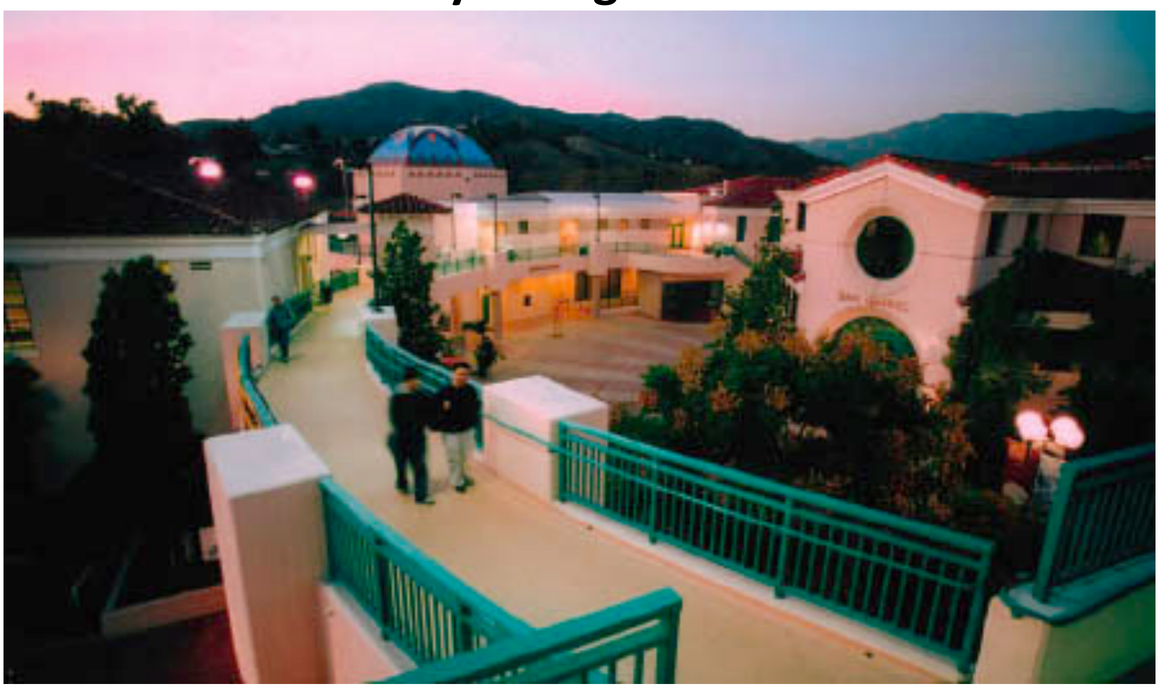
Energy Audit

for

Glendale Community College District



3 November 2010

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DISCLAIMER

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This study is for budgeting and planning purposes only. The equipment inventory is reasonably accurate for the purposes of this energy analysis, but is not exhaustive. As such the engineering analyses and recommendations are schematic in nature and NOT FOR CONSTRUCTION. Additional design and engineering is required before bidding or construction activities are pursued.

1.0 EXECUTIVE SUMMARY

Glendale Community College seeks to reduce its energy consumption and cost in a logical and orderly fashion. To this end, PE Consulting is pleased to present this Comprehensive Energy Audit to the College. This audit identifies upgrades that will substantially reduce operating costs and the College's carbon footprint while improving building occupant comfort, security and safety.

The scope of this project included engineering surveys of College buildings at the Verdugo and Garfield Campuses, collection of detailed equipment nameplate and operating conditions, as well as available original design specifications and building structures. From this information, comprehensive building energy models were balanced against historical (baseline) energy bills and strategies to reduce energy use were identified and analyzed for energy savings and cost effectiveness. Implementation of the recommended energy efficiency measures (EEMs) in this report will help Glendale Community College achieve their carbon reduction goals. A summary of the recommendations follows:

Baseline kBTU Energy use (CO2 tonnes)	77,449,592	(6,594)
Baseline kW Demand	2,911	
Projected kBTU Savings (%)	21,372,529	(28%)
Projected kW Demand Reduction (%)	525	(18%)
Upgrade Cost	$6,038,830	
Incentives and Rebates (%)	$655,247	(11%)
1st Year Annual Savings (%)	$465,452	(26%)
Simple Payback w/o incentives	13 yrs	
Net Return on Investment (%)	10 yrs	(10%)

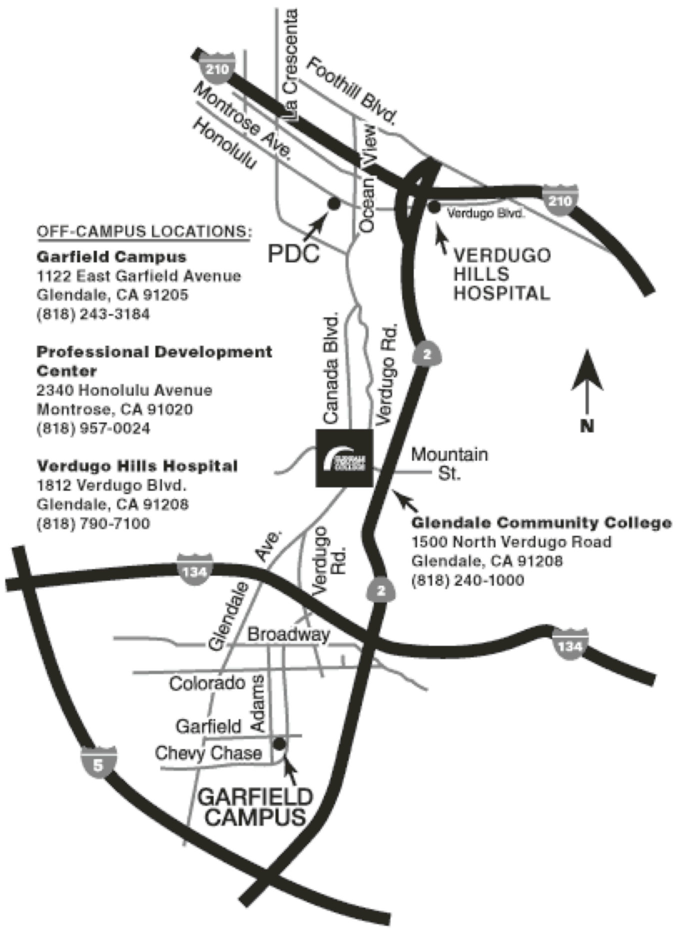
Notes: Baseline demand is average power demand (kW), not annual peak nor maximum potential connected load. Net ROI assumes conservative 5% *average* annual utility escalation rate and includes incentives. Incentives are contingent on available funds.

PE Consulting applauds Glendale Community College for its proactive approach in modernizing the college to reduce energy use (and greenhouse gas emissions). The College's actions will not only assist in meeting its Climate Action Plan goals but also positions the College as a role model for other organizations to cost effectively reduce emissions. We look forward to discussing this energy audit with Glendale Community College stakeholders and answering any questions the College may have as well as assisting with successful implementation including design, project management, commissioning, certification and performance validation of this program.

2.0 INTRODUCTION

2.1 Background

Glendale Community College District is located in the city of Glendale, CA. Two campuses were included in the scope of this report. The main (Verdugo) campus in Northern Glendale at 1500 North Verdugo Road and the Garfield Campus in suburban Glendale at 1122 East Garfield Ave.



The purpose of this Comprehensive Energy Audit (sponsored by Glendale Water & Power) is to identify energy efficiency and renewable energy upgrades to significantly reduce energy and operating costs. Since much of the equipment on the campus is reaching the end of its useful life and newer equipment efficiencies have increased over the last several years, the College has requested that PE Consulting incorporate redesign and equipment replacement options where feasible.

The following paper reports on the findings from PE Consulting's Comprehensive Energy Audit. The report details existing conditions and suggests cost effective measures that will reduce energy use and costs as well as help Glendale Community College District reduce costs and improve comfort and reliability.

2.2 Understanding this Report

This is a Comprehensive Energy Audit (CEA) report. It includes a detailed building and survey analysis that incorporates an analysis of recent energy usage patterns, review of operation and maintenance procedures, evaluation of the condition of existing equipment and systems, and energy modeling. Energy modeling was completed using ASHRAE engineering algorithms via proprietary software. In this report we have also exceeded level 2 requirements with renewable energy analyses and other environmentally sustainable modeling

Also, as requested by the College, this report includes information about anticipated carbon emission offsets and cost per ton to achieve these carbon offsets. Some recommended measures require further engineering prior to final budgeting. For additional engineering or design assistance, please refer to www.peconsulting.com.

This report is divided into the following sections:

1. **Executive Summary** – Provides an overview of the project, the findings, and the recommendations. College administration and other decision makers can read this section to get a good basic understanding of the steps we suggest the College implement to go green.

2. **Introduction** - Provides information about the purpose of the report and the format of this report.

3. **Energy Use Analysis** - This section provides information about the site visit and the utility bill analysis. It establishes the baseline energy used by the College.

4. **Existing Conditions and Recommendations –** For each building, this section provides a discussion about the existing conditions and a list of recommendations to improve the energy efficiency.

5. **Summary** – Suggests an approach to implement the energy efficiency measures identified and summarizes the energy savings and cost to implement these measures.

6. **Appendices** – Provides additional information such as building lists, meter lists, lighting and mechanical equipment lists, etc.

3.0 ENERGY USE ANALYSIS

3.1 Site Visit

Campus-wide site surveys for Glendale and Garfield campuses were conducted in June and July, 2010. During the site visits, PE Consulting engineers met with College managers and facilities maintenance to discuss the energy issues concerning the College. PE Consulting engineers toured over 31 buildings, 9 parking areas, a footbridge and various outdoor hardscapes totaling approximately 1 million square feet of space. At each building, detailed information was collected about the building construction, mechanical and electrical equipment, and operations.[1]

A comprehensive list of the buildings audited including detailed: occupancy, building envelope, mechanical, lighting and appliance data is provided in the Appendices.

3.2 Baseline Energy Use

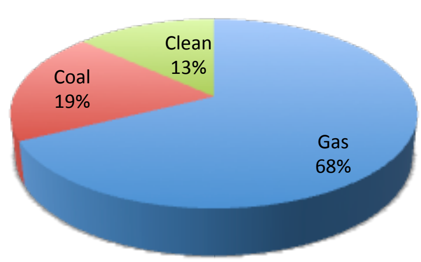
Following the site visit, historical electric and natural gas utility meter information provided by GWP and SCG respectively was compiled and disaggregated to determine energy use on a building-by building basis. Monthly electric and gas data for the past 24 months was analyzed and benchmarked for each meter at each site.

Using the baseline energy data for each individual meter, we compiled the data to develop a baseline[2] energy use and carbon footprint for all of the buildings audited. Note that gas usage data has been difficult to validate. It is shown "as provided". However, we believe the data provided for Garfield campus is significantly overstated.

Baseline Energy Use by Glendale Community College (CY 2009)

Campus	Peak kW	kWh	Therms	kBTU	CO2[3] (tonnes/yr)
Verdugo	2,714	9,893,651	207,244	54,491,431	6,061
Garfield	197	683,200	206,264	22,958,162	533
Total	**2,911**	**10,576,851**	**413,508**	**77,449,592**	**6,594**

GCCD Actual Fuel Mix[3]



[1] For example, at office buildings, information about occupancy hours and the number of employees was gathered. Then, information about the building envelope (roof, windows, and walls) [1], mechanical, electrical, and lighting equipment were inventoried and specifications (manufacturer, model number, condition, etc) were documented.
[2] The baseline energy use for the entire College is the CY 2009 "baseline" for all of the meters in the scope of work for this audit. For a comprehensive list of the meters analyzed, please see utility data in the appendices.
[3] Based on 2009 GWP power content label: 42% coal, 33% gas.

3.3 Energy Benchmarking

The purpose of benchmarking is to rank and compare energy use between similar buildings or facilities. The Energy Use Index (EUI) is a useful tool in prioritizing energy efficiency efforts. The state median for educational buildings is 50 kBTU/sf and 19 kBTU/sf for this climate zone. An EUI of 145 is the highest scale for education buildings in the State according to CalArch, a benchmarking reference established by the California Energy Commission and Lawrence Berkeley Labs. As shown in the chart below, nearly all buildings surveyed have a high EUI and are well above the state median for energy efficiency. We would rate this a D or F. The district's current EUI is more than double the state median. **The district should aggressively seek to cut energy use by at least 50% to reach the benchmark state average - a passing grade.**

Building	Floor Area	Gas	Electric	kBTU	EUI (kBTU/SF)
Verdugo Campus:					
Los Robles Culinary Arts	4,400	8,762	189,257	1,522,135	345.94
Arroyo Seco	21,120	23,403	397,513	3,697,012	175.05
Aviation/Art Annex	3,900	4,950	53,527	677,686	173.77
Library	71,866	77,274	1,130,025	11,584,176	161.19
Student Center/Bookstore	16,750	17,028	239,629	2,520,654	150.49
Cimmarusti Science Center	15,192	8,935	363,466	2,134,001	140.47
Camino Real	21,890	17,751	315,819	2,853,005	130.33
Health Sciences/OM	97,312	38,049	2,326,567	11,745,504	120.70
Administration	43,652	19,834	899,051	5,051,861	115.73
Life Skills	1,650	0	52,944	180,697	109.51
Aviation Arts	25,743	15,087	334,617	2,650,781	102.97
Verdugo Gym Trailers	4,230	0	125,410	428,026	101.19
Advanced Technology	22,253	7,959	392,475	2,135,417	95.96
Santa Barbara	5,200	2,417	51,761	418,361	80.45
San Gabriel	64,509	21,692	860,978	5,107,742	79.18
EOPS Annex (modular)	1,953	0	44,439	151,671	77.66
Sierra Madre	17,366	0	394,191	1,345,373	77.47
San Rafael	34,659	11,588	437,518	2,652,062	76.52
Auditorium	46,465	14,379	614,743	3,535,989	76.10
Verdugo Gym	37,102	12,906	429,689	2,757,130	74.31
San Fernando (modulars)	19,440	0	382,666	1,306,038	67.18
Sierra Nevada Gym	17,620	6,091	150,507	1,122,781	63.72
Child Dev Ctr	5,428	0	97,802	333,799	61.50
Elevator Tower/Bridge	2,023	0	27,142	92,636	45.79
Sartoris Field Storage	2,117	0	28,403	96,941	45.79
Santa Anita (was Temp M&O)	4,000	0	0	0	0.00
Duplicating	0	0	0	0	0.00
Gardeners Building	1,200	0	0	0	0.00
Verdugo Building Totals	**609,040**	**308,106**	**10,340,141**	**66,101,476**	**108.53**
Garfield Campus:					
Garfield Campus Building	27,365	7,623	463,890	2,345,571	85.71
Bungalows (Modulars)	7,600	0	179,022	611,001	80.39
Child Care Center (modular)	1,920	0	30,201	103,076	53.69
Garfield Building Totals	**36,885**	**7,623**	**673,112**	**3,059,647**	**82.95**

Notes:

1. The higher the EUI - the less efficient the building.
2. Electric (kWh) and natural gas (therms) energy use are combined into common British Thermal Units per square foot kBtu.

3. Central plant energy use is distributed among the buildings they serve to enable reliable benchmarking. Other metrics may influence comparisons such as: power demand (kW) and energy rates, occupancy, operating hours, average local temperatures, etc.

Comments:

1. The benchmarks above illustrate the inefficiency of some of the College's larger buildings compared to regional averages.
2. The central plants do not include office space so their EUI is skewed disproportionately.

3.4 Energy Balance

Since the campus is master-metered and individual building electrical consumption isn't available, we calculated individual building end-use energy consumption using the EPA's CBECS Tables and established a campus-wide energy end-use model from those figures. Then, using the building system information gathered during the campus on-site audits, we calculated individual building heating and cooling loads, lighting loads, and "plug" loads and inserted them in the proper places in the model. Similar to an accounting analysis, when the campus total energy consumption and the sum of the calculated individual building energy end-use match closely, we can be assured that our models are accurate and this projected energy savings will be accurate as well.

For this project, our overall building energy models balanced within 10% of historical baseline energy consumption. Electric was very accurate - within 4%. Gas use accounts for a much smaller proportion of energy use, was not accurate. This is most likely due to unclear accounting of natural gas usage. As a result, we have relied on our models and experience for accurate gas accounting. Detailed results are included in the Appendices.

3.5 Energy Costs and Forecasts

Prior to 1999, energy prices in the US were easily forecasted to grow at moderate 3-4% growth rates. Since that time, we have clearly outstripped our domestic fossil fuel capacity and are currently very dependent on global fuel prices. As such, we can count on volatile prices going forward. While the current recession may keep fuel costs temporarily suppressed, increased domestic and global demand will surely increase the escalation rate of natural gas and electricity. Overlaid with a renewed national responsibility to reduce air pollution and particularly CO_2, fossil fueled electric and natural gas prices are sure to escalate much faster than they have historically. As an example, in 2008, electric prices rose an average of 9% across California. While unlikely to rise that much in 2010, high single digit and even double digit rate increases will not be uncommon in the near future in the US. For these reasons, we recommend using an energy escalation rate of 5 - 6% annual average.

4.0 EXISTING CONDITIONS

4.1 Overview

The following section provides detailed discussion of the existing conditions followed by the recommended improvements and energy efficiency measures.

Verdugo Campus Overview:

Verdugo is the district's main campus. It covers an area of roughly 24 acres on a hillside bordered by the 2 Freeway to the East, Verdugo Road to the West and Mountain Street to the South. The campus currently has 27 permanent buildings, 15 temporary modular buildings and 8 lighted parking lots. The main part of the campus surrounds an outdoor amphitheater and fountain.

Most of the buildings are heated by individual boilers providing heating hot water to coils in air handlers, fan-coil units, or reheat terminals. The ages of these boilers vary considerably and the seasonal efficiencies vary as well. Rated efficiencies will range from 78% to 84%. However, we estimate that most of the boilers have a seasonal (operating) efficiency ranging from 65% to 72%. A few buildings are heated by either gas-electric roof-top equipment, roof-top heat pumps, or through-wall packaged heat pumps (Bard, etc.).

There are two chilled water plants serving air handlers on approximately half of the buildings on campus. Chiller Plant #1 serves 6 buildings on the west side of the campus, while Chiller Plant #2 serves 4 buildings on the east side. The balance of air conditioning is provided by individual rooftop air conditioning units and split systems.

Chiller Plant #1 has three (3) centrifugal chillers with a rated capacity of 185 tons each, resulting in a total capacity of 555 tons. The connected load is estimated at 395 tons. Three sets of duplex pumps, each equipped with a variable frequency drive (VFD) distribute chilled water to the individual buildings. The piping apparently is not looped, but was run as individual runouts to the building systems. The chilled water pumps range in size from 20 – 30 hp. Two 40 hp condenser water pumps circulate condenser water from the cooling tower to the chillers. The chillers are controlled so that Chiller #3 is the lead chiller, Chiller #2 is the lag chiller, and Chiller #1 is a backup, which is rarely used.

Chiller Plant #2 has (2) centrifugal chillers with a rated capacity of 525 tons each, resulting in a total capacity of 1,050 tons. The connected load is estimated at 508 tons. Three 50 hp chilled water pumps with VFD’s distribute chilled water to the various buildings connected to this plant. Two 25 hp condenser water pumps circulate condenser water from the cooling tower to the chillers. The chillers are controlled so that only one chiller operates at a time, with the second chiller in standby.

The science center has a small solar PV system on the roof. The new parking garage B was built with a solar PV canopy provided by GWP. There are also two small backup diesel generators on campus. One serves the San Rafael building and one serves the Lot B structure.

Garfield Campus Overview:
The Garfield campus is primarily an adult learning campus located in a more suburban part of Glendale. It covers an area of roughly 1 acre. The campus includes the main three-story building and 11 temporary modular buildings.

The main building is essentially a two-story structure on stilts over grade level parking. Air conditioning is provided by rooftop air handlers fed from an air-cooled chiller in the parking lot adjacent to the building. The modular buildings are heated and cooled by wall-mounted heat pumps. The modulars will likely be removed when the new building is completed next door.

4.2 Buildings

Building Envelope Summary:

Most of the buildings are constructed of concrete with clay tile roofs while the smaller buildings are wood frame. Only the newest building, Health Sciences, has efficient double pane windows and insulation.

ID	Building Name	#	OGSF	Const Yr	Flrs	Windows	Walls	Roofs
	Verdugo Campus:							
HS	Health Sciences/OM	55	97,312	2007	3	dual pane	concrete	tile/bitumen
LB	Library	22	71,866	1997	4	single pane	concrete	bitumen
SG	San Gabriel	45	64,509	1997	3	single pane	concrete	tile/bitumen
AU	Auditorium	3	46,465	1947	2	single pane	concrete	tile/bitumen
AD	Administration	1	43,652	1936	2	single pane	concrete	tile
VG	Verdugo Gym	16	37,102	1937	2	single pane	concrete	bitumen
SR	San Rafael	5	34,659	1989	3	single pane	steel/stucco	tile/bitumen
AA	Aviation Arts	23	25,743	1976	1	single pane	concrete	bitumen
AT	Advanced Technology	18	22,253	1942	1	single pane	concrete	bitumen/tile
CR	Camino Real	17	21,890	1937	2	single pane	concrete	tile
AS	Arroyo Seco	15	21,120	1962	2	single pane	concrete	tile/bitumen
SF	San Fernando (modulars)	47	19,440	1998	1	single pane	wood/panel	metal
SN	Sierra Nevada Gym	21	17,620	1937	1	single pane	concrete	bitumen
SM	Sierra Madre	14	17,366	1978	2	single pane	concrete	bitumen
SC	Student Center/Bookstore	4	16,750	2000	2	single pane	concrete	tile
CS	Cimmarusti Science Center	50	15,192	2003	2	single pane	concrete	bitumen
CDC	Child Dev Ctr	10	5,428	1990	1	single pane	wood/stucco	tile
SB	Santa Barbara	51	5,200	2003	2	single pane	concrete	tile
LR	Los Robles Culinary Arts	2	4,400	2000	1	single pane	wood/panel	bitumen
VGT	Verdugo Gym Trailers	42	4,230	1994	1	single pane	wood/panel	bitumen
SA	Santa Anita (was Temp M&O)	52	4,000	2004	1	none	steel/metal	metal
AA	Aviation/Art Annex	54	3,900	1998	1	single pane	concrete	gravel
AU/CP1	Central Plant 1 Plumbing	3	3,600	2001	1	none	concrete	bitumen
HS	Central Plant 2	55	2,300	2007	1	none	concrete	bitumen
FS	Sartoris Field Storage	53	2,117	2005	1	none	wood/stucco	tile
Elev	Elevator Tower/Bridge	57	2,023	2007	2	none	steel/stucco	tile
EA	EOPS Annex (modular)	34	1,953	1987	1	single pane	wood/stucco	bitumen
LS	Life Skills	46	1,650	1997	1	single pane	wood/stucco	tile
GB	Gardeners Building	49	1,200	1999	1	single pane	wood/stucco	metal
A	Lot A	A	38,750					
B	Lot B	B	180,000					
	Lot C Parking Structure	56	336,180					
D	Lot D	D	6,250					
E	Lot E	E	7,500					
F	Lot F	F	10,000					
G	Lot G	G	15,000					
H	Lot H	H	3,750					
I	Lot I	I	12,500					
	Verdugo footbridge		1,200					
	Campus lighting		262,500					
	Verdugo subtotal		**1,045,009**					
	Garfield Campus:							
ACTC	Garfield Campus Building	26	27,365	1994	2	single pane	steel/stucco	tile/bitumen
ACTC	Garfield Modulars (bungalows)	27	7,600	2009	1	single pane	wood/panel	Metal
ACTC	Garfield Child Care Center (modular)	28	1,920	2009	1	single pane	wood/panel	Metal
	Garfield subtotal		**36,885**					
	CITY LOTS							
30	Lot 30	30	80,000					
31	Lot 31	31	50,000					
32	Lot 32	32	32,500					
33	Lot 33	33	40,000					
34	Lot 34	34	60,000					
	subtotal		**262,500**					
	TOTAL		**1,344,394**					

HVAC Summary:

Approximately for 25% of the conditioned space is cooled and 17% is heated by unitary equipment. However, this small percentage of equipment likely accounts for the majority of HVAC maintenance costs and is less efficient than central plant design.

Load Type	HVAC-u													
Sum of Qty	q/Fixt Typ													
Bldg	**AC - split**	**AC unit**	**Air comp**	**Condens**	**Evaporat**	**Fan**	**Gas Pkg**	**HP**	**HP - split**	**HP - wall**	**Tstat**	**Exh Fan**	**Heater-ga**	**Total**
Administration			1								38			39
Advanced Technology	1										9	2		12
Arroyo Seco				2							6	11		19
Auditorium		2	1								19			22
Aviation Arts						2	4		1		4	4		15
Camino Real												3		3
Child Dev Ctr									5		4			9
Cimmarusti Science Ctr											14			14
EOPS								1			1			2
Garfield		1												1
Garfield Bungalows										10				10
Garfield Child Center										2				2
Health Sciences/O&M			1								5			6
Library		2			1						1	2		6
Life Skills									1		1			2
Los Robles				3			3				3	5		14
San Fernando										27	15			42
San Gabriel	1										11	9		21
San Rafael											3			3
Santa Anita														
Santa Barbara														
Sierra Madre	1	5						6			2	3		17
Sierra Nevada		8									9			17
Verdugo Gym		2						4			3	2	6	17
Verdugo Gym Trailers										12	7			19
Grand Total	**3**	**20**	**3**	**5**	**1**	**2**	**7**	**11**	**7**	**51**	**155**	**41**	**6**	**312**

Central Plant Equipment Summary:

There are eleven boilers, nine chillers and associated equipment distributed across both campuses.

Load Type	HVAC									
Sum of Qty	Eq/Fixt Type									
Bldg	**AHU**	**Boiler**	**Chiller**	**CW Pump**	**FCU**	**HW Pump**	**TES**	**VFD**	**Clg Tower**	**Grand Total**
Administration	5			2		2		4		13
Advanced Technology	4	1				1				6
Arroyo Seco	3	1				2		1		7
Auditorium	3							1		4
Camino Real	1	1			8	2				12
Central Plant 1		1	3	8		2	3	9	2	28
Central Plant 2			2	3				5	2	12
Cimmarusti Science Ctr	3		1					3		7
Garfield	4	1	1	2		2				10
Health Sciences/O&M	5	1			5	2		8		21
Library	4	1	2	2	40			4		53
San Gabriel	4	2			145			4		155
San Rafael	1							2		3
Sierra Madre	2									2
Sierra Nevada		1								1
Verdugo Gym	1	1								2
Grand Total	**40**	**11**	**9**	**17**	**198**	**13**	**3**	**41**	**4**	**336**

The chillers comprise over 1,800 tons of cooling capacity, serving approximately 75% of conditioned space.

Bldg	Qty	size (Tons)
Central Plant 1	1	165
Central Plant 1	1	165
Central Plant 1	1	165
Central Plant 2	2	525
Cimmarusti Science Center	1	14.5
Garfield Campus Building	1	65
Library	1	100
Library	1	100
Total		1,814.5

The boilers comprise over 9 million btu of heating capacity, serving approximately 83% of conditioned space.

Bldg	Qty	size (BTU)
Advanced Technology	1	750,000
Arroyo Seco	1	144,000
Camino Real	1	144,000
Central Plant 1	1	144,000
Garfield	1	871,500
Health Sciences/O&M	1	1,050,000
Library	1	1,900,000
San Gabriel	1	1,900,000
San Gabriel	1	399,000
Sierra Nevada	1	990,000
Verdugo Gym	1	750,000
Total		**9,042,500**

Domestic Hot Water Summary:

Bldg	Qty	size (#)	units
Advanced Technology	1	30,000	btu/hr
Arroyo Seco	1	76,000	btu/hr
Auditorium	1	34,000	btu/hr
Aviation Arts	1	180,000	btu/hr
Camino Real	1	100,000	btu/hr
Child Dev Ctr	1	40,000	btu/hr
Garfield Child Center	1	42,000	btu/hr
Health Sciences/O&M	1	240,000	btu/hr
Life Skills	1	2,000	w
Los Robles	1	120,000	btu/hr
San Gabriel	1	399,000	btu/hr
Sierra Madre	1	240,000	btu/hr
Sierra Madre	1	120,000	btu/hr
Verdugo Gym	1	270,000	btu/hr

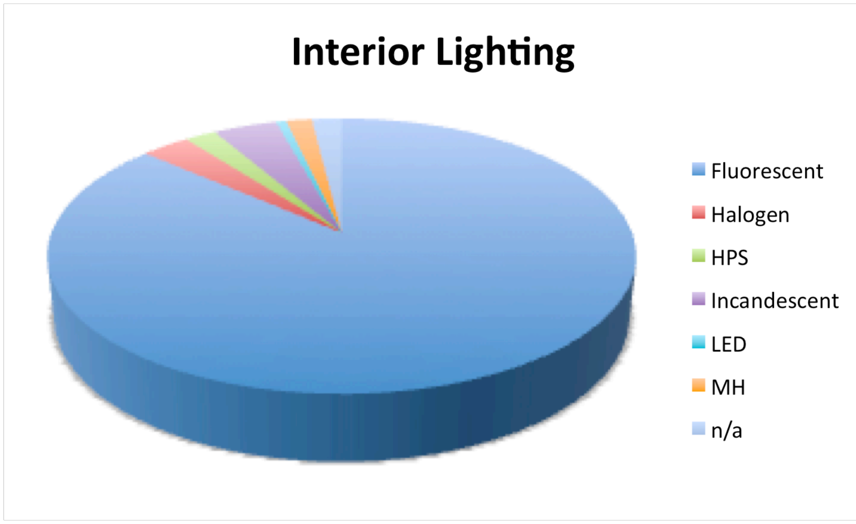
Distributed Generation Summary:

There is limited supply of on site distributed generation capacity. The largest is the grid connected solar PV canopy owned and operated by GWP. There is a smaller PV array located on the Science Center and two diesel back up generators.

Bldg	Qty	Type	size (Watts)
Cimmarusti Science Ctr	1	Solar PV	17,000
Lot B Structure	1	Solar PV	400,000
Lot B Structure	1	Backup Diesel	100,000
San Rafael	1	Backup Diesel	20,000

Lighting Summary:

Nearly all of the exterior lighting is high pressure sodium while approximately 86% of the interior lighting is fluorescent.



Misc Electric Loads:

An accurate inventory of miscellaneous and plug loads was not provided and is beyond the scope of this assessment. However, plug loads and appliances were observed and statistically characterized so that we could disaggregate and account for energy use and provide energy efficiency recommendations. Where plug loads were heavy, such as the computing labs where computers and monitors dominate electrical energy consumption, fairly accurate counts were taken. Typically plug loads such as computers, printers and appliances account for approximately 10% of electrical energy use in educational (classroom) buildings and about 30% in office buildings.

In computer labs such as the San Rafael building's second floor, plug load energy is approximately 65% of the building's overall electrical energy use. San Rafael building has more than 280 personal computers with monitors and more than 66 printers. Following is a summary of the plug load equipment counted.

Load Type	Plug
Sum of Qty	Bldg
Eq/Fixt Type	San Rafael
computer/monitor	280
copier	4
Fax	1
Microwave	1
Printer	66
Projector	5
Refrigerator	2
Scanner	1
Toaster	2
TV	1
VCR	3
Washer/Dryer	1
Grand Total	367

5.0 RECOMMENDATIONS

5.1 Summary

The measures we recommend include: Building envelope and weatherization, Central Plant, HVAC and building automation retrofits, Daylighting and interior lighting retrofits, Exterior and street lighting retrofits, Solar power generation and Data Center improvements as summarized below:

Building	Measure Number	Energy Efficiency Measure	Estimated Energy Savings			Estimated Utility Savings			Total Measure Cost	Incentives		Simple Payback[3,4]
			kW	kWh	therms	electric	gas	total		electric[1]	gas[2]	
AD	1	Replace single pane windows		37,017	1971	$ 5,553	$ 1,577	$ 7,129	$131,804	$32,951	$1,971	**13.6**
	2	Add Solar Control Film		18,127		$ 2,719	$ -	$ 2,719	$27,660	$6,915	$0	**7.6**
	3	Add Roof Insulation		11,187	615	$ 1,678	$ 492	$ 2,170	$32,800	$8,200	$615	**11.1**
	4	Add Skylights at 2nd Floor Roof		13,500		$ 2,025	$ -	$ 2,025	$49,500	$12,375	$0	**18.3**
	5	Upgrade AHU			832	$ -	$ 665	$ 665	$20,000	$0	$832	**28.8**
	6	Upgrade Lighting/Controls	9.5	9,866		$ 1,528	$ -	$ 1,528	$28,615	$7,154	$0	**14.0**
	7	Upgrade and extend ems		37,161	2,994	$ 5,574	$ 2,395	$ 7,969	$45,000	$11,250	$2,994	**3.9**
	8	Connect to new HHW loop			3,859	$ -	$ 3,087	$ 3,087	$99,624	$0	$3,859	**31.0**
AT	1	Add Skylights		13,500		$ 2,025	$ -	$ 2,025	$49,500	$12,375	$0	**18.3**
	2	Replace Boiler (Option to CP)			2,169	$ -	$ 1,735	$ 1,735	$35,100	$0	$2,169	**19.0**
	3	Upgrade Lighting/Controls	2.5	3,534		$ 542	$ -	$ 542	$2,305	$576	$0	**3.2**
	4	Connect to new HHW loop			1,527	$ -	$ 1,222	$ 1,222	$72,101	$0	$1,527	**57.8**
	5	Install rooftop solar PV	16.6	24,429		$ 3,747	$ -	$ 3,747	$74,783	$48,126	$0	**7.1**
AS	1	Replace single pane windows		20,222	1,547	$ 3,033	$ 1,237	$ 4,271	$55,150	$13,788	$1,547	**9.3**
	2	Install skylights		7,280		$ 1,092	$ -	$ 1,092	$29,250	$7,313	$0	**20.1**
	3	Upgrade and extend ems		19,383	3,117	$ 2,907	$ 2,494	$ 5,401	$30,000	$7,500	$3,117	**3.6**
	4	Upgrade Lighting/Controls	2.1	2,119		$ 329	$ -	$ 329	$10,670	$2,668	$0	**24.4**
	5	Connect to new virtual CP		52,243		$ 7,836	$ -	$ 7,836	$67,600	$16,900	$0	**6.5**
	6	Connect to new HHW loop			4,776	$ -	$ 3,821	$ 3,821	$80,703	$0	$4,776	**19.9**
AU	1	Replace single pane windows		26,066	1,068	$ 3,910	$ 854	$ 4,764	$21,252	$5,313	$1,068	**3.1**
	2	Install skylights		21,800		$ 3,270	$ -	$ 3,270	$34,100	$8,525	$0	**7.8**
	3	Upgrade VAV terminals for CR's		7,611	609	$ 1,142	$ 487	$ 1,629	$26,000	$6,500	$609	**11.6**
	4	Replace roof top packaged units		15,221	1,342	$ 2,283	$ 1,074	$ 3,357	$41,600	$10,400	$1,342	**8.9**
	5	Upgrade Lighting/Controls	65.8	81,881		$ 12,611	$ -	$ 12,611	$60,715	$15,179	$0	**3.6**
	6	Connect to new HHW loop			2,655	$ -	$ 2,124	$ 2,124	$127,015	$0	$2,655	**58.5**
	7	Upgrade and extend ems		41,384	3,717	$ 6,208	$ 2,974	$ 9,181	$48,750	$12,188	$3,717	**3.6**
AA	1	Install skylights		35,400		$ 5,310	$ -	$ 5,310	$50,000	$12,500	$0	**7.1**
	2	Replace DX with chilled water		51,579		$ 7,737	$ -	$ 7,737	$76,750	$19,188	$0	**7.4**
	3	Convert MZU to VAV		28,369	3,372	$ 4,255	$ 2,698	$ 6,953	$71,500	$17,875	$3,372	**7.2**
	4	Upgrade Lighting/Controls	19.9	21,026		$ 3,253	$ -	$ 3,253	$28,140	$7,035	$0	**6.5**
	5	Upgrade and extend ems		22,695	2,697	$ 3,404	$ 2,158	$ 5,562	$20,000	$5,000	$2,697	**2.2**
	6	Connect to new HHW loop			2,380	$ -	$ 1,904	$ 1,904	$28,000	$0	$2,380	**13.5**
CR	1	Replace single pane windows		22,042	5,618	$ 3,306	$ 4,494	$ 7,801	$80,240	$20,060	$5,618	**7.0**
	2	Install skylights		9,280		$ 1,392	$ -	$ 1,392	$49,700	$12,425	$0	**26.8**
	3	Convert Fan-coil units to VAV		13,750	3,500	$ 2,063	$ 2,800	$ 4,863	$62,400	$15,600	$3,500	**8.9**
	4	Repair duct insulation in attic		2,750	700	$ 413	$ 560	$ 973	$11,000	$2,750	$700	**7.8**
	5	Insulate attic		24,967	5,838	$ 3,745	$ 4,670	$ 8,415	$42,700	$10,675	$5,838	**3.1**
	6	Upgrade Lighting/Controls	6.9	12,346		$ 1,886	$ -	$ 1,886	$18,570	$4,643	$0	**7.4**
	7	Upgrade and extend ems		21,786	5,578	$ 3,268	$ 4,462	$ 7,730	$45,500	$11,375	$5,578	**3.7**
	8	Connect to new HHW loop			8,134	$ -	$ 6,507	$ 6,507	$76,332	$0	$8,134	**10.5**
CDC	1	Install skylights		9,480		$ 1,422	$ -	$ 1,422	$31,200	$7,800	$0	**16.5**
	2	Upgrade Lighting/Controls	10.7	11,682		$ 1,806	$ -	$ 1,806	$13,465	$3,366	$0	**5.6**
	3	Upgrade and extend ems		7,956		$ 1,193	$ -	$ 1,193	$13,000	$3,250	$0	**8.2**
	4	Replace Heat Pumps		13,370		$ 2,006	$ -	$ 2,006	$26,000	$6,500	$0	**9.7**
CSC	1	Upgrade Lighting/Controls	2.9	4,841		$ 741	$ -	$ 741	$14,455	$3,614	$0	**14.6**
	2	Upgrade and extend ems		7,945	1,861	$ 1,192	$ 1,489	$ 2,681	$32,500	$8,125	$1,861	**8.4**
	3	Connect to new virtual CP		10,167		$ 1,525	$ -	$ 1,525	$28,000	$7,000	$0	**13.8**
	4	Connect to new HHW loop			1,368	$ -	$ 1,094	$ 1,094	$100,606	$0	$1,368	**90.7**
EA	1	Install skylights		2,000		$ 300	$ -	$ 300	$4,500	$1,125	$0	**11.3**
	2	Upgrade Lighting/Controls	2.0	2,938		$ 451	$ -	$ 451	$1,690	$423	$0	**2.8**
	3	Install new heat pump		3,969		$ 595	$ -	$ 595	$4,000	$1,000	$0	**5.0**
HS	1	Install skylights		8,500		$ 1,275	$ -	$ 1,275	$19,500	$4,875	$0	**11.5**
	2	Connect to new HHW loop			5,820	$ -	$ 4,656	$ 4,656	$235,970	$0	$5,820	**49.4**

cont'd next page.

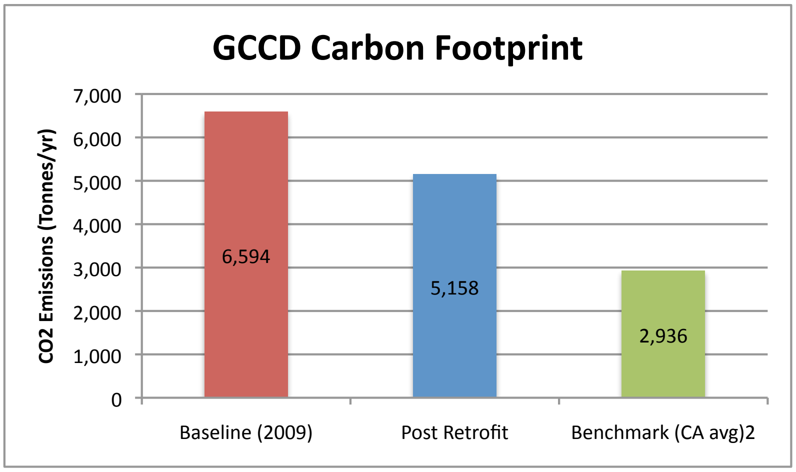
Building	Measure Number	Energy Efficiency Measure	Estimated Energy Savings			Estimated Utility Savings			Total Measure Cost	Incentives		Simple Payback[3,4]
			kW	kWh	therms	electric	gas	total		electric[1]	gas[2]	
LB	1	Install skylights		11,905		$ 1,786	$ -	$ 1,786	$21,450	$5,363	$0	9.0
	2	Convert MZU to MZU-VAV		38,856	9,271	$ 5,828	$ 7,417	$ 13,245	$85,800	$21,450	$9,271	4.2
	3	Replace Boiler			9,270	$ -	$ 7,416	$ 7,416	$35,100	$0	$9,270	3.5
	4	Upgrade Lighting/Controls	23.8	32,131		$ 4,938	$ -	$ 4,938	$55,200	$13,800	$0	8.4
	5	Connect to new HHW loop			18,115	$ -	$ 14,492	$ 14,492	$185,050	$0	$18,115	11.5
	6	Connect to new virtual CP		44,378		$ 6,657	$ -	$ 6,657	$50,000	$12,500	$0	5.6
	7	Upgrade and extend ems		49,736	11,866	$ 7,460	$ 9,493	$ 16,953	$26,000	$6,500	$11,866	0.5
	8	IT Server Virtualization/Thin Clients	21.3	186,610		$ 28,098	$ -	$ 28,098	$204,995	$51,249	$0	5.5
	9	Add rooftop solar pv	49.9	73,288		$ 11,243	$ -	$ 11,243	$224,350	$144,377	$0	7.1
LR	1	Install skylights		7,600		$ 1,140	$ -	$ 1,140	$11,700	$2,925	$0	7.7
	2	Replace (3) rooftop units		16,423	730	$ 2,463	$ 584	$ 3,047	$46,800	$11,700	$730	11.3
	3	Install range hood VAV		3,983		$ 597	$ -	$ 597	$4,000	$1,000	$0	5.0
	4	Upgrade Lighting/Controls	4.4	4,294		$ 666	$ -	$ 666	$6,025	$1,506	$0	6.8
	5	Upgrade and extend ems		6,897	468	$ 1,035	$ 374	$ 1,409	$13,000	$3,250	$468	6.6
LS	1	Install skylights		2,304		$ 346	$ -	$ 346	$4,880	$1,220	$0	10.6
	2	Upgrade Lighting/Controls	0.4	360		$ 56	$ -	$ 56	$1,030	$258	$0	13.9
	3	Upgrade and extend ems		3,430	150	$ 515	$ 120	$ 635	$3,900	$975	$150	4.4
SB		Upgrade Lighting/Controls	0.1	163		$ 25	$ -	$ 25	$1,075	$269	$0	32.4
SF	1	Install skylights		30,000		$ 4,500	$ -	$ 4,500	$31,200	$7,800	$0	5.2
	2	Replace Bard thru-wall A/C		47,313		$ 7,097	$ -	$ 7,097	$132,600	$33,150	$0	14.0
	3	Upgrade Lighting/Controls	9.6	17,150		$ 2,620	$ -	$ 2,620	$13,620	$3,405	$0	3.9
	4	Upgrade and extend ems		62,408		$ 9,361	$ -	$ 9,361	$52,600	$13,150	$0	4.2
SG	1	Install skylights		22,321		$ 3,348	$ -	$ 3,348	$34,100	$8,525	$0	7.6
	2	Upgrade Lighting/Controls	13.3	20,505		$ 3,142	$ -	$ 3,142	$26,510	$6,628	$0	6.3
	3	Replace Boiler			2,234	$ -	$ 1,787	$ 1,787	$35,100	$0	$2,234	18.4
	4	upgrade and extend ems		42,305	5,004	$ 6,346	$ 4,003	$ 10,349	$247,000	$61,750	$5,004	17.4
	5	Connect to new virtual CP		21,584		$ 3,238	$ -	$ 3,238	$30,000	$7,500	$0	6.9
	6	Connect to new HHW loop			3,972	$ -	$ 3,178	$ 3,178	$158,539	$0	$3,972	48.6
SR	1	Install skylights		12,295		$ 1,844	$ -	$ 1,844	$23,400	$5,850	$0	9.5
	2	Upgrade air handling units		2,844	368	$ 427	$ 294	$ 721	$5,000	$1,250	$368	4.7
	3	Upgrade Lighting/Controls	21.2	33,806		$ 5,177	$ -	$ 5,177	$36,290	$9,073	$0	5.3
	4	Connect to new virtual CP		20,318		$ 3,048	$ -	$ 3,048	$28,000	$7,000	$0	6.9
	5	Connect to new HHW loop			4,084	$ -	$ 3,267	$ 3,267	$98,359	$0	$4,084	28.9
SM	1	Install skylights		12,191		$ 1,829	$ -	$ 1,829	$15,550	$3,888	$0	6.4
	2	Replace rooftop Heat Pumps		9,112		$ 1,367	$ -	$ 1,367	$52,000	$13,000	$0	28.5
	3	Replace rooftop Gas Packs		30,896	874	$ 4,634	$ 699	$ 5,334	$127,400	$31,850	$874	17.8
	4	Install range hood VAV		3,983		$ 597	$ -	$ 597	$4,000	$1,000	$0	5.0
	5	Upgrade Lighting/Controls	1.3	2,118		$ 324	$ -	$ 324	$10,320	$2,580	$0	23.9
	6	Upgrade and extend ems		22,239	682	$ 3,336	$ 546	$ 3,881	$39,000	$9,750	$682	7.4
	7	Add rooftop solar pv	33.2	48,858		$ 7,495	$ -	$ 7,495	$149,566	$96,251	$0	7.1
SN	1	Replace rooftop A/C units		10,090	817	$ 1,514	$ 654	$ 2,167	$45,700	$11,425	$817	15.4
	3	Upgrade and extend ems		7,265	653	$ 1,090	$ 522	$ 1,612	$26,000	$6,500	$653	11.7
VG	1	Install skylights		19,200		$ 2,880	$ -	$ 2,880	$26,250	$6,563	$0	6.8
	2	Replace rooftop A/C units		10,163	404	$ 1,524	$ 323	$ 1,848	$56,100	$14,025	$404	22.6
	3	Upgrade Lighting/Controls	2.2	2,614		$ 403	$ -	$ 403	$5,000	$1,250	$0	9.3
	4	Install rooftop solar PV	106.4	156,347		$ 23,984	$ -	$ 23,984	$478,613	$308,003	$0	7.1
VGT	1	Install skylights		5,600		$ 840	$ -	$ 840	$11,700	$2,925	$0	10.4
	2	Replace through-wall A/C units		15,353		$ 2,303	$ -	$ 2,303	$62,400	$15,600	$0	20.3
	3	Upgrade Lighting/Controls	21.1	23,132		$ 3,575	$ -	$ 3,575	$25,010	$6,253	$0	5.2
	4	Upgrade and extend ems		15,321		$ 2,298	$ -	$ 2,298	$15,600	$3,900	$0	5.1
BK / SC	1	Install skylights		7,619		$ 1,143	$ -	$ 1,143	$19,500	$4,875	$0	12.8
	2	Upgrade Lighting/Controls	4.7	7,975		$ 1,220	$ -	$ 1,220	$15,665	$3,916	$0	9.6
	3	Upgrade and extend ems		22,646	1,870	$ 3,397	$ 1,496	$ 4,893	$19,500	$4,875	$1,870	2.6
	4	Connect to virtual CP		48,088		$ 7,213	$ -	$ 7,213	$110,000	$27,500	$0	11.4
	5	Connect to HHW loop			3,464	$ -	$ 2,771	$ 2,771	$64,973	$0	$3,464	22.2
Campus	1	Upgrade Lighting/Controls	28.3	45,310		$ 6,938	$ -	$ 6,938	$20,730	$5,183	$0	2.2
Pk Lots	2	Upgrade Lighting/Controls	34.5	41,250		$ 6,360	$ -	$ 6,360	$56,850	$14,213	$0	6.7
GC	1	Install skylights		9,280		$ 1,392	$ -	$ 1,392	$17,550	$4,388	$0	9.5
	2	Upgrade and extend ems		11,538	1,287	$ 1,731	$ 1,030	$ 2,760	$52,000	$13,000	$1,287	13.7
	3	Upgrade Lighting/Controls	10.9	11,676		$ 1,806	$ -	$ 1,806	$25,865	$6,466	$0	10.7
GCT	1	Replace through wall A/C units		16,084		$ 2,413	$ -	$ 2,413	$52,000	$13,000	$0	16.2
	2	Upgrade and extend ems		14,000		$ 2,100	$ -	$ 2,100	$14,000	$3,500	$0	5.0
CP-1, CP-2	1	Virtual Cooling Plant (included above)		453,591		$ 68,039	$ -	$ 68,039	$1,625,000	$406,250	$0	17.9
	1a	Add Pony Chiller (interim option)		55,200		$ 8,280	$ -	$ 8,280	$230,000	$57,500	$0	20.8
	2	Central Heating Plant (included above)			71,431	$ -	$ 57,145	$ 57,145	$1,232,400	$0	$71,431	20.3
	3	Campus-Wide DDC Controls (incl above)		60,000	39,150	$ 9,000	$ 31,320	$ 40,320	$612,000	$153,000	$39,150	10.4
	4	Thermal Storage (option)	753.0			$ 171,360	$ -	$ 171,360	$1,170,000	$292,500	$0	5.1
TOTALS[5]			**525.3**	**2,257,524**	**155,247**	**$ 341,255**	**$ 124,197**	**$ 465,452**	**$6,038,830**	**$1,511,494**	**$155,247**	**9.7**
% Baseline			*18%*	*21%*	*38%*	*23%*	*38%*	*26%*				

Notes:

1. Electric Rebates include: GWP 25% BES Program, capped at $100k/yr and Solar PV (5yr) incentives, for which funds are not currently available.
2. Gas Rebates include: EECIP program at $1/therm.
3. Simple Payback excludes inflation and is only benefical to compare between measures (not other investments).
4. Various financing programs are available: leasing, on bill financing, long term power agreements, etc. Contact PE Consulting for further assistance.
5. Totals exclude standalone options.

5.2 Energy and Carbon Savings

Implementing all of the recommended improvements are expected to reduce the College's carbon and energy footprint as follows:



	Peak kW	kWh	Solar kWh[3]	Therms	kBTU	CO2 (tonnes/yr)[1]
Baseline (2009)	**2,911**	**10,576,851**	**400,000**	**413,508**	**77,449,592**	**6,594**
Verdugo	2,714	9,893,651	400,000	207,244	54,491,431	6,061
Garfield	197	683,200		*206,264*	22,958,162	533
Post Retrofit	**2,386**	**8,319,327**		**276,832**	**56,077,063**	**5,158**
Verdugo	2,200	7,698,705		71,855	33,461,180	4,663
Garfield	186	620,622		204,977	22,615,883	495
Savings (per EE Audit)	**525**	**2,257,524**		**136,676**	**21,372,529**	**1,436**
Verdugo	514	2,194,946		135,389	21,030,251	1,398
Garfield	11	62,578		1,287	342,279	38
Benchmark (CA avg)[2]					**32,296,250**	**2,936**
Verdugo		4,461,178		152,260	30,452,000	2,768
Garfield		270,180		9,221	1,844,250	168

1. Based on 2008/09 GWP fuel mix of 42% coal, 33% nat gas, 25% clean sources
   US Avg 1,041 kWh/tonne for Coal
   US Avg 1,678 kWh/tonne for Nat Gas
2. Assumes 50% BTU split for gas/electric
3. GWP garage solar array is separately metered and NOT included in baseline kBTU
4. No output meter data was provided for 17kW PV array on Science Center rooftop

5.3 Energy Efficiency Measures

Our approach to energy efficiency and sustainable design is as follows. First, we seek to eliminate costly mechanical and electrical systems by using passive designs that reduce our need for heating, cooling and electrical lighting. Second, we harvest reliable, clean energy sources such as the sun, wind, light and temperature changes to balance our needs. Third, we use smart, highly reliable open source building automation and smart grid technologies to ensure our energy architecture is cleaner, safer, reliable and sustainable. A summary of the measures we recommend for the college follow.

Campus-wide Measures:

1. Virtual Chilled Water Plant.

    a. Expand the chilled water system to additional buildings and connect the two existing central plants together. This will add significant diversity and reliability to operations by creating redundancy and more ability to match chilled water supply to demand. This virtual chilled water plant will provide cooling to the connected buildings more efficiently than the disparate packaged systems currently in use. It will remove compressors and refrigerant from many of the buildings reducing maintenance costs and energy costs.
    b. Should the Virtual Chilled Water Plant (VCWP) not be funded, it is recommended that the College add a small "pony" chiller and other control algorithms into Central Plant 2 to reduce energy use during periods of low demand such as late afternoon hours or evenings when cooling loads are well below the point of efficient operation of the larger chillers in the Plant . This chiller should be a water-cooled, multi-compressor screw chiller of approximately 120 tons capacity. It should be of the latest, energy efficient design and utilize an environmentally friendly refrigerant, such as 134a.
    c. Install (thermal) energy storage to shift power (kW) from peak periods when energy is most expensive to off peak periods when it is least expensive. This can be accomplished with ice storage tanks, cold water storage tanks or small packaged units that can be mounted on rooftops.

2. Virtual Heating Plant. Expand the heating hot water system to additional buildings and connect several building systems together. This will add significant diversity and reliability to operations by creating redundancy and more ability to match heating hot water supply to demand. For example, if one boiler fails or is down for repairs, other boilers can automatically take up the slack. This virtual heating water plant will provide heating to the connected buildings more efficiently than the disparate packaged systems currently in use.

3. Campus-wide energy management and control. Expand the energy management system and building automation system into more building HVAC and lighting systems and campus lighting. A variety of technologies will be used.

    a. You can't manage what you don't measure! Sub-metering should be deployed in each building and central plants to continuously measure and benchmark energy performance. This information should be integrated into a campus energy portal (website sustainability dashboard) to allow all occupants (staff and students) to monitor energy use and see their direct influence on energy use, costs and sustainability.
    b. Many of the rooms and offices should have lighting and HVAC occupancy or vacancy sensors installed that will automatically shut equipment off when rooms are unoccupied. For example, in some areas lights would switch on automatically when occupied and off when vacant. In other areas, lights must be manually turned on, but automatically shut off when vacated. Cubicle areas

can also be controlled to shut off monitors, lighting and other "vampire" loads when vacant.

c. Integrate nighttime lighting sweeps to shed all lighting that is not controlled by a mesh of occupancy or vacancy sensors discussed above. Consider moving some or all janitorial services to daytime to eliminate heavy nighttime lighting use when the campus is empty.
d. Exterior and interior lighting fixture controls, particularly photocells, should be retro-commissioned and enhanced where necessary. During our site surveys, several exterior fixtures were noticed to be on during daylight hours, coming on too early. Security and campus safety should also be addressed during this process to turn off lamps that are not needed or turn others on that are. Interior time clock controls should be augmented with photocell controls (for daylight harvesting) and replaced by connection to the campus energy management system and lighting sweeps mentioned above.

4. Campus Exterior lighting

   a. Campus lighting demand (kW) and energy use (kWh) can be cut in half or more by retrofitting or replacing exterior fixtures with induction and LED lights. Typically, signage, display, wall wash, path way, accent and landscape lights should be replaced or retrofitted with LED lamps. LED lamps last about six times longer than the existing high pressure sodium and metal halide lamps. Higher wattage lamps such as parking lot and tennis court lights should be retrofitted or replaced with induction lights. Induction lights last about ten times longer than existing lamps.
   b. Currently, the majority of exterior lighting is High Pressure Sodium. However, there is a large variety of fixture that have been introduced over time on campus. During design of a comprehensive lighting retrofit, lamps and fixtures should be standardized to reduce the excessive variation. This procurement standard should be centralized (if not already) and maintained to keep maintenance costs down over time and influence all new building or landscaping design. Most or all of these should be replaced with LED or compact fluorescent lights that last longer and significantly reduce labor intensive maintenance costs.

Building Measures:

1. Passive Heating and Cooling Improvements.

   a. Roof/attic Insulation. Increase insulation in some buildings to reduce cooling and heating loads. Many of the buildings have mansard roofs, with the mansards covered with tile. The interior flat roof sections should be either re-roofed with a heat-reflecting roof system, or covered with a green, vegetated roof. Either of these options would significantly reduce solar heat gain in the summer.
   b. Window replacements. Replace single pane windows with double pane, especially West facing, windows to reduce summer heat into the buildings and winter heat loss out of the buildings.

c. Daylight Harvesting. The majority of lighting energy is used during daylight hours. Daylight harvesting enables the use of (free) natural light deeper into the buildings. Install skylights, light tubes and clerestories on various roofs. Install light shelves on several window areas to reflect light up onto the ceilings.

2. HVAC upgrades.

   a. Re-design the air conditioning system serving the IT department in the Library. Replace the existing air-cooled and water-cooled units with new units connected to the Central Plant. Re-design ductwork to supply air to the underfloor plenum and locate air supply outlets to control the flow of warm air from the computer equipment. Re-size the equipment to provide adequate cooling at all times. Provide for 100% backup and humidity control. Design and select equipment to maintain room conditions as recommended by the computer equipment vendor.
   b. Replace packaged units with air handlers to coordinate with CHW/HHW expansion.
   c. Replace older existing wall-mounted (Bard) heat pumps with newer, more efficient units.
   d. Upgrade single zone systems with variable volume systems, where applicable. Provide new variable frequency drives, adjust fan speeds, re-balance systems.
   e. Re-build older central fan units; provide new, higher efficiency motors, install cog-type belts, install high efficiency, low pressure drop filter systems; tighten seams to eliminate air leaks, check bearings and re-balance fans if necessary.
   f. Re-condition existing variable volume fan systems with new, cog-type belts and high efficiency, low pressure drop filters.
   g. Retro-commission all large fan systems. Confirm operation of all equipment, and re-balance according to individual space needs. For most areas, this would require new heat-gain, heat-loss and supply air volume calculations.

3. Lighting Retrofits.

   a. Retrofit and replace fluorescent fixtures with more efficient lamps and ballasts. This will reduce electric demand (kW) and energy use (kWh). Signage and accent lighting should be replaced with LED lamps. Various recessed can fixtures can be replaced with LED lamps as well. Most fluorescent lighting can be retrofitted with high efficiency lamps and ballasts.
   b. Currently, there are over six different lighting technologies and dozens of fixture styles that have been introduced over time on campus. During design of a comprehensive lighting retrofit, lamps and fixtures should be standardized to reduce the excessive variation. This procurement standard should be centralized (if not already) and maintained to keep costs down over time and influence all new building design.

4. Plug loads.

   a. Remodel the data center with correct layout of the server racks and cabling to increase cooling airflows. Install virtualization software to increase server utilization. In some cases, utilization efficiency can be increased by more than 50%. This will also reduce cooling loads by the same amount thereby doubling energy savings. We have estimated HVAC savings. However, the savings from virtualization, "hot desking" and other IT improvements is beyond the scope of this energy audit.

b. Replace desktop computers with workstation clients. Personal Computers in the workplace account for up to 30% of office building energy use, require continual expensive software upgrades and present significant security vulnerabilities. The Workstation Client (such as Sun's Sun Ray) is a simple, low-cost, low power device that enables just a few system administrators to manage up to thousands of workstations. The thin client does not have a local operating system, so the clients do not need to be upgraded every time new applications are introduced. Data and applications are centralized on a server where they can be easily backed up and made secure against theft and attacks. Users access their session on the Sun Ray client with a smart card. The smart card can be inserted into any Sun Ray client on the network, enabling users to move from one place to another and call up their session simply by inserting their smart card. This "hot desking" capability allows you to move from your office to a conference room, accessing your session easily. It also significantly reduces: software costs, energy costs, data loss from insufficient backups and replacement costs while improving security and privacy.
c. Remove or replace old, inefficient appliances with Energy Star appliances. Remove and disallow staff and students to bring in floor heaters and other wasteful appliances. Infiltration of these appliances generally signals other building HVAC control issues or needed commissioning. They also translate into wasted energy from appliances being left on when not needed or force additional cooling by the a/c system to offset the added heat being put into the space.

5. On site energy.

    a. Install additional solar PV on rooftops and parking areas to further reduce daytime electric demand and campus energy use.
    b. Consider future installation of geothermal (ground source) wells in the football field to provide free cooling to Central Plant 1.
    c. Consider future installation of solar thermal (hot water) heating or as a source of energy for solar cooling such as combined concentrating PV /Thermal arrays or solar hot water coupled with adsorption or absorption chillers for cooling/chilled water to the virtual central plant system.
    d. Consider future gas combined heat and power systems such as micro-turbines or fuel cells to provide on site electricity from natural gas, biogas, on site municipal waste or other more renewable resources.

6. Waterless urinals, low flow toilets, faucet aerators or automatic shutoff faucets (consider self closing as they are less expensive). The Metropolitan Water District, MWD) has ongoing assistance and rebate programs for water efficiency.

5.4 Financial Analysis

A financial cost analysis is provided below. The financial analysis includes our best engineering judgment of the total first cost to implement these improvements as well as the currently available incentives, operational cost savings and return on investment.

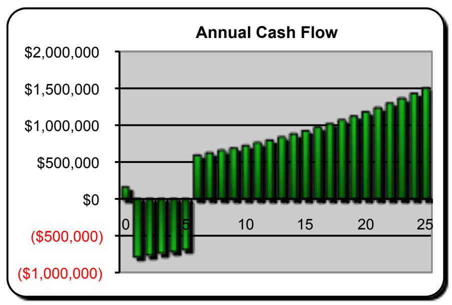
GCCD CASH FLOW ESTIMATE (Financed)

Project Cost Estimate:		
	Design	$603,883
	Constr Admin	$301,942
	Constr / Bonds	$4,831,064
	CX/Training	$301,942
	Energy Monitoring	TBD
	EPA/LEED Cert	TBD
Total Project Cost		**$6,038,830**
Incentives and Cost Offsets:		
	Capital Contr.	$0
	Rebates/Incentives	$1,666,740
	Tax Credits (year 0)	$0
Net Project Cost		**$4,372,090**

Finance Factors:	
Finance Term (years)	5
Finance rate	3.85%
Energy Escalation	5.0%
Maint. Escalation	3.0%

Projected Annual Savings:	
Energy Savings (yr 1)	$465,452
Maint Savings (yr 1)	$0
Total Annual Savings	**$465,452**

Life Cycle Benefits:		
Cost Savings	**$22,869,940**	
Demand Reducti	525	kW
Energy Savings	2,257,524	kWh/yr
Nat Gas Savings	155,247	Therms/yr
Water Savings	-	Gallons/yr
GHG Reduction	1,436	tonnes CO2/yr



Pro Forma

YR	ENERGY SAVINGS	MAINT. SAVINGS	INCENTIVES & TAX CREDITS	AVOIDED CAPITAL	TOTAL SAVINGS	PAYMENTS	CASHFLOW	CUMULATIVE SAVINGS (EXPENSES)
0	$0	$0	$155,247	$0	$155,247	$0	$155,247	$155,247
1	$465,452	$0	$100,000	$0	$565,452	($1,350,774)	($785,322)	($630,075)
2	$488,725	$0	$100,000	$0	$588,725	($1,350,774)	($762,049)	($1,392,124)
3	$513,161	$0	$100,000	$0	$613,161	($1,350,774)	($737,613)	($2,129,737)
4	$538,819	$0	$100,000	$0	$638,819	($1,350,774)	($711,955)	($2,841,691)
5	$565,760	$0	$100,000	$0	$665,760	($1,350,774)	($685,014)	($3,526,705)
6	$594,048	$0	$0	$0	$594,048	$0	$594,048	($2,932,657)
7	$623,751	$0	$0	$0	$623,751	$0	$623,751	($2,308,906)
8	$654,938	$0	$0	$0	$654,938	$0	$654,938	($1,653,968)
9	$687,685	$0	$0	$0	$687,685	$0	$687,685	($966,282)
10	$722,069	$0	$0	$0	$722,069	$0	$722,069	($244,213)
11	$758,173	$0	$0	$0	$758,173	$0	$758,173	$513,960
12	$796,082	$0	$0	$0	$796,082	$0	$796,082	$1,310,041
13	$835,886	$0	$0	$0	$835,886	$0	$835,886	$2,145,927
14	$877,680	$0	$0	$0	$877,680	$0	$877,680	$3,023,607
15	$921,564	$0	$0	$0	$921,564	$0	$921,564	$3,945,171
16	$967,642	$0	$0	$0	$967,642	$0	$967,642	$4,912,813
17	$1,016,024	$0	$0	$0	$1,016,024	$0	$1,016,024	$5,928,837
18	$1,066,825	$0	$0	$0	$1,066,825	$0	$1,066,825	$6,995,663
19	$1,120,167	$0	$0	$0	$1,120,167	$0	$1,120,167	$8,115,829
20	$1,176,175	$0	$0	$0	$1,176,175	$0	$1,176,175	$9,292,004
21	$1,234,984	$0	$0	$0	$1,234,984	$0	$1,234,984	$10,526,988
22	$1,296,733	$0	$0	$0	$1,296,733	$0	$1,296,733	$11,823,721
23	$1,361,570	$0	$0	$0	$1,361,570	$0	$1,361,570	$13,185,291
24	$1,429,648	$0	$0	$0	$1,429,648	$0	$1,429,648	$14,614,939
25	$1,501,131	$0	$0	$0	$1,501,131	$0	$1,501,131	$16,116,069
Σ	**$22,214,693**	**$0**	**$655,247**	**$0**	**$22,869,940**	**($6,753,870)**	**$16,116,069**	

Note: This is not an offer to finance. It is an estimated projection of project cash flow

5.5 Building Certification

In addition to the measures discussed above, it is also recommended that green building certifications be sought as a means of continual benchmarking and monitoring building performance, but also illustrating the College's commitment to building energy efficiency and sustainability.

The two most recognized efficiency and green building certifications are EPA Energy Star and USGBC LEED™ Certification. An overview of each and steps the College would need to take to become certified are provided below.

5.5.1 EPA ENERGY STAR™

The ENERGY STAR is the national symbol for energy efficiency in America. More than 50 different kinds of products as well as thousands of new homes, commercial and industrial facilities have earned the ENERGY STAR for superior energy performance.

Since the ENERGY STAR for commercial buildings was first introduced in 1999, thousands of buildings across the country have earned the ENERGY STAR rating and are saving billions in energy costs.

The energy performance of commercial and industrial facilities is scored on a 1-100 scale and those facilities that achieve a score of 75 or higher are eligible for the ENERGY STAR, indicating that they are among the top 25% of facilities in the country for energy performance. Commercial buildings that have earned the ENERGY STAR use on average 35% less energy than typical similar buildings and generate one-third less carbon dioxide. Increasing concern about the financial and environmental risks associated with climate change is driving more organizations to strive for the ENERGY STAR for their buildings, as it is seen as a symbol of an organization that is working to reduce global warming and its impacts.

All state-owned and commercial buildings in California are required to benchmark their buildings through Energy Star Portfolio Manager, starting in 2010 per AB1103. The US Energy Independence and Security Act also mandates that all federal buildings are required to be benchmarked as well. It is likely that this will become a requirement for all public institutions in the near future as well. Thus, it would be beneficial to "get ahead of the curve".

5.5.2 USGBC LEED™

As concerns about energy usage and costs escalate, there is also increasing concern about future water and natural resource availability, air quality, and conservation of the natural environment. As such, the importance of having a sustainable building is increasingly important. To encourage sustainable building practices, the United States Green Building Council (USGBC) has developed the Leadership in Energy and Environmental Design (LEED™) Rating System. This rating system quantifies how efficient a building is using a credit rating system. For existing buildings (LEED™ EB), credits can be awarded in the topical categories of Sustainable Sites, Energy and Atmosphere, Materials and Resources, Water Efficiency, Indoor Environmental Quality, and Innovation and Design Process.

PE Consulting encourages its clients to become LEED™ Certified for the following reasons:

- ✓ Certification by the USGBC as a green building provides credibility that the building provides for a healthy, productive working environment
- ✓ The certification process provides a way to verify achievement of sustainability and a reduced carbon footprint through quality assurance and performance verification
- ✓ Becoming certified demonstrates a building owner's commitment to sustainability
- ✓ Certification aids in qualification for incentives and potential tax benefits.

Depending on the number of credits awarded, a building can receive one of four certification levels: Certified, Silver, Gold, or Platinum.

Table 1: LEED™ Version 3 2009 for Existing Buildings

Certification Level	Point Required
Certified	40-49
Silver	50-59
Gold	60-79
Platinum	80-110

The District requires LEED certification for new construction (LEED-NC). However, the District could seek LEED™ Certification under the LEED™ 2009 for Existing Buildings: Operation and Maintenance category for several buildings on either campus. This would require the facility to dedicate itself to sustainability in the seven categories including: sustainable sites, water efficiency, energy efficiency, materials and resources, indoor environmental quality, innovation in design, and regional priority.

LEED™ Certification will require the College to adopt sustainable purchasing, recycling, and energy management policies and plans. This would be a natural extension of this effort to make the buildings more efficient. Other credit categories that may require additional attention and planning are sustainable sites (landscaping policies, pest management policies, etc), water efficiency (landscaping water use), material usage policies (purchase sustainable products including office consumable products and durable products) and green cleaning policies.

LEED-EB™ Certification is a good idea for the College to help illustrate overall sustainability and serve as a starting point for green building education. Studies show LEED™ certified buildings operate approximately 30% more efficiently over the long term than buildings that are not certified.

5.5.3 Campus Sustainability Program

The district seems to have a budding energy and environmental sustainability program. We encourage the district to more aggressively nurture this program by engaging students, faculty and operations staff to develop the campuses as living laboratories for energy efficiency, renewable energy and long term sustainability. By integrating education best practices into this program, the district will not expand creative resources for the district's benefit as well as the community. The district will yield more efficient operations, more publicity attracting clean tech students and a more appreciative community helping Glendale and surrounding areas become a healthier place to live.

5.6 Next Steps

We recommend that Glendale Community College seriously consider investing in the sustainable, energy efficient improvements recommended in this report. These improvements will permanently improve the indoor air quality and health of the buildings while lowering operating costs and the College's environmental footprint. Next steps involve preliminary design of the measures that most closely meet the owner's goals to determine the best benefits and return on investment. As an energy project, the College has the flexibility of procuring these solutions in several ways: design/bid, design/build, power purchase agreements or a combination of all. Regardless of the contracting process chosen, a highly qualified design team along with skilled commissioning and customer training are critical to long term, efficient and sustained performance.

About PE Consulting. PE Consulting is a world-class energy services company specializing in transforming government, institutions and businesses into highly efficient, sustainable enterprises. PE Consulting provides cost effective green buildings, renewable energy and clean water solutions. Distinguished by our bundling and integration of innovative solutions and customer-centric approach, PE Consulting has a solid reputation for developing, managing and commissioning sustainable energy efficient projects with practical quality and team synergy unmatched in the industry.

Founded in 1994, PE Consulting is committed to providing the highest value to its clients seeking to reduce their operating costs while reducing their environmental and carbon footprints. Over the last 15 years, **we have saved our clients more than $1 billion dollars in energy and water costs (and counting)**. So if you are passionate about saving money and the environment for a sustainable future, come join us!

PE Consulting is an EPA Energy Star Partner and USGBC Member with highly skilled LEED™ accredited professionals, design engineers, project managers, commissioning agents and measurement and verification technicians. Using our unbiased services as the client's Engineer, we will help ensure the best value for your company. We would be excited to act as your lead A&E firm developing this retrofit program from the conceptual ideas illustrated in this report and turning those into reality.

6.0 APPENDICES

APPENDIX A. Utility Bill Data

This appendix includes detailed utility (electric and gas) meter data used for the baseline energy use for each campus.

Glossary of terms:

kW	kilowatt, a unit of electrical power
kWh	kilowatt hour, a unit of electrical energy
Therm	a unit of natural gas energy
BTU	a unit of energy, often a combination of electrical and thermal

APPENDIX B. Lighting Inventory

This appendix includes detailed lighting inventory for each building and exterior campus lights.

Glossary of terms:

Flr	Floor or elevation level
Qty	Quantity
Eq/Fixt Type	Equipment or Lighting Fixture Type
Make	Equipment Manufacturer
Model/Code	Equipment Model or Lighting Fixture Code
Size	Watts per fixture
Control	Type of fixture controls

Fixture Code Format
xyz: x = # lamps, y = lamp type, z = lamp wattage

Lamp Types:
CF = compact fluorescent
F = linear fluorescent
FC = fluorescent circular shape
FU = fluorescent U-shape
HAL = halogen
HPS = high pressure sodium
INC = incandescent
IND = induction
LED = light emitting diode
MH = metal halide
MV = mercury vapor

Control Types:
COS = ceiling occupancy sensor
DT = digital timer
OS = occupancy sensor
PC = photocell
TC = timeclock
TT = twist timer
VS = vacancy sensor
WOS = wall occupancy sensor

APPENDIX C. HVAC Inventory

This appendix includes detailed mechanical inventory for each building.

Glossary of terms:

Flr	Floor or elevation level
Qty	Quantity
Eq/Fixt Type	Equipment or Lighting Fixture Type
Make	Equipment Manufacturer
Model/Code	Equipment Model or Lighting Fixture Code
Size	Watts per fixture
Control	Type of fixture controls

APPENDIX D. Solar Energy Analysis

This appendix includes solar energy assessments for specific buildings used in our recommendations.

Glossary of terms:

Usable SF	usable space
kWh/kW	annual solar hours
System eff	overall system efficiency
Module eff	average DC power per SF of module

SOLAR PV ANALYSIS				
Location Data:	**AT**	**LB**	**SM**	**VG**
available SF	5250	8000	7500	10,000
usable SF	1250	3750	2500	8,000
kWh/kW	1,470	1,470	1,470	1,470
system eff	180%	280%	280%	80%
Module Data:				
module W	230	230	230	230
Module SF	17.3	17.3	17.3	17.3
module eff (kW/SF)	0.0133	0.0133	0.0133	0.0133
Calculated Output:				
avail kW	16.6	49.9	33.2	106.4
annual kWh	24,429	73,288	48,858	156,347
Est Cost/kW	$ 4,500	$ 4,500	$ 4,500	$ 4,500
Est Cost	$ 74,783	$ 224,350	$ 149,566	$ 478,613
GWP Rebate/kWh	0.394	0.394	0.394	0.394
# years	5	5	5	5
GWP Rebate	$ 48,126	$ 144,377	$ 96,251	$ 308,003