CAPITAL COST ESTIMATE

#	Parameter	Value	
1	Capital Cost for Replacement	$1,275	Manufacturer's Data
2	Installation Cost	$3,300	60 Hrs @ $ 55/hr
3	Rentals, Subcontract, Misc	$500	
4	Total Installed Cost	$5,075	

PAYBACK PERFORMANCE

#	Parameter	Value	
1	Capital Cost	$5,075	Manufacturer's Data
2	Rebate	$5,075	from SCE Rebate
3	Net Installation Cost	$ -	
4	Savings	$8,042	From Savings
5	Simple Payback	$ -	Instantaneous Payback

EEM 10—
Planetarium Electric Heating to Hydronic Heating Upgrades

Background

Planetarium building has a chilled water plant that is cooled by air cooled condenser. The air handler has six zones and each zone has electric reheat. This ECM attempts to install hydronic components (VAV reheat) from a new Hydronic heater located in the Gymnasium (or any other new Adjacent Building).

FIGURE 14 MULTI ZONE AIR HANDLING SYSTEM

Assumptions

Inputs used for energy conservation calculations and other assumptions made are tabulated below. The central plant hydronic hot water is assumed to supply hot water to Planetarium. Hence, a capital cost of local hydronic heater is not included in this ECM.

Savings and Rebates

Savings and Rebates for the ECM-11 are calculated in the table below. Baseline energy consumption of electric heating is derived through E-Quest modeling results.

Payback

Simple payback for the EEM-11 is tabulated below.

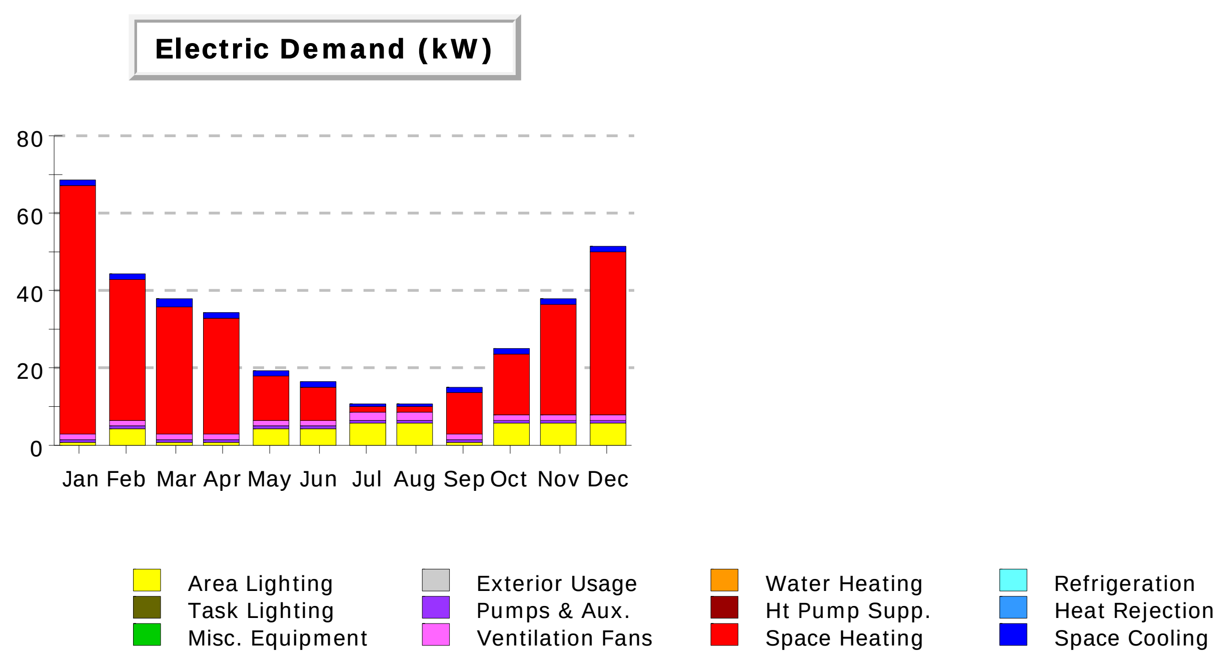
MULTI-ZONE AIR HANDLING UNIT

#	Parameter	Value	Units	Comments
1	Cost of Electricity	$0.13	$/kWh	From Utility Bills
2	Gas Rebate	$1.00	$/Therm	CCC-IOU Rebate
3	Electricity Rebate	$0.24	$/kWh	CCC-IOU Rebate
4	Hydronic Boiler Efficiency	80%	%	Assumption
5	Cost of Natural Gas	$0.81	$/Therm	Current Meter Costs

SAVINGS

#	Parameter	Value	Units	Comments
1	Existing Space Heating Energy Consumption	11,570	kWh/yr	From Preliminary E-Quest Simulation
2	Baseline Heating Energy Costs	$1,474	$/Yr	
3	Existing Space Heating Energy Consumption	494	Therms/Yr	
4	Fuel Costs for Hydronic Heating Systems	$400	$/Yr	Proposed Fuel Costs
5	Rebate	$2,777	$	@ 0.24$/kWh CCC-IOU Rebate
6	Cost Savings	$1,074	$/Yr	@ Calculated cost of Electricity

E-QUEST MODELING RESULTS (BASELINE)



Electric Demand (kW)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Cool	1.42	1.44	1.44	1.45	1.47	1.46	0.84	0.93	1.46	1.46	1.45	1.44	16.26
Heat Reject.	-	-	-	-	-	-	-	-	-	-	-	-	-
Refrigeration	-	-	-	-	-	-	-	-	-	-	-	-	-
Space Heat	63.98	36.01	33.06	30.09	11.51	8.54	1.89	1.90	10.31	15.86	28.65	41.96	283.77
HP Supp.	-	-	-	-	-	-	-	-	-	-	-	-	-
Hot Water	-	-	-	-	-	-	-	-	-	-	-	-	-
Vent. Fans	1.58	1.58	1.58	1.58	1.58	1.58	1.58	1.58	1.58	1.58	1.58	1.58	18.97
Pumps & Aux.	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	7.03
Ext. Usage	-	-	-	-	-	-	-	-	-	-	-	-	-
Misc. Equip.	0.26	0.32	0.26	0.26	0.32	0.32	0.36	0.36	0.26	0.35	0.35	0.35	3.77
Task Lights	-	-	-	-	-	-	-	-	-	-	-	-	-
Area Lights	0.58	4.13	0.58	0.58	4.13	4.13	5.70	5.70	0.58	5.41	5.41	5.41	42.31
Total	68.41	44.07	37.51	34.55	19.59	16.61	10.95	11.05	14.78	25.23	38.02	51.32	372.10

PAYBACK

#	Parameter	Value	Units	Comments
1	Estimated Capital Costs	$10,926	$	26292 310 0150
2	Rebate	$2,777	$	
3	Net Installed Cost	$8,149	$	=Total Installed Costs-Rebates
4	Savings	$1,074	$/Yr	
5	Simple Payback	7.6	Yrs	

CAPITAL COSTS

Qty	CSI Number	Description	Crew	Daily Output	Labor Hours	Unit	Bare Mat.	Bare Labor	Total	Total Incl. O&P	Zip Code Prefix	Type	Release
6	23821 610 3120	Coil, flanged, hot water booster coil, copper tubes, aluminum fins, galvanized end sheets, H is finned height, L is finned length, 1 row, 10 fins per inch, 1/2" x .017" tube, .0065 fins, 15"H x 30"L	Q5	9.22	1.735	Ea.	$2,280	$504	$2,784	$3,270	906	Union	2010
240	22111 323 1180	Pipe, copper, tubing, solder, 3/4" diameter, type K, includes coupling & clevis hanger assembly 10' O.C.	1 Plum	74	0.108	L.F.	$1,332	$1,332	$2,664	$3,456	906	Union	2010
240	22071 910 4301	Insulation, pipe (price copper tube one size less than I.P.S.), cellular glass, closed cell foam, all service jacket, sealant, 0 water vapor transmission, working temperature (-450 Deg.F to +900 Deg.F), 1-1/2" wall, 1" iron pipe size, includes sealant	Q14	105	0.152	L.F.	$689	$1,440	$2,129	$3,000	906	Union	2010
6	23095 310 6150	Control Components, valves, motorized zone, sweat connections, with end switch, 2 wire, 3/4" CxC	1 Stpi	20	0.4	Ea.	$924	$120	$1,044	$1,200	906	Union	2010
	Totals						$5,225	$3,396	$8,621	$10,926			

EEM 11—Planetarium AHU Supply Fan VFD

Background

Planetarium building has a chilled water plant that is cooled by air cooled condenser. The air handler has six zones and each zone has electric reheat. This EEM attempts to install VFD and premium efficiency motor on the air handing unit supply motor to evaluate the payback performance. E-Quest was used to model the performance of the baseline and savings.

Assumptions

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

Savings and Rebate

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

Capital Costs & Payback

Capital costs include installation of a premium efficiency motor and a variable speed drive on the supply fan of the AHU. The table below summarizes capital costs required for ECM-12.

ASSUMPTIONS AND INPUTS

#	Parameter	Value	Units	Comments
1	Cost of Electricity	$0.13	$/kWh	From Utility Bills
2	Gas Rebate	$1.00	$/Therm	CCC-IOU Rebate
3	Electricity Rebate	$0.24	$/kWh	CCC-IOU Rebate
4	Hydronic Boiler Efficiency	80%	%	Assumption

SAVINGS AND REBATE

#	Parameter	Value	Units	Comments
1	Existing Ventilation Fan Energy consumption	17,558	kWh/yr	From Preliminary E-Quest Simulation
2	Proposed Ventilation Fan Energy Consumption	7,113	kWh/yr	From Preliminary E-Quest Simulation
3	Energy Savings for ECM-12	10,445	kWh/yr	=Baseline - Proposed
5	Rebate	$2,507	$	@ 0.24$/kWh CCC-IOU Rebate
6	Cost Savings	$1,331	$/Yr	@ Calculated cost of Electricity

CAPITAL COSTS AND PAYBACK

#	Parameter	Value	Units	Comments
1	Estimated Capital Costs, VFD	$2,025	$	262923100110
2	5 HP Premium Efficiency Motor	$630	$	
3	Total Installed Cost	$2,655		
4	Rebate	$2,507	$	
5	Net Installed Cost	$148	$	=Total Installed Costs-Rebates
6	Savings	$1,331	$/Yr	
7	Simple Payback	0.1	Yrs	

E-QUEST OUTPUT FOR PLANETARIUM AHU SUPPLY FAN VFD

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	576	90.97	56,222	--	21,299	33,089	--	113	68	0
1	0+Fan Power & Ctrl EEM	494	78.05	48,235	--	21,299	25,102	--	86	68	0
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	82	12.92 (14%)	7,987 (14%)	--	0 (0%)	7,987 (24%)	--	27 (24%)	-0 (-0%)	0 (3%)
Cumulative SAVINGS	(values (and % savings) are relative to the Base Case, negative entries indicate increased use)										
1	0+Fan Power & Ctrl EEM	82	12.92 (14%)	7,987 (14%)	--	0 (0%)	7,987 (24%)	--	27 (24%)	-0 (-0%)	0 (3%)

EEM 12—High SEER Condensing Units

Background

Planetarium building has a chilled water plant that is cooled by air cooled condenser. The air handler has six zones and each zone has electric reheat. This ECM attempts to install VFD and premium efficiency motor on the air handing unit supply motor to evaluate the payback performance. E-Quest was used to model the performance of the baseline and savings.

Savings

Energy savings are generated based on operational efficiency gain. All units analyzed under this EEM are serving computer server rooms and hence use of 2500 operational hours per year is conservative. Thermostats in these spaces are set to 72 ˚F temperature settings.

ASSUMPTIONS

#	Parameter	Value	Comments
1	Blended cost of electricity ($/kWh)	$0.13	From SCE Bills
2	Data Center Cooling Hrs/Yr @ full capacity	2500	Needs to be Validated
3	Non Data Center Cooling Hrs?Yr	1000	Standard Seasonal Hrs
4	Rebate rate, if available for 2010 ($/kWh)	$0.24	CCC-IOU Rebate

ENERGY EFFICIENCY IMPROVEMENT CALCULATIONS

			Existing		Proposed			
ID#	Bldg	BTU/h	EER	Operating Cost ($/Yr)	EER	Operating Cost ($/Yr)	kWH/Yr Savings	Savings. ($/yr)
CU-2	AUD	18,000	8	$730	15	$389	2,625	$341
CU-1	CC	18,000	9	$649	15	$389	2,000	$259
CU-2	CC	24,000	9	$865	15	$519	2,667	$346
CU-1	HLS	18,000	11	$531	15	$389	1,091	$142
CU-2	HLS	18,000	9	$259	15	$156	2,000	$104
CU-3	HLS	18,000	11	$531	15	$389	1,091	$142
CU-1	LIB	9,000	9	$324	15	$195	1,000	$130
Totals				$1,378		$778	4,625	$600

CAPITAL COST ESTIMATE

ID#	Bldg	BTUh	Total Installed Cost ($)	Notes
CU-2	AUD	18,000	$1,775	
CU-1	CC	18,000	$1,775	
CU-2	CC	24,000	$1,875	
CU-1	HKS	18,000	$1,775	
CU-2	HLS	18,000	$1,775	1,000 Hrs/ Yr Operation
CU-3	HLS	18,000	$1,775	
CU-1	LIB	9,000	$1,200	
Total Cost			$11,950	

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-2	AUD	18,000	$1,775	2,625	$341	$630	5.2	3.4
CU-1	CC	18,000	$1,775	2,000	$259	$480	6.8	5.0
CU-2	CC	24,000	$1,875	2,667	$346	$640	5.4	3.6
CU-1	HKS	18,000	$1,775	1,091	$142	$262	12.5	10.7
CU-2	HLS	18,000	$1,775	2,000	$104	$480	17.1	12.5
CU-3	HLS	18,000	$1,775	1,091	$142	$262	12.5	10.7
CU-1	LIB	9,000	$1,200	1,000	$130	$240	9.3	7.4
			$11,950	4,625	$1,462	$2,994	8.2	6.1

EEM 13—Monitoring Based Commissioning (MBCx)

Background

This EEM evaluates implementing MBCx to select buildings that are currently served by chilled water systems and have current Automated Logic DDC controls (ALC).

MBCx is a process through the CCC/IOU partnership that is performed over 7 phases and occurs during a course of a year. After the MBCx process is completed the partnership will pay $0.24 per kWh saved and $1.00 per therm saved that was verified up to the total amount that was estimated during the application period.

1. Application: Forms are filled out and savings estimated to be submitted to the partnership. Once approved the process can go forward.
2. Baseline: The building's current energy consumption is trended for three months by installing permanent metering; the process normalizes the energy consumption data for a year's worth of weather to estimate the yearly consumption. During this phase of the project the deficiencies of the building are discovered, and improvements suggested. Improvements consist of sequence changes, and fixing broken control devices. A report of the findings is produced.
3. Pre-functional Testing: The sequence changes improvements are tested manually to test validate proposed energy savings and operational improvements. A report of the findings is produced.
4. Functional Testing: During this phase equipment and controls are fixed, and the sequences are implemented and tested. After the changes are complete the post monitoring of energy consumption is trended for three months by the permanent metering; and the energy consumption data is normalized for the same years worth of weather of the baseline to estimate the annual post energy consumption. The baseline energy consumption is compared to the post energy consumption. A report of the findings is produced.
5. Training: Training occurs throughout the process with the operation staff since they will be involved during the project. At the end of the project a formal class is conducted which reviews the changes, and what actions they take can help or hurt operation of the buildings, and what to look out for in other buildings.
6. Systems Manual: A manual is assembled to help the operators to understand what the changes are and how they work, reference of important information about the system such as the control diagrams and sequences, operational manuals on equipment, energy rate structure, and the functional test lists to retest the sequences.
7. Final Report: The final report summarizes what has occurred over the course of the project. What was implemented which worked and did not work. It provides a master list of difficencies of what need to be fixed in the building and

The controls of all the buildings and subsystems at SBVC utilize both conventional, and some demand resetting control sequences.

Conventional sequences are typically single loop control. One sensor controls the action of one or more heating or air conditioning devices. Such as the dual duct VAV box, the thermostat knows what the temperature is and what it should be. If the temperature is too cold, the hot deck opens up, if the temperature is too hot, the hot deck closes and the cold deck opens up; both operate to meet the requirements of the room. Single loop control is the most common control in heating and air conditioning devices. With the advent of electronic and direct digital controls in the late 1970's, it became easier to perform multiple decisions (more than one control loop for a single device). Today, advanced control systems can be programmed graphically with function blocks rather than computer code. This makes it easier to make decisions on multiple variables in the network of systems in the building. Up until now, set points were used to control the most based on the most demanding days of the year.

On moderate days, systems operated using these same exaggerated set points, and other components in the system were required to compensate in response. This would be analogous to setting your vehicle's cruise control to 65 mph on the freeway, then using your brakes (without disengaging the cruise control) to regulate your speed around city streets.

Some control methods have used factors that have an indirect relation to what you are trying to control. Outside temperature could be used to control cooling such as resetting the supply air temperature up when it is cold out, or resetting the supply temperature down when it is hot out in a building. On cold days, cooling may not be required for most of the building, but may still be desirable in parts of the building with south-facing glass.

In the last couple of years, a significant advancement in control theory has been made. This advancement will allow for what is called demand and relational control.

Demand control is to operate a system based on the minimum requirements to satisfy everyone. For example, a pumping system for a chilled water system could be controlled. In the past, the pumping pressure set point was fixed. Now, with demand control, all the valves in the system are monitored to keep the most open valve open to no more than 85% and no less than 85% by changing the pressure set point in the system to this requirement. This would be like finding the speed at which you can safely drive through most of the traffic lights in a series of green traffic signals. The other added benefit of demand control is the fact that trouble areas will be easily identified by always being the most demanding or least demanding areas.

Relational control is a mode of operation where the efficiency of operation of two devices is interrelated with each other such that the increase of operation of one device will reduce the energy consumption of the other. If the operation for the same device decreases the consumption of the other is allowed to increase. Between the maximum and minimum operation of the two devices exists a set point that will reduce the combined consumption. Using programming to change values to find the best operation with the lowest consumption is considered relational control. The interaction of cooling tower condenser water set point and chiller operation is an example of relational control.

Utilizing the two methods of controlling can meet all demands of the building and will result in the lowest energy use. This is the type of control that will be provided for in the sequences under the MBCx project.

The typical payback period has been 2-3 years when implementing MBCx based on our experience. For this EEM we are conservatively projecting a 10-year payback period.

We have evaluated the following buildings for implementing MBCx.

Buildings

Administration and Student Services (AD/SS)

<u>Equipment Information</u>

The Administration and Student Service DDC Controls was renovated in 2004. The building consists of a small chiller and boiler plant. The building is served by 37 four pipe fan coils.

<u>Energy Management System</u>

The building consists of the latest generation of ALC controllers.

<u>Findings</u>

The controls modification would incorporate two functions under MBCx; improved metering and revised sequences for demand control.

Savings

43,000 kWh annually.

Cost

MBCx including programming $150,000

Payback

Less than 25 years for the MBCx Work

North Hall

Equipment Information

The building consists of 4 large package units and VAVs for the zones. The controllers installed in this building are the latest controllers.

Energy Management System

Since the building is not considered for the retrofit to chilled water at this time the control system should not be touched until then, when the design approach is known the controllers shall be replaced for the new configuration. The only item to be performed is installation of building level metering, which can be reused with the new control system and MBCx.

Findings

The controls modification to incorporate now is improved metering and revised sequences we would recommend executing through MBCx so some of the cost can be recovered by the partnership program. The savings can be expected to save 10% of the current annual energy use.

Savings

64,000 kWh annually.

Cost

MBCx including programming $150,000

Payback

Payback for the MBCx implementation is expected to be 16 years or less

Chemistry/Physical Science Building

Equipment Information

The building was just built and consists of an air cooled chiller, chilled water AHU's, VAV's, Tek-Air lab system, heating hot water system, split units, exhaust fans, vaccum pump, air compressor, and Domestic electric hot water system.

Energy Management System

The controls in building are a mixture of ALC, Tek-Air, and Mitsubishi stand alone split unit controls. There is currently no energy monitoring in the building.

Findings

The controls modification would incorporate two functions; improved metering and revised sequences for demand control.   For revised sequences we would recommend executing through MBCx so some of the cost can be recovered by the partnership program.

Savings

147,000 kWh annually.

Cost

MBCx including programming $150,000

Payback

Payback for the MBCx implementation is expected to be 6 years or less.

In summary the buildings that we recommend to implement MBCx, the cost to perform MBCx and the projected savings are shown below.

Building Name	Cost	Annual kWh Projected Savings
Administration and Student Services	$150,000	43,000 kWh
North Hall	$150,000	64,000 kWh
Chemistry/Physical Science Building	$150,000	147,000 kWh
Total	$450,000	278,000 kWh

EEM 14—Premium Efficiency Motors

Background & Observations

SBVC have over 100 motors in ten buildings being analyzed for energy conservation. It is recommended that SBVC 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 many building with large motors (HP>3) have been retrofitted with premium efficiency motors. Premium efficiency motors are a right replacement for any motor that operates more than 1000 hours/yr. SBVC should mandate the use of premium efficiency motors for all future retrofits and new buildings. It is recommended that the replacement be co-ordinated with the OEM (Original Equipment Manufacturer), particularly for Lathes and CNC machines in technical building.

Assumptions

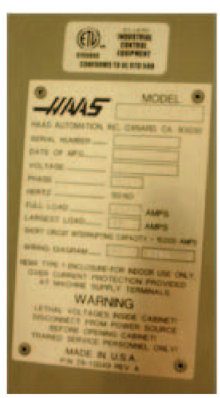
1.The operating hours of the motors being analyzed are outlined in the tables in this section. No data logging or M&V is performed to validate this.

2.The load factors are based on general observations during the site visits of the conservation study and they are on conservative side.

Other inputs considered for this EEM are listed below.

Savings, Costs and Paybacks

Table-2 summarizes savings, costs and paybacks for the motors identified as replacement candidates.



INPUTS

#	Parameter	Value	Units	Comments
1	Cost of Electricity	$0.13	$/kWh	From Utility Bills
2	Electricity Rebate	$0.24	$/kWh	CCC-IOU Rebate

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	Attach- ment #
Machines-1	T	1,000	12	70%	ODP	460	83.7	85.9	Rewind	1.5	1,392	$996	$334	$177	5.62	3.7	15-1
Machines-2	T	900	4	70%	TEFC	460	82.6	90.2	Rewind	5	896	$896	$215	$114	7.85	6.0	15-2
CHWP	P	1,600	1	50%	TEFC	460	81	89.7	Rewind	5	355	$224	$85	$45	4.95	3.1	15-5
Totals											2,643	$2,116	$634	$337	6.28	4.4	

EEM 15—Control Retrofit

Background

This ECM will implement replacing the control system from a mixture of pneumatics or obsolete DDC to the latest generation of current Automated Logic DDC controls (ALC).

Pneumatic controls have been around for over 100 years. They are reliable, but require maintenance, calibration, use more energy than DDC to operate and do not easily give feedback or the ability to easily implement advanced control sequences.

Some of the buildings contain ALC U-Line generation controls. These are buildings that were either built or retrofitted with DDC prior to 2002 typically but also some that were retrofitted as late as 2004. U-line controllers are no longer available, and do not perform a lot of the features available with the newer controllers (ME, SE, and ZN-Line controllers).

The controls of all the buildings and subsystems at Valley utilize both conventional, and some demand resetting sequences of operation.

Conventional sequences are usually referenced to single loop control. One sensor controls the action of one or more heating or air conditioning devices. Such as the dual duct VAV box, the thermostat knows what the temperature is and what it should be. If the temperature is too cold, the hot deck opens up, if the temperature is too hot, the hot deck closes and the cold deck opens up; both operate to meet the requirements of the room. Single loop control is the most common control in heating and air conditioning devices. With the advent of electronic and direct digital controls in the late 1970’s, it became easier to perform multiple decisions (more than one control loop for a single device). Today, advanced control systems can be programmed graphically with function blocks rather than computer code. This makes it easier to make decisions on multiple variables in the network of systems in the building. Up until now, set points were used to control the most based on the most demanding days of the year.

On moderate days, systems operated using these same exaggerated set points, and other components in the system were required to compensate in response. This would be analogous to setting your vehicle’s cruise control to 65 mph on the freeway, then using your brakes (without disengaging the cruise control) to regulate your speed around city streets.

Some control methods have used factors that have an indirect relation to what you are trying to control. Outside temperature could be used to control cooling such as resetting the supply air temperature up when it is cold out, or resetting the supply temperature down when it is hot out in a building. On cold days, cooling may not be required for most of the building, but may still be desirable in parts of the building with south-facing glass.

In the last couple of years, a significant advancement in control theory has been made. This advancement will allow for what is called demand and relational control.

Demand control is to operate a system based on the minimum requirements to satisfy everyone. For example, a pumping system for a chilled water system could be controlled. In the past, the pumping pressure set point was fixed. Now, with demand control, all the valves in the system are monitored to keep the most open valve open to no more than 85% and no less than 85% by changing the pressure set point in the system to this requirement. This would be like finding the speed at which you can safely drive through most of the traffic lights in a series of green traffic signals. The other added benefit of demand control is the fact that trouble areas will be easily identified by always being the most demanding or least demanding areas.

Relational control is a mode of operation where the efficiency of operation of two devices is interrelated with each other such that the increase of operation of one device will reduce the energy consumption of the other. If the operation for the same device decreases the consumption of the other is allowed to increase. Between the maximum and minimum operation of the two devices exists a set point that will reduce the combined consumption. Using programming to change values to find the best operation with the lowest consumption is considered relational control. The interaction of cooling tower condenser water set point and chiller operation is an example of relational control.

Utilizing the two methods of controlling can meet all demands of the building and will result in the lowest energy use.

There are quite a few buildings on campus that have pneumatic controls, obsolete ALC UNI controller or a mixture of both. Unfortunately the buildings may have small package units, which may get changed out when the building converts to chilled water in the future, which is pointless to convert the controls now, or they will be renovated and are not included in the master plan.

The following buildings we are considering to replace the controls on under Priority 1 chilled water connections:

Recommendations

The following buildings we are considering to replace the controls on under Priority 1 chilled water connections:

Planetarium (PL) Building

<u>Equipment Information</u>

The building contains a multi-zone unit with electric heat and air-cooled chiller plant.

<u>Energy Management System</u>

The control system is a combination of Pneumatic and DDC.

<u>Findings</u>

The existing controls shall be removed and new DDC controls and metering be installed with demand control sequences. After the controls and metering for all the utilities are installed the system shall be commissioned. Although it is a capital project it should be investigated if Partnership money is available. This work shall be in conjunction with EEM 11 & 12

<u>Savings</u>

The building is served by an aircooled chiller plant, and electric zone heat in a constant volume multizone unit. Through our experience by properly controlling the electric heat(or hot water heat per EEM-11), VFD fan / VAV zones / static pressure reset, temperature reset of the supply temperature, economizer operation, and chiller plant operation through demand control based on our experience we can expect savings annually of – 58,350 kWh in addition to EEM 11 &12.

<u>Cost</u>

Complete Controls retrofit, metering and commissioning $50,000

Payback

Less than 17 years

In summary the Priority 1 buildings that we recommend to receive a control retrofit/commissioning and the projected savings are the following:

Building Name	Cost	Annual kWh Projected Savings
Planetarium (PL) Building	$130,000	130,000 kWh

The following buildings we are considering to replace the controls on under priority two chilled water connections:

Health and Life Science (HLS) Building

The building consists of package units, split units, and exhaust fans. The controllers installed in this building are the obsolete ALC UNI controllers.

Energy Management System

Since the building is not considered for the retrofit to chilled water at this time the control system should not be touched until then, when the design approach is known the controllers shall be replaced for the new configuration

Findings

The existing controls shall be removed and new DDC controls and metering be installed with demand control sequences. After the controls and metering for all the utilities are installed the system shall be commissioned. Although it is a capital project it should be investigated if Partnership money is available.

Savings

The building is currently served by package units, single zone or multiple zone control by demand or complaint. By connecting the building to the central plant the package units and distribution will have to be replaced by few AHU units. The controls will have to be changed. The new control system will remove the cycling operation of the package units cooling and heating, utilize temperature reset / demand based boiler system control for heat / optimized economizer operation, have VFD fans/static pressure reset. From our experience we can expect savings annually of 65,000 kWh.

Cost

When the units are converted to chilled water the conversion cost for the entire building with commissioning will be $100,000 considering that there are 34 units to retrofit. If units are consolidated the installation cost will be reduced.

Payback

10 years to payback

Library (LRC)

Equipment Information

The building consists of package units and zone dampers with a main bypass damper for some of the package units. The controllers installed in this building are the obsolete ALC UNI controllers.

Energy Management System

Since the building is not considered for the retrofit to chilled water at this time the control system should not be touched until then, when the design approach is known the controllers shall be replaced for the new configuration. The only item to be performed is installation of building level metering, which can be reused with the new control system.

Findings

The existing controls shall be removed and new DDC controls and metering be installed with demand control sequences. After the controls and metering for all the utilities are installed the system shall be commissioned. Although it is a capital project it should be investigated if Partnership money is available.

Savings

The building is currently served by package units, single zone or multiple zone control by demand or complaint. By connecting the building to the central plant the package units and distribution will have to be replaced by few AHU units. The controls will have to be changed. The new control system will remove the cycling operation of the package units cooling and heating, utilize temperature reset / demand based boiler system control for heat / optimized economizer operation, have VFD fans/static pressure reset. From our experience we can expect savings annually of 65,000 kWh.

Cost

When the units are converted to chilled water the conversion cost for the entire building with commissioning will be $200,000 considering that there are 17 units to retrofit. If units are consolidated the installation cost will be reduced.

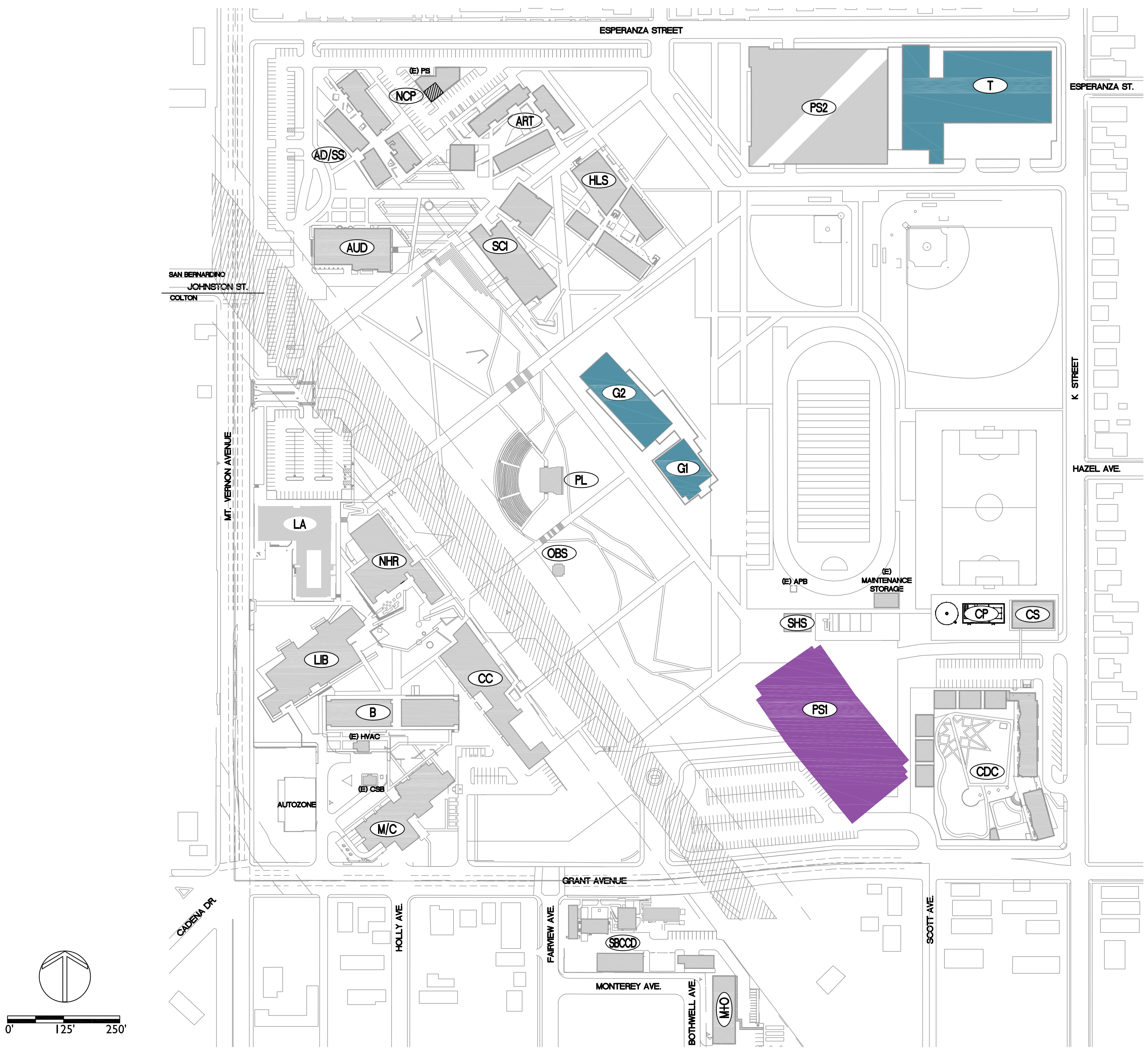
Payback

22 years to payback

In summary the Priority 1 buildings that we recommend to receive a control retrofit/commissioning and the projected savings are the following.

Building Name	Cost	Annual kWh Projected Savings
Health and Life Science Building	$100,000	65,000 kWh
Library (LRC) Building	$200,000	65,000 kWh
Total	$300,000	130,000 kWh

Appendix C—PV System Supporting Data



EXISTING BUILDING IDENTIFICATION

AD/SS	ADMINISTRATION / STUDENT SERVICES
ART	ART & GALLERY
AUD	AUDITORIUM
B	BUSINESS
CC	CAMPUS CENTER
CDC	CHILD DEV CENTER
CS	CENTRALIZED STORAGE
HLS	HEALTH & LIFE SCIENCES
LA	LIBERAL ARTS
LIB	LIBRARY
MC	MIDDLE COLLEGE
OBS	OBSERVATORY
PL	PLANETARIUM
SHS	STUDENT HEALTH SERVICES
MEDIA	MEDIA / COMMUNICATIONS
M&O	MAINTENANCE & OPERATIONS
NCP	NORTH CENTRAL PLANT
NHR	NORTH HALL REPLACEMENT
SCI	CHEMISTRY / PHYSICAL SCIENCES

FUTURE BUILDING IDENTIFICATION

CP	CENTRAL PLANT
G1	GYMNASIUM 1
G2	GYMNASIUM 2
PS1	PARKING STRUCTURE 1
PS2	PARKING STRUCTURE 2
T	TECHNICAL

LEGEND

- PV PANEL - PHASE 1
- PV PANEL - PHASE 3

Proposed PV Site Plan

PVWatts * * * * *

AC Energy & Cost Savings

* * * * * Cautions for Interpreting the Results

(Type comments here to appear on printout; maximum 1 row of 90 characters.)

Station Identification	
Cell ID:	0176362
State:	California
Latitude:	34.0 ° N
Longitude:	117.3 ° W
PV System Specifications	
DC Rating:	150.0 kW
DC to AC Derate Factor:	0.850
AC Rating:	127.5 kW
Array Type:	Fixed Tilt
Array Tilt:	15.0 °
Array Azimuth:	180.0 °
Energy Specifications	
Cost of Electricity:	13.0 ¢/kWh

Results			
Month	Solar Radiation ($kWh/m^2/day$)	AC Energy (kWh)	Energy Value ($)
1	3.96	14667	1906.71
2	4.59	15465	2010.45
3	5.51	20394	2651.22
4	6.36	22307	2899.91
5	7.09	25490	3313.70
6	7.82	26567	3453.71
7	7.69	26556	3452.28
8	7.45	25612	3329.56
9	6.44	21602	2808.26
10	5.19	18513	2406.69
11	4.34	15430	2005.90
12	3.73	13790	1792.70
Year	5.85	246394	32031.22

Output Results as Text

Saving Text from a Browser

Run PVWATTS v.2 for another location

Run PVWATTS v.1

Please send questions and comments to Webmaster

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

KWH OUTPUT FOR 200 KW PV SYSTEM

AC Energy & Cost Savings

* * * * * * * * * *

Cautions for Interpreting the Results

(Type comments here to appear on printout; maximum 1 row of 90 characters.)

Station Identification	
Cell ID:	0176362
State:	California
Latitude:	34.0 ° N
Longitude:	117.3 ° W
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:	13.0 ¢/kWh

Results			
Month	Solar Radiation ($kWh/m^2/day$)	AC Energy (kWh)	Energy Value ($)
1	3.96	19557	2542.41
2	4.59	20620	2680.60
3	5.51	27192	3534.96
4	6.36	29742	3866.46
5	7.09	33986	4418.18
6	7.82	35423	4604.99
7	7.69	35409	4603.17
8	7.45	34150	4439.50
9	6.44	28803	3744.39
10	5.19	24684	3208.92
11	4.34	20573	2674.49
12	3.73	18386	2390.18
Year	5.85	328525	42708.25

Output Results as Text

Saving Text from a Browser

Run PVWATTS v.2 for another location

Run PVWATTS v.1

Please send questions and comments to Webmaster

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 90 characters.)

Station Identification	
Cell ID:	0176362
State:	California
Latitude:	34.0 ° N
Longitude:	117.3 ° W
PV System Specifications	
DC Rating:	250.0 kW
DC to AC Derate Factor:	0.850
AC Rating:	212.5 kW
Array Type:	Fixed Tilt
Array Tilt:	15.0 °
Array Azimuth:	180.0 °
Energy Specifications	
Cost of Electricity:	13.0 ¢/kWh

Results

Month	Solar Radiation ($kWh/m^2/day$)	AC Energy (kWh)	Energy Value ($)
1	3.96	24446	3177.98
2	4.59	25776	3350.88
3	5.51	33990	4418.70
4	6.36	37178	4833.14
5	7.09	42483	5522.79
6	7.82	44278	5756.14
7	7.69	44261	5753.93
8	7.45	42687	5549.31
9	6.44	36004	4680.52
10	5.19	30855	4011.15
11	4.34	25717	3343.21
12	3.73	22983	2987.79
Year	5.85	410657	53385.41

Output Results as Text

Saving Text from a Browser

Run PVWATTS v.2 for another location

Run PVWATTS v.1

Please send questions and comments to Webmaster

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 90 characters.)

Station Identification	
Cell ID:	0176362
State:	California
Latitude:	34.0 ° N
Longitude:	117.3 ° W
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:	13.0 ¢/kWh

Results

Month	Solar Radiation ($kWh/m^2/day$)	AC Energy (kWh)	Energy Value ($)
1	3.96	39113	5084.69
2	4.59	41241	5361.33
3	5.51	54383	7069.79
4	6.36	59485	7733.05
5	7.09	67972	8836.36
6	7.82	70846	9209.98
7	7.69	70817	9206.21
8	7.45	68299	8878.87
9	6.44	57606	7488.78
10	5.19	49368	6417.84
11	4.34	41147	5349.11
12	3.73	36773	4780.49
Year	5.85	657050	85416.50

Output Results as Text

Saving Text from a Browser

Run PVWATTS v.2 for another location

Run PVWATTS v.1

Please send questions and comments to Webmaster

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
600,000	*$3,000,000*	*$5.00*	*987,000*	*$0.19*	*$187,530*	*$0.130*	*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	$187,530	$128,310.00	($3,000,000)	($2,684,160)	($2,684,160)	987	714,588	592	790	325
yr 2	$187,500	$131,517.75	$0	$319,018	($2,365,142)	1,974	1,429,176	1,184	1,579	651
yr 3	$187,500	$134,805.69	$0	$322,306	($2,042,837)	2,961	2,143,764	1,777	2,369	976
yr 4	$187,500	$138,175.84	$0	$325,676	($1,717,161)	3,948	2,858,352	2,369	3,158	1,302
yr 5	$187,500	$141,630.23	$0	$329,130	($1,388,030)	4,935	3,572,940	2,961	3,948	1,627
yr 6		$145,170.99	$0	$145,171	($1,242,860)	5,922	4,287,528	3,553	4,738	1,953
yr 7		$148,800.26	$0	$148,800	($1,094,059)	6,909	5,002,116	4,145	5,527	2,278
yr 8		$152,520.27	($240,000)	($87,480)	($1,181,539)	7,896	5,716,704	4,738	6,317	2,604
yr 9		$156,333.28	$0	$156,333	($1,025,206)	8,883	6,431,292	5,330	7,106	2,929
yr 10		$160,241.61	$0	$160,242	($864,964)	9,870	7,145,880	5,922	7,896	3,254
yr 11		$164,247.65	$0	$164,248	($700,716)	10,857	7,860,468	6,514	8,686	3,580
yr 12		$168,353.84	$0	$168,354	($532,363)	11,844	8,575,056	7,106	9,475	3,905
yr 13		$172,562.69	$0	$172,563	($359,800)	12,831	9,289,644	7,699	10,265	4,231
yr 14		$176,876.75	$0	$176,877	($182,923)	13,818	10,004,232	8,291	11,054	4,556
yr 15		$181,298.67	$0	$181,299	($1,624)	14,805	10,718,820	8,883	11,844	4,882
yr 16		$185,831.14	($240,000)	($54,169)	($55,793)	15,792	11,433,408	9,475	12,634	5,207
yr 17		$190,476.92	$0	$190,477	$134,684	16,779	12,147,996	10,067	13,423	5,532
yr 18		$195,238.84	$0	$195,239	$329,922	17,766	12,862,584	10,660	14,213	5,858
yr 19		$200,119.81	$0	$200,120	$530,042	18,753	13,577,172	11,252	15,002	6,183
yr 20		$205,122.81	$0	$205,123	$735,165	19,740	14,291,760	11,844	15,792	6,509
yr 21		$210,250.88	$0	$210,251	$945,416	20,727	15,006,348	12,436	16,582	6,834
yr 22		$215,507.15	$0	$215,507	$1,160,923	21,714	15,720,936	13,028	17,371	7,160
yr 23		$220,894.83	$0	$220,895	$1,381,818	22,701	16,435,524	13,621	18,161	7,485
yr 24		$226,417.20	$0	$226,417	$1,608,235	23,688	17,150,112	14,213	18,950	7,811
yr 25		$232,077.63	$0	$232,078	$1,840,313	24,675	17,864,700	14,805	19,740	8,136

Size (DC W installed)	Total Installed Cost	Cost $/w	Production kW·hr/yr	CPUC Incentive		Power Cost	
				PBI ($/kW·hr)	Annual income	SCE rate	Rate Inflation
800,000	$6,400,000	$8.00	1,314,100	$0.19	$249,679	$0.130	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	$249,679	$170,833.00	($6,400,000)	($5,979,488)	($5,979,488)	1,314	951,408	788	1,051	433
yr 2	$249,679	$175,103.83	$0	$424,783	($5,554,705)	2,628	1,902,817	1,577	2,103	867
yr 3	$249,679	$179,481.42	$0	$429,160	($5,125,545)	3,942	2,854,225	2,365	3,154	1,300
yr 4	$249,679	$183,968.46	$0	$433,647	($4,691,897)	5,256	3,805,634	3,154	4,205	1,733
yr 5	$249,679	$188,567.67	$0	$438,247	($4,253,651)	6,571	4,757,042	3,942	5,256	2,166
yr 6		$193,281.86	$0	$193,282	($4,060,369)	7,885	5,708,450	4,731	6,308	2,600
yr 7		$198,113.91	$0	$198,114	($3,862,255)	9,199	6,659,859	5,519	7,359	3,033
yr 8		$203,066.75	($320,000)	($116,933)	($3,979,188)	10,513	7,611,267	6,308	8,410	3,466
yr 9		$208,143.42	$0	$208,143	($3,771,045)	11,827	8,562,676	7,096	9,462	3,900
yr 10		$213,347.01	$0	$213,347	($3,557,698)	13,141	9,514,084	7,885	10,513	4,333
yr 11		$218,680.68	$0	$218,681	($3,339,017)	14,455	10,465,492	8,673	11,564	4,766
yr 12		$224,147.70	$0	$224,148	($3,114,869)	15,769	11,416,901	9,462	12,615	5,200
yr 13		$229,751.39	$0	$229,751	($2,885,118)	17,083	12,368,309	10,250	13,667	5,633
yr 14		$235,495.18	$0	$235,495	($2,649,623)	18,397	13,319,718	11,038	14,718	6,066
yr 15		$241,382.56	$0	$241,383	($2,408,240)	19,712	14,271,126	11,827	15,769	6,499
yr 16		$247,417.12	($320,000)	($72,583)	($2,480,823)	21,026	15,222,534	12,615	16,820	6,933
yr 17		$253,602.55	$0	$253,603	($2,227,221)	22,340	16,173,943	13,404	17,872	7,366
yr 18		$259,942.61	$0	$259,943	($1,967,278)	23,654	17,125,351	14,192	18,923	7,799
yr 19		$266,441.18	$0	$266,441	($1,700,837)	24,968	18,076,760	14,981	19,974	8,233
yr 20		$273,102.21	$0	$273,102	($1,427,735)	26,282	19,028,168	15,769	21,026	8,666
yr 21		$279,929.76	$0	$279,930	($1,147,805)	27,596	19,979,576	16,558	22,077	9,099
yr 22		$286,928.01	$0	$286,928	($860,877)	28,910	20,930,985	17,346	23,128	9,532
yr 23		$294,101.21	$0	$294,101	($566,776)	30,224	21,882,393	18,135	24,179	9,966
yr 24		$301,453.74	$0	$301,454	($265,322)	31,538	22,833,802	18,923	25,231	10,399
yr 25		$308,990.08	$0	$308,990	$43,668	32,853	23,785,210	19,712	26,282	10,832