“Sample” Energy Opportunity Survey Report

Intermediate School, CA

UC Davis Energy Efficiency Center
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CCC Energy Corps Initiative: Partnership between CCC and UC Davis

From the beginning of the Clean Energy Jobs Act and Senate Bill 73 (California Proposition 39), the California Conservation Corps (CCC) and the Energy Efficiency Center (EEC) at the University of California, Davis (UC Davis) have been partnered in conducting Energy Opportunity Surveys (ASHRAE compliant energy audits), training, and developing reports and recommendations for K-12 schools throughout California, with the shared goal of increasing energy efficiency in California schools and reducing energy related operating costs, while providing workforce development education and developing pathways for employment for CCC Corpsmembers.

The CCC deploys their Energy Corps crews to conduct AHRAE level 1+ Energy Opportunity Surveys at schools across the state. For each school energy audit, the CCC performs observations and measurements, records a detailed data set, and provides the data to the UC Davis team for use in analysis and developing the audit reports. During their site visit, the CCC Energy Corps crews collect and create a detailed inventory of all equipment and appliances that use electricity, natural gas, and other fuels. They also record each school's site layout and individual building characteristics, as well as observable operations and maintenance (O&M) issues. The data collected is then transcribed and sent to the UC Davis Energy EEC for compilation, analysis, and report generation.

Within the framework of the CEC's Proposition 39 Guidelines and recommendations, UC Davis determines and recommends the appropriate energy conservation measures (ECMs), costs of the ECMs, and compiles an audit report to be presented to the school to which it pertains. Each Energy Opportunity Survey report contains the details of each school's energy consumption (electricity and natural gas) and their annual costs. These data are inserted into a benchmarking calculator provided by the CEC to determine the school's energy use intensity (EUI) and show comparisons of their energy habits with national averages.

All participating schools will receive the following documents:

- An energy audit report compiled by the UC Davis EEC
- A draft of the California Energy Commission's Energy Savings Calculator
- Spreadsheet inventories of the schools' appliances, lights, and HVAC systems
- Sketches from the field audit compiled in a (PDF) report by the CCC
- CCC Energy Opportunity Survey Recommended Whole Building "Best Practices"

The ultimate goal of this report is to provide each school with their current energy performance and a straightforward guideline of recommendations for achieving energy efficiency and cost savings on their campus.

Acknowledgements and Contact

Under the professional supervision and direction of UC Davis EEC staff, this Energy Opportunity Survey report was compiled to a large extent by graduate and undergraduate student assistants. EEC professional staff developed the methodologies and processes used to analyze data, make recommendations, and deliver the report. We would like to acknowledge the following EEC staff and students involved in developing this report.

Key EEC Staff Contacts

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Special thanks also go to the staff and Corpsmembers of the California Conservation Corps; we would like to thank the Fresno team for their hard work and dedication to the Energy Corps Initiative and completing the school's energy survey. We would like to thank **Bill McNamara, Director of the Energy Corps** at the CCC for his invaluable contributions toward the content and structure of this report. We would also like to thank **Scott Linton, Prop 39 Manager** and his team for their painstaking efforts toward ensuring the in-field logistics and data quality for the surveys conducted throughout California by the CCC.

We would also like to extend special thanks to TerraVerde Renewable Partners for their support in assisting in the development of the reporting process, as well as dedicating resources to assist with the EEC process development.

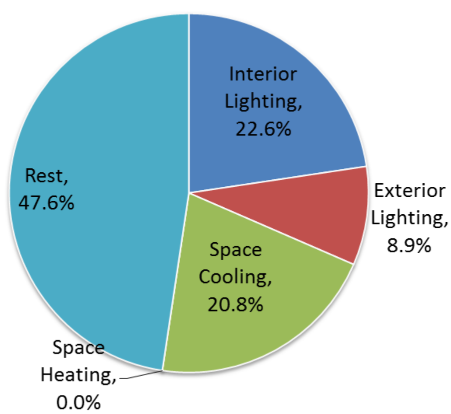
For any further questions about this report, please contact us at **prop39@ucdavis.edu**.

Executive Summary

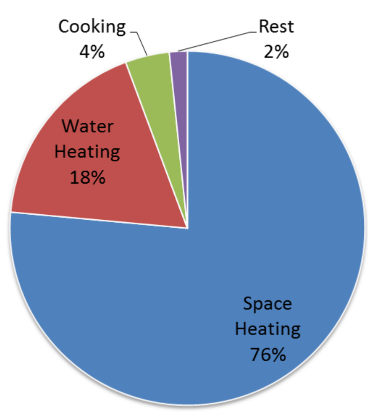
The CCC conducted an on-site Energy Opportunity Survey of the Riverside Meadows Intermediate School on 01/09/2014. The CCC crew surveyed a total of 8 buildings on the campus and catalogued nearly all of the electricity and natural gas using equipment. Based on the school's calendar, runtimes for the equipment provided during the CCC survey and industry accepted assumptions, we developed estimates on how energy is used at your school. The figure below breaks down the energy use by end uses.

Figure 1: Electricity and Natural Gas End Use Percentages

According to our estimates, HVAC accounts for 20.8% of all electrical energy use, while lighting accounts for 31.5%. Apart from plugloads, the "rest" category also includes domestic water heating and other process/specialty loads that the survey did not include. Based on the 2006 study by Intron Inc., the typical California school uses 30% of all electricity use on HVAC and 48% on lighting.



According to our estimates, space heating accounts for 76% of all natural gas energy use, while water heating and cooking account for 18% and 4% respectively. Based on the CEUS study, the typical California school uses 63% of all natural gas use on space heating, 29% on water heating, and 6% on cooking.



Energy Conservation Measures (ECMs) and associated cost savings

The energy conservation measures (ECMs) are the recommendations for reducing energy usage. It is **very important to note that the recommended measures in this report were "chosen from and limited to" the 21 recommendations listed by the California Energy Commission in its Prop 39 Guidelines**. Based on the survey data and communication with the school's staff we picked **5 ECMs**, which are listed in the following table. More information on the ECMs is provided in Section 4 of the report.

Table 1: Summary of Recommended Energy Conservation Measures (ECMs)

This table shows a summary of each of the recommended energy saving measures. Included in this table is the total annual cost savings for each measure, as well as the project implementation cost, simple payback and estimated SIR value, generated by the CEC Calculator.

	CEC Recommended Measures	Cost Savings	Project Cost	Simple Payback (years)	SIR Value
	Lighting Energy Efficiency Measures				
ECM7	Replace 32 Watt T8 lamps with 28 Watt T8 Lamps	$2,906	$12,744	4.22	1.02
	HVAC Measures				
ECM11	Replace old packaged/split HVAC unit wi th high-efficiency HVAC	$11,710	$252,000	21.06	0.92
ECM16	Install new programmable/set back ther mostat	$1,676	$2,520	1.18	9.32
	Plug-Load Efficiency Measures				
ECM19	Install smart strip/PC management to co ntrol computers/printers	$1,197	$2,750	1.73	2.43
ECM20	Install vending machine occupancy contr ol.	$50	$250	4.52	1.20
Total		$17,540	$270,264	15.00	1.00

Potential Cost Saving based on the ECMs

Potential savings and other associated econometrics for each ECM are captured in the preceding table. These savings estimates were generated using the Prop 39 calculator that was made available by the California Energy Commission (CEC). **It is very important to note that the savings estimated by the CEC's calculator are not**

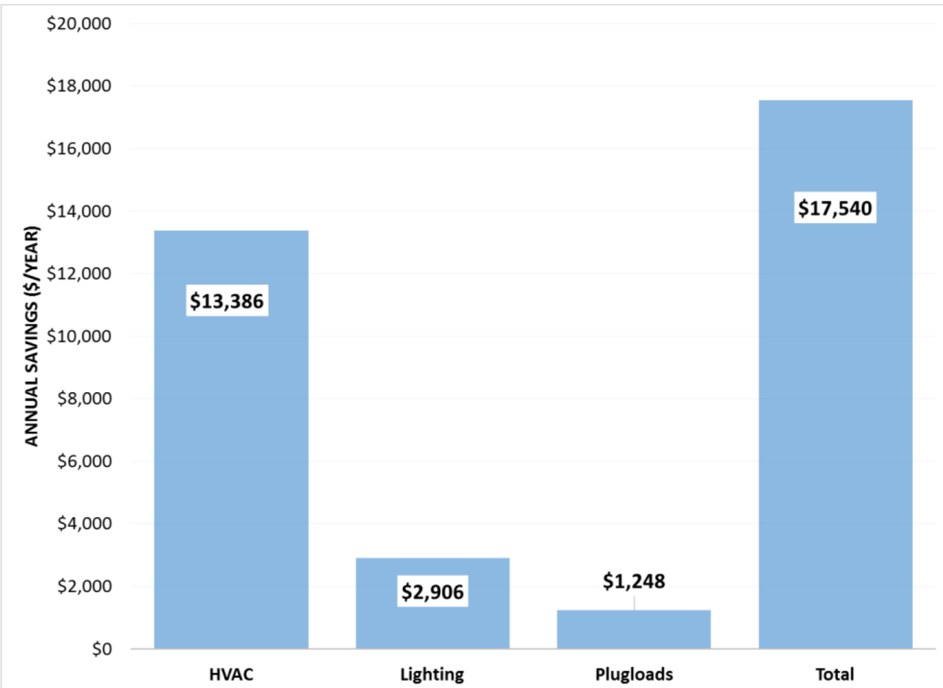
completely specific to the school. While the inputs to the calculator take into account the school's inventory, the calculator does not base the savings on the equipment runtimes or climate conditions specific to the school.

The savings are rather based on savings data reported on projects completed by Utilities across the state. Hence the savings estimated for specific ECM is only a good ball park value and should not be considered very accurate.

The following chart shows the total potential energy (electric and gas together) cost savings as well as savings by category for the three major end use categories: HVAC, lighting, and plug loads.

Figure 2: Potential Energy Cost Savings by End Use

The graphs shows the cost saving if all ECMs under consideration were to be implemented.

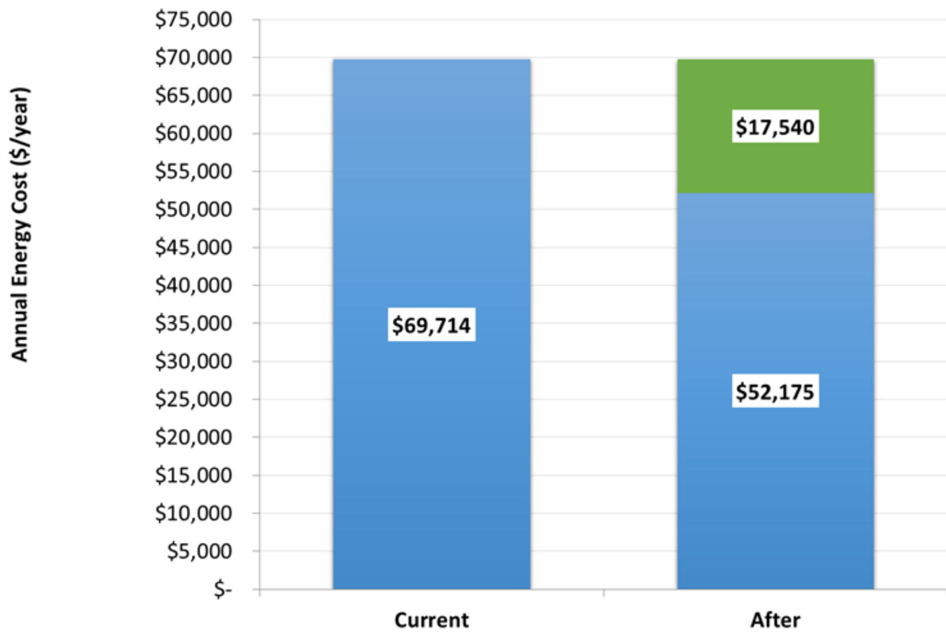


Current Energy Costs and Potential Savings

For the calendar year under consideration the total cost of energy (electricity and natural gas together) for the school was about $69,714.

Figure 3: Current Annual Energy Costs and Potential Savings

If all ECMs under consideration were implemented it would reduce the current energy cost by $17,540. This translates to a reduction in energy costs of **25%**



1 Overview of the Report: Focus and Limitations

This document is a sample energy efficiency assessment report that was prepared for an Intermediate School located in Northern California.. This report was prepared by the Energy Efficiency Center (EEC) at the University of California, Davis (UC Davis). Note that consistent with the CEC's 'loading order' of energy efficiency first, identifying renewable energy opportunities are not within the intended scope of this report.

The on-site Energy Opportunity Survey observations, measurements, and data collection for each of the school's buildings was completed 'on site' by the California Conservation Corps (CCC) crew from Sacramento, CA on 01/09/2014. During the Energy Opportunity Survey, the CCC crew collected valuable information regarding the energy use of the school and developed a detailed inventory of electrical and gas using equipment and appliances that are in use at the school. The inventory developed for the school includes the following key areas:

- Building Envelope
- Interior and exterior lighting
- Heating, ventilating and air-conditioning (HVAC) systems
- Plug loads, such as computers, printers, vending machines, microwaves etc.
- Fenestration, which includes windows, doors and skylights and how they are oriented
- Domestic hot-water systems used for bathrooms and food preparation
- And other miscellaneous equipment such as kitchen appliances, freezers etc.

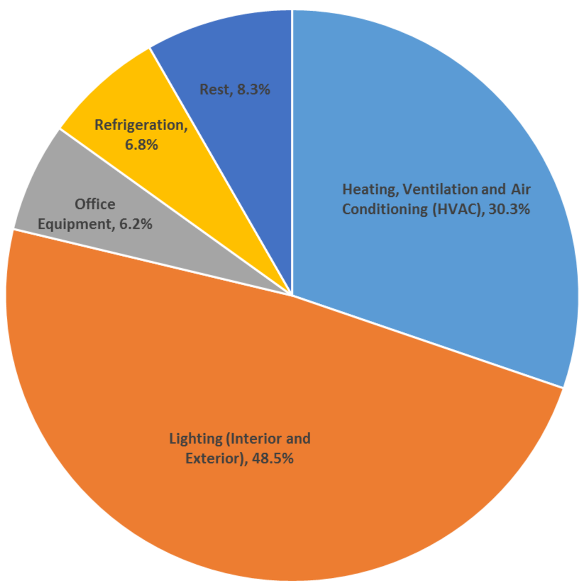
In addition to developing the inventory of equipment and appliances listed above, the CCC interviewed school O&M staff to gather the schedules and operating hours for the school and equipment. Lastly, the CCC made note of any maintenance issues that they observed while on site consistent with ASHRAE O&M standards.

Overview of Energy Use in California Schools

Figures 4 and 5 show the average distribution of electric and natural gas energy use for California schools based on a Commercial End Use Survey (CEUS) published by Itron, Inc. in 2006.

Figure 4: Typical electric energy usage distribution at a CA school

Nearly 50% of electrical energy use at California schools is attributed to interior and exterior lighting. Space conditioning (HVAC) accounts for another 30% of total school electricity use.



Based on this vital information, the efforts of the CCC's Energy Opportunity Survey are primarily focused toward lighting and HVAC, which together account for nearly 80% of total electricity use at schools. Similarly for gas usage, Energy Opportunity Survey efforts were primarily focused on space heating and domestic hot water, which together account for over 90% of gas energy usage at a typical school. This focus is also reflected in the energy conservation measures (ECMs) recommended by the California Energy Commission (CEC) in their final Proposition 39 Guidelines, which are substantially focused on lighting and HVAC.

Energy Opportunity Survey Data Limitations and Completeness

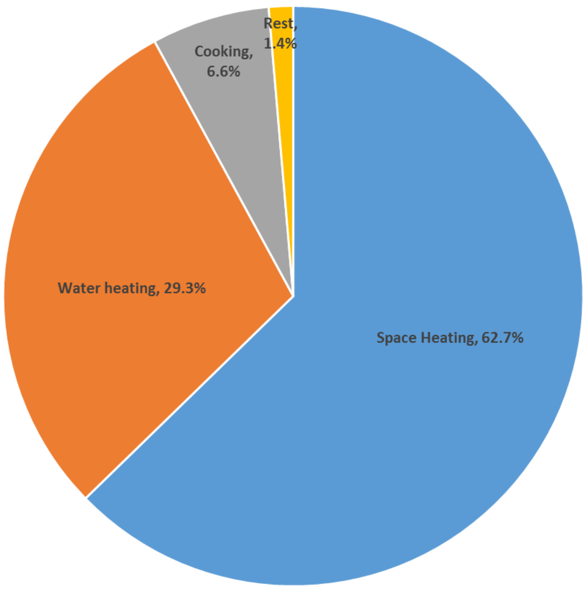
The data required for developing this report has been collected primarily by the CCC via different processes starting from the application that the schools submitted to the CCC requesting the Energy Opportunity Survey, to the actual on-site Energy Opportunity Survey itself, and interviews with the school's M&O staff. Another critical aspect of the data collected is the utility bills which are requested from the utility service provider, or in some cases submitted directly to UC Davis EEC by the school. This data has also been augmented by visiting the school website in some cases.

The scope of data collected by the CCC during the on-site Energy Opportunity Survey was focused primarily on addressing the 21 recommendations or energy conservation measures (ECMs) listed by the California Energy

Commission (CEC) in the Proposition 39 guidelines, which encompass the great majority of all potential energy saving opportunities.

Figure 5: Gas usage distribution at a typical CA school

Natural gas use is predominately space heating and water heating, accounting for 62.7% and 29.3% of total gas use, respectively.



The data collected during the site surveys might be limited by accessibility of certain equipment such as exterior pole lights and air conditioning units on roofs considered unsafe for the Corpsmembers (CMs) to reach. CMs rely on the nameplates of appliances and equipment to obtain critical information regarding their energy use. In cases where this was unavailable, the CMs rely on information from O&M staff at the school. It must be noted that while the CMs make every effort to obtain this information, there are typically some instances where specific information required for a more accurate and thorough analysis is unavailable. In such cases the analysis is based on industry averages and practices.

Finally, while schools often have multiple utility accounts for electric and gas, for the purposes of this report we are limited to the meter(s) serving the school buildings receiving the Energy Opportunity Surveys. Utility meters serving athletic stadiums, etc. are outside the scope of this report.

2 Site Details and Energy Overview

The following section provides an overview of the overall energy performance of the school by establishing the necessary benchmarking metrics and summarizing the energy and gas usage data for the calendar year of 2012-2013

2.1 Site Details and Naming Convention

One of the first tasks for the CCC Energy Opportunity Survey crew is to create a site map and assign building 'IDs' to all of the buildings for the purpose of the surveys and analysis. Figure 6 is a satellite image that includes the numbering convention of the buildings on site. For this school the CCC crew surveyed a total of 8 buildings on site.

Figure 6: Satellite image of school site (Google)

Table 2: Site Level Basic Information

The table below provides the age, gross square footage, and description of the buildings primary 'end use'. The combined square footage of all school buildings surveyed is estimated to be 47,650 sq-ft.

Building ID	Year Built	Building End Use	Gross Area per Story (sq-ft)	# of Stories
B1	2006	admin	3136	1
B2	2006	gym	11330	1
B3	2006	classes	6664	1
B4	2006	classses	6664	1
B5	2006	classses	3840	1
B6	2006	classes	7546	1
B7	2006	classes	2880	1
B8	2006	mulit-purpose	5590	1

2.1.1 Runtime Approximations

One of the key variables in estimating the energy use of specific electric and gas using equipment and appliances is the normal operating hours. Based on 1) the school's general operating hours, 2) data collected regarding operating schedules during the Energy Opportunity Survey and 3) in some cases data based on industry averages by climate zone, the operating hours for lighting and HVAC equipment were approximated.

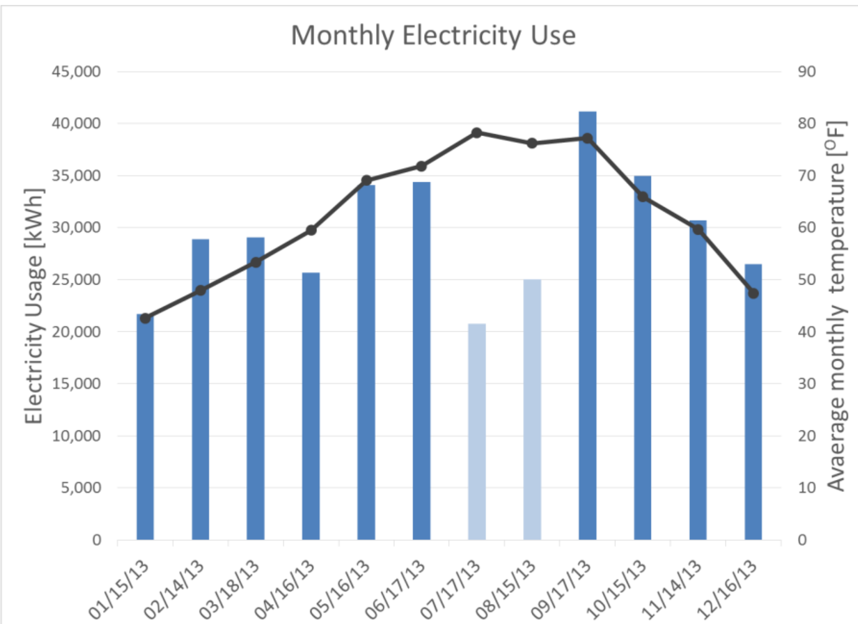
2.2 Electric and Gas Usage at the School

For the calendar year under consideration the school purchased a total of 356,000 kWh of electricity and 4,703 therms of natural gas, which cost the school $65,549 and $4,166 respectively.

The two following figures show the normalized total monthly electricity and gas use of the school plotted along with average monthly air temperatures. This visualization is extremely useful to identify any abnormal trends in monthly electric and gas usages.

Figure 7: Normalized Monthly Electricity Use and Average Air Temperature

As expected, the monthly electricity use fluctuates alongside changes in monthly air temperature. More electricity is used during hotter months when the demand for air conditioning is greater.

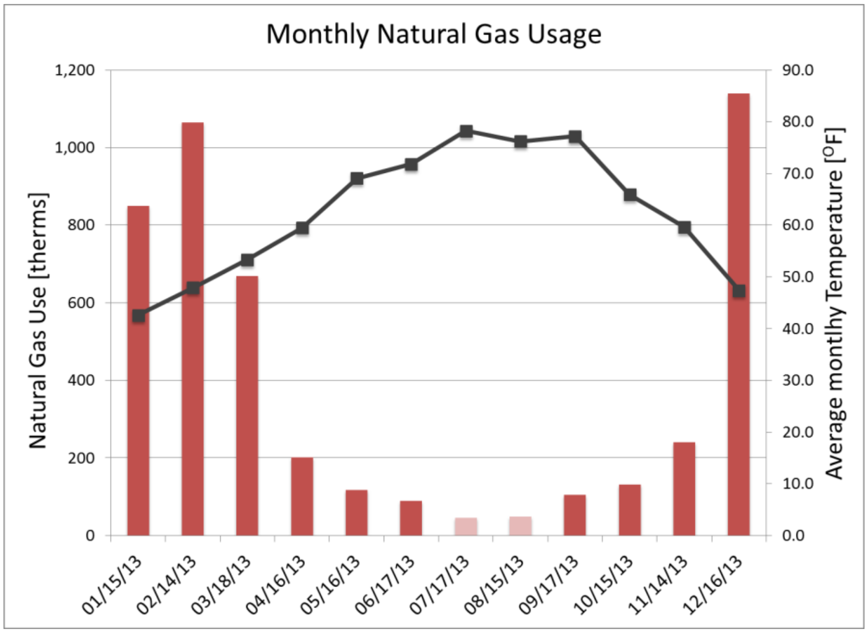


Potential operations and maintenance issues:

- July is the lowest month in terms of electricity use. This means the school should operate at or near this level during all non-operating months. The data shows that non-operating months of July and August had relatively high usage. All the energy usage during non-operating months might be going toward exterior lighting or that the school was occupied for special programs or end of the year office work. **In any case, attention needs to be paid toward this in order to make sure that all unnecessary HVAC systems, lighting, and plug loads are turned off during the school's summer season.**

Figure 8: Normalized monthly natural gas use and average air temperature

As previously noted, about 90% of natural gas usage at a typical school goes toward heating water and space heating in a school setting. As expected, natural gas use at this school increases during the winter months when there is a greater demand for space heating. **The gas monthly use figure for this school shows no major concerns.**



Potential operations and maintenance issues:

- Based on the gas consumption figures, it can be seen that even during non-operating months, natural gas use was around 50 therms. Since there is only one gas domestic hot water units at the school, this usage can be attributed as standby for gas using equipment.

2.3 CEC Benchmarking Metrics

Benchmarking allows schools of different sizes to compare their energy performance, expressed in terms of annual energy use per sq-ft. The benchmarking metrics are calculated for the school using the CEC calculator.

Table 3: CEC Benchmarking Calculator

This table shows the inputs for the CEC Benchmarking Calculator based on the information collected. A couple of notes:

- All unavailable and non-applicable input fields are left as "0", per CEC's direction

Electricity	
Average Maximum Demand (kW):	0
Total Annual Electric Use (kWh):	356000
Total Annual Electric Charges ($):	65549
Natural Gas	
Total Annual Natural Gas Use (therms):	4703
Total Annual Gas Charges ($):	4166
Other Fuels (if applicable)	
Total Annual Propane Use (gals):	0
Total Annual Propane Charges ($):	0
Total Annual Fuel Oil Use (gals):	0
Total Annual Fuel Oil Costs ($):	0

Table 4: CEC Energy Use Intensity (EUI) Calculator

The Energy Use Intensity (EUI) of the school is 7.47 kWh/sf/year. **This is very slightly higher than the California average EUI based on the CEUS data, which is 7.46 kWh/sf/year.**

Energy Use Intensity (EUI) Calculator					
Electricity		**Natural Gas**		**Other Fuels**	
0.00	W/SF	0.10	Therms/SF/Yr	-	Propane gal/SF/Yr
7.47	kWh/SF/Yr	$0.09	Gas Cost/SF/Yr	-	Fuel Oil gal/SF/Yr
$1.38	Cost/SF/Yr			$-	Fuel Cost/SF/Yr
Energy Costs/SF/Year:	$1.46		Energy EUI(Kbtu)/SF/Year:	89.9	

Table 5: Average Unit Energy Cost

The table lists the average unit cost of various fuels. These costs are used to calculate all baseline estimates.

Average Cost		
Electricity	$0.184	$/kWh
Natural Gas	0.885745269	$/therm
Propane	0.0	$/gal
Fuel Oil	0.0	$/gal

3 Inventory Characteristics and Observations

This section summarizes the inventory of electric and gas end usage at the school that was collected by the CCC during the Energy Opportunity Survey. The information is calculated and provided for each individual school building, as identified in the table. This section also provides estimates for the total energy used by each energy end use category, as well as the operating costs for each of them. The estimates provided are based on best available data, approximations and simple engineering calculations.

The section is divided into five sub sections:

1. Electric End Use Characteristics
2. Gas End Use Characteristics
3. Building Envelope Characteristics
4. Specialty and Miscellaneous loads and Characteristics
5. Observed O&M issues

3.1 Electric End Use Characteristics

The main areas of focus in the electric end use section are Lighting and HVAC, which together account for over 80% of electric energy use at a typical CA school. Other electric usage data is summarized as available. The cost estimates for electric usage throughout the document are calculated using the blended cost of electricity of $0.184 per kWh established in "Table 5: Average Unit Energy Cost" of the previous section.

Note that the perceived discrepancies in totals at the end of tables when compared with the sum of all individual entries is due to rounding the numbers and in fact are not incorrect.

3.1.1 Lighting Characteristics

The following two tables are summaries of interior and exterior lighting at the school. Cells highlighted in yellow, if any, signify assumptions that were made due to suspect or missing data. The total energy used in each row of the tables was calculated using an approximate of reported annual operating hours of 1,770 for all interior lights and 5,110 for exterior lighting.

Table 6: Building Interior Lighting Inventory

Building ID	Building Type	Lamp Type	Lamp Wattage (W)	Lamps per Fixture	Number of Fixtures	Total Power (kW)	Total Annual Energy Use (kWh)	Total Annual Operating Cost ($)
B1	admin	Ft	32	6	4	0.77	1,359	**$250**
B1	admin	CFL	25	2	4	0.20	354	**$65**
B2	gym	Ft	32	2	47	3.01	5,324	**$980**
B2	gym	Ft	32	3	64	6.14	10,875	**$2,002**
B3	classes	Ft	32	2	94	6.02	10,648	**$1,961**
B4	classes	Ft	32	2	94	6.02	10,648	**$1,961**
B5	classes	Ft	32	4	48	6.14	10,875	**$2,002**
B6	classes	Ft	32	2	94	6.02	10,648	**$1,961**
B7	classes	Ft	32	2	86	5.50	9,742	**$1,794**
B8	Multi-purpose	Ft	32	2	89	5.70	10,082	**$1,856**
Total/Avg					624	45.512	80556.24	**$14,832**

Figure 9: Interior Lighting Distribution by Lamp Type

This chart shows a breakdown of interior lighting energy use by lamp type. The majority of lights in the school are T8 Fluorescent fixtures.

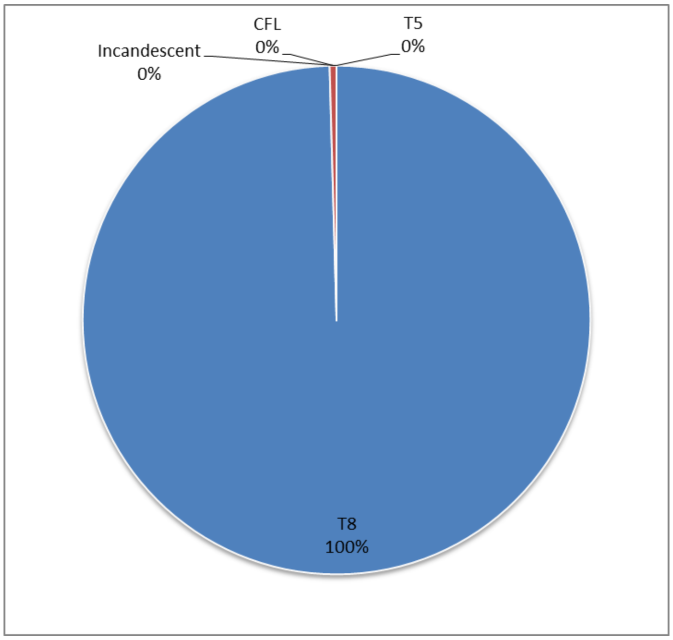
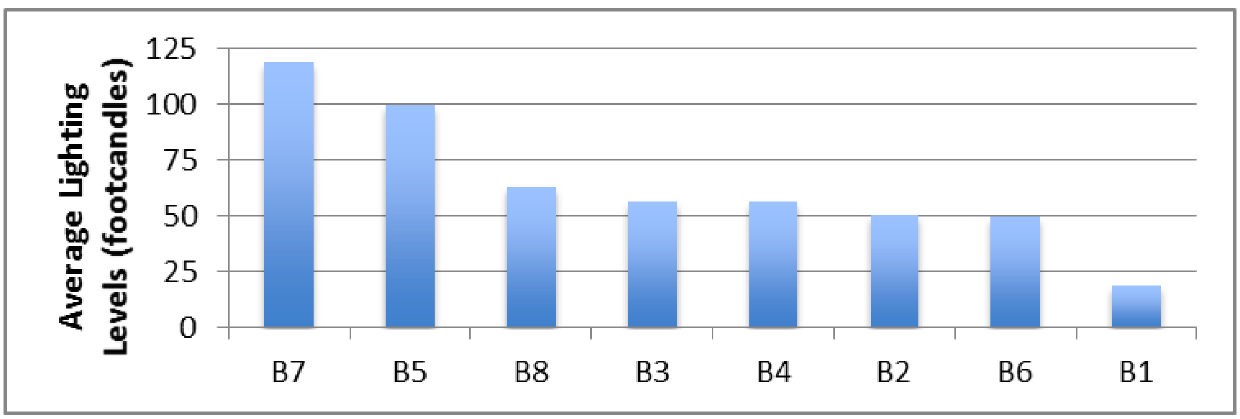


Figure 10: Average Illuminance for Each Building

This figures shows the average illumination levels of each building, assuming all documented lights in each room are turned on during operating hours and ignoring natural light.



The Illuminating Engineering Society of North America (IESNA Handbook, 9th Edition) recommends lighting levels in classrooms to be between 30-50 footcandles. Special attention should be given to buildings with levels above 50 footcandles, as there may be opportunities to leave some lights turned off or lamps removed. Reducing lighting levels in these areas will reduce electricity use and lower energy costs.

Based on our observations, lighting levels may be high in buildings B7, B5, B8, B3 and B4. Further investigation may be necessary to identify energy savings measures in lighting for these buildings.

Table 7: Building Exterior Lighting Inventory

Building ID	Building Type	Lamp Type	Lamp Wattage (W)	Lamps per Fixture	Number of Fixtures	Total Power (kW)	Total Annual Energy Use (kWh)	Total Annual Operating Cost ($)
B1	admin	CFL	32	1	4	0.13	654	**$120**
B1	admin	HAL	60	1	5	0.30	1,533	**$282**
B2	gym	CFL	32	1	10	0.32	1,635	**$301**
B2	gym	HAL	60	1	19	1.14	5,825	**$1,073**
B3	classes	CFL	32	1	5	0.16	818	**$151**
B3	classes	HAL	60	1	11	0.66	3,373	**$621**
B4	classes	CFL	32	1	5	0.16	818	**$151**
B4	classes	HAL	60	1	11	0.66	3,373	**$621**
B5	classes	CFL	32	2	4	0.26	1,308	**$241**
B6	classes	CFL	32	1	5	0.16	818	**$151**
B6	classes	HAL	60	1	11	0.66	3,373	**$621**
B7	classes	HAL	60	1	11	0.66	3,373	**$621**
B7	classes	CFL	32	1	4	0.13	654	**$120**
B7	classes	CFL	32	2	2	0.13	654	**$120**
B8	multi-purpose	CFL	32	1	6	0.19	981	**$181**
B8	multi-purpose	HAL	60	1	8	0.48	2,453	**$452**
Total/Avg					121	6.19	31,641	**$5,826**

Based on these calculations, approximately 23% **of all electrical energy is used for indoor lighting and 9% is used for exterior lighting** at the school. Some data presentation has been rounded or compressed for presentation purposes.

3.1.2 HVAC Characteristics

Heating, ventilation, and air conditioning (HVAC) equipment is responsible for maintaining comfortable spaces in the building. Typically cooling and ventilation are accomplished using electricity and heating is accomplished using natural gas. However, many California schools have window or wall mounted heat pumps that use electricity to heat the spaces. This section of HVAC addresses electric heating, cooling and ventilation only. Heating provided by gas equipment can be found in section 3.2.2 of this report. Following table is a summary of the major electricity using HVAC equipment. Note that any swamp coolers and mini splits that are used to cool server rooms are not included in the table. Without real-time monitoring or smart meter data, operating hours of HVAC equipment must be approximated. Following table shows annual electricity use of HVAC equipment using ASHRAE's estimated heating and cooling operating hours most applicable for a school's climate zone. Cells highlighted in yellow signify assumptions that were made due to suspect or missing data.

Table 8: Building Level HVAC Equipment Inventory

Building ID	Building Type	Unit Type	Unit Capacity* (tons)	Annual cooling Energy	Annual Energy Use	Total Annual	Total Annual Operating

				Use (kWh)	for heating (kWh)	Energy Use (kWh)	Cost ($)
B1	admin	package	6	2356	0	2356	$434
B1	admin	package	6	2356	0	2356	$434
B2	gym	package	8.5	3338	0	3338	$615
B2	gym	package	8.5	3338	0	3338	$615
B2	gym	package	6	2356	0	2356	$434
B2	gym	package	6	2356	0	2356	$434
B2	gym	package	6	2356	0	2356	$434
B3	classes	package	3	1178	0	1178	$217
B3	classes	package	4	1571	0	1571	$289
B3	classes	package	4	1571	0	1571	$289
B3	classes	package	4	1571	0	1571	$289
B3	classes	package	4	1571	0	1571	$289
B3	classes	package	4	1571	0	1571	$289
B3	classes	package	4	1571	0	1571	$289
B4	classes	package	3	1178	0	1178	$217
B4	classes	package	4	1571	0	1571	$289
B4	classes	package	4	1571	0	1571	$289
B4	classes	package	4	1571	0	1571	$289
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B4	classes	package	4	1571	0	1571	$289
B5	classes	package	4	1571	0	1571	$289
B5	classes	package	4	1571	0	1571	$289
B5	classes	package	4	1571	0	1571	$289
B5	classes	package	4	1571	0	1571	$289
B6	classes	package	4	1571	0	1571	$289
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B6	classes	package	4	1571	0	1571	$289
B6	classes	package	4	1571	0	1571	$289
B6	classes	package	4	1571	0	1571	$289
B6	classes	package	4	1571	0	1571	$289
B6	classes	package	4	1571	0	1571	$289
B7	classes	package	4	1571	0	1571	$289
B7	classes	package	5	1964	0	1964	$362
B7	classes	package	5	1964	0	1964	$362
B7	classes	package	5	1964	0	1964	$362
B8	multi-purpose	package	4	1571	0	1571	$289
B8	multi-purpose	package	6	2356	0	2356	$434
B8	multi-purpose	package	5	1964	0	1964	$362
B8	multi-purpose	package	10	3927	0	3927	$723
Total / Average				74225	0	74225	$13,667

Based on the calculations approximately 20.85% **of all electrical energy is used toward space cooling**. Some data presentation has been rounded or compressed for presentation purposes.

3.1.3 Plug Loads

Plug loads, such as computers, copiers, and other office equipment; represent over 6% of all electricity use in a typical California school. Without real-time monitoring or smart meter data, operating hours of plug load equipment using statistical means is not always reliable. The table below provides a summary of all plug loads in the school. Cells highlighted in yellow, if any, signify assumptions that were made due to inaccurate or missing data.

Table 9: Plug Load summary

Load Source	Quantity	Total Power (kilo Watts)
printer	10	unavailable
computer	48	unavailable
laptop	7	unavailable
fax machine	1	unavailable
laminator	1	unavailable
printer/copier	2	unavailable
refrigerator	3	unavailable
soda machine	1	unavailable
microwave	9	unavailable
TV	28	unavailable
mini fridge	5	unavailable
Copier	1	unavailable
projector	35	unavailable
computer speakers	3	unavailable
pencil sharpener	17	unavailable
clock	3	unavailable
speakers	26	unavailable
Copy machine	1	unavailable
Coffee Maker	2	unavailable
lamp	1	unavailable
Radio	8	unavailable
DVD/VCR combo	7	unavailable
vacuum cleaner	1	unavailable
Telephone	2	unavailable
Electric clock	5	unavailable
fish tank	1	unavailable
Electric Keyboard	1	unavailable
Radio w/speakers	1	unavailable

walkie talkies	9	unavailable
DVD Player	1	unavailable
computers	8	unavailable
Copy machines	2	unavailable
sterilizer	1	unavailable
stove	1	unavailable
smart board	2	unavailable
Total		unavailable

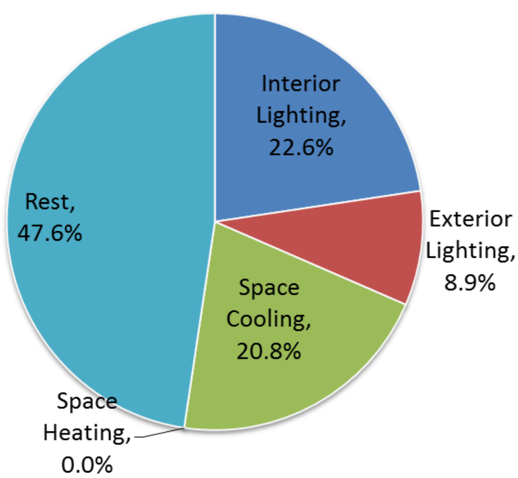
The easiest way to reduce electricity use in plug loads is by turning off equipment when it is not in use.

3.1.4 Electricity End Use Summary

A pie chart of the electric usage by end use categories: Interior lighting, exterior lighting, space cooling, Space heating, and rest.

Figure 11: Summary of the Electrical End Use Percentages at the School

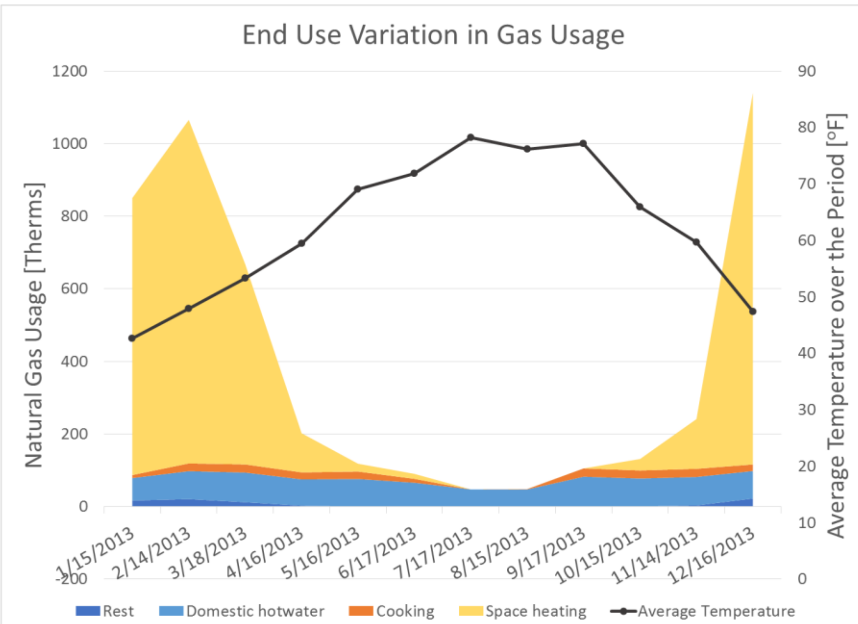
According to our estimates, HVAC accounts for 20.8% of all electrical energy use, while lighting accounts for 31.5%. Apart from plugloads, the "rest" category also includes domestic water heating and other process/specialty loads that the survey did not include. Based on the 2006 study by Intron Inc., the typical California school uses 30% of all electricity use on HVAC and 48% on lighting.



3.2 Gas End Use Characteristics

Natural gas is primarily used in schools for space heating, water heating, and cooking. The three end uses amount to nearly 99% of gas use in a typical California school. In order to estimate the natural gas usage by end use, the relationship between monthly usage, school operating schedule and local temperature has been statistically examined. The stacked area graph shown below represents how gas is used over a year.

Figure 12: Seasonal Gas Use by End Use



Based on the results obtained from the statistical analysis approximately 76% **of the annual natural gas use is spent on space heating, which amounts to 3,597 therms. Another 189 therms, or 4% of total natural gas use, is used for cooking and another 842 therms, or 18%% of total natural gas use, is used for heating water.**

3.2.1 Space Heating Using Natural Gas

Based on the results of the regression analysis, annually a total of 3,597 therms, or 76% of the total natural gas usage, goes towards space heating.

Most of the gas based heating is accomplished using 'packaged units', which were listed in "Table 8: Building Level HVAC Equipment Inventory". Apart from these packaged units there are no separate furnaces at the school. All package units have approximately 82% thermal efficiency.

3.2.2 Gas Domestic hot water and cooking characteristics

Based on the results of the regression analysis, annually a total of 1,031 therms, or 22% of the total natural gas usage, goes towards non-space heating, which includes, domestic hot water, cooking and any other existing process loads at the school. The table below lists the gas based domestic hot water tanks located during the survey.

Table 10: Domestic Hot Water Inventory

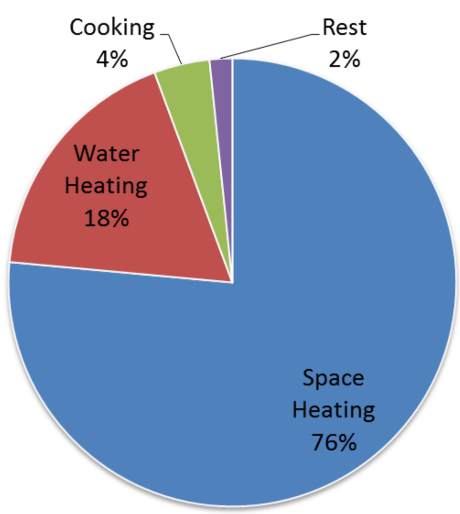
Building ID	Type	Total Storage (gal)	Location	No. of Units	Fuel type
B1	Storage water heater	125 us gallons	closet	1	natural gas

3.2.3 Gas End Use summary

Breaking down total energy use into end use categories helps to identify where energy efficiency efforts should be focused.

Figure 13: Natural Gas Energy Use Breakdown by End Use

According to our estimates, space heating accounts for 76% of all natural gas energy use, while water heating and cooking account for 18% and 4% respectively. Based on the CEUS study, the typical California school uses 63% of all natural gas use on space heating, 29% on water heating, and 6% on cooking.



3.3 Building Envelope Characteristics

This section provides a brief summary of the observed building envelope characteristics. These observations will not necessarily contribute to the savings calculations, but this information can be used to inform energy savings measures.

Table 11: Calculated Solar Heat Gain through Windows

This table shows the annual solar heat gain through single pane windows based on the school's location.

	Solar Heat Gain (Btu/ft2)							
	N	NE	E	SE	S	SW	W	NW
Total	78,500	137,600	258,000	342,000	357,000	342,000	258,000	137,600

Table 12: Total Solar Heat Gain Area for Each Building

The table summarizes the amount of heat potentially entering into the conditioned space

Building ID	Solar heat gain through each direction (kBTU)							
	N	NE	E	SE	S	SW	W	NW
B1	1211	0	3583	0	15422	0	7165	0
B2	0	0	0	0	0	0	1592	0
B3	2453	0	0	0	14872	0	0	0
B4	1635	0	0	0	11154	0	2687	0
B5	7065	0	0	0	32130	0	0	0
B6	0	4299	0	0	0	0	8061	0
B7	545	955	0	8311	2479	0	6269	2388
B8	0	478	0	2374	0	5540	0	8598
Totals	12909	5732	3583	10685	76056	5540	25774	10986

There is a little amount of single pane, south and west facing windows at the school. The school is not a good candidate for window upgrades. These values are to be used if the school decides to implement measures for windows.

3.4 Specialty and Miscellaneous Loads and Characteristics

This section provides characteristics and suggest ECMs (retrofits) based on specialty and miscellaneous loads information from the Energy Opportunity Survey that include kitchen appliances and other energy loads, such as air curtains, swimming pools, etc.

No information on these types of loads is applicable or available for your school.

3.5 Observed O&M issues

This section provides a list of O&M issues that were observed during the Energy Opportunity Survey.

No information regarding observed O&M issues is available for your school.

Please refer to Appendix E for information on resources that the school can use to investigate further O&M and Energy Efficiency measures.

4 CEC Recommended Measures and Cost Effectiveness

The scope of the energy efficiency measures and recommendations contained in this report are limited to the 21 ECMs outlined in the CEC Proposition 39 final guidelines. **Based on the depth of information collected during the Energy Opportunity Surveys, a subset of these 21 recommendations were recommended for this school.** This section also summarizes the cost-effectiveness of the selected measure(s) using the Proposition 39 calculators that the CEC published at the end of April 2014. Recommendations for any further measures, and their associated cost effectiveness calculations, would need further analysis, and in many cases would need a more detailed energy audit (ASHRAE Level 2 or above).

4.1 Selected Measures Based on the Energy Opportunity Survey

Table 14 lists all the recommended ECMs by CEC and checks the ECMs that are recommended to the school based on the survey data.

Table 13: List of ECM recommendations for Schools by CEC

The table provides the list of the ECM recommendations by CEC and points to which amongst them are applicable for the school based on the survey data.

	CEC Recommended Measures	Measure Applicable?	Comments
	Lighting Energy Efficiency Measures:		
ECM 1	Replace incandescent light with compact fluorescent light	No	No Incandescent lamps were located at school
ECM 2	Replace incandescent light with LED light	No	No Incandescent lamps were located at school
ECM 3&4	Convert incandescent/CFL exit sign to LED exit sign	No	Information unavailable
ECM 5&6	Convert T12 fluorescent to T8 with electronic ballast or LED Lamps	No	No T12 were located at the school
ECM 7	Replace 32 Watt T8 lamps with 28 Watt T8 Lamps	Yes	1416 T8 of 32 watts each were located at the school the total wattage of these lamps is 45,310
ECM 8&9	Replace exterior mercury vapor/HPS with LED/Induction lights	No	No HPS were located at the school
ECM 10	Install occupancy control for intermittently occupied rooms	No	Information unavailable or not sure
	HVAC Measures:		
ECM11	Replace old packaged/split HVAC unit wi th high-efficiency HVAC	Yes	31, under 5.4 ton packaged with an estimated total capacity of 126 tons were located at the school
ECM12	Replace old heat pump with high-efficiency heat pump	No	No Heat pumps with a total capacity of 60 tons were located at the school
ECM13A	Replace boiler with high efficiency condensing boiler	No	No boilers were located at the school

ECM13B	Replace furnace with high efficiency condensing furnace	No	No furnaces located but Information is incomplete
ECM14	Seal existing leaky duct	No	Duct leaks were visually not observed, but is a very good idea
ECM15	Install premium efficiency motors	No	Information unavailable or not sure
ECM16	Install new programmable/set back ther mostat	Yes	36 non-programmable thermostats located at the school
ECM17	Install variable speed drive for pumps a nd fans	No	Information unavailable or not sure
ECM18	Replace storage water heater with insta ntaneous water heater	No	No gas fired tanks were located in the school
	Plug-Load Efficiency Measures:		
ECM19	Install smart strip/PC management to co ntrol computers/printers	Yes	55 unique rooms with plugloads were located
ECM20	Install vending machine occupancy cont rol.	Yes	1 vending machines located at school
	Simple PV Self-Generation Project:		
ECM21	School-owned PV system		PV is outside scope of this report

4.2 Inputs for the CEC calculator

Based on the measures selected, the inputs for the CEC calculator were created. A 'prefilled' electronic version of CEC calculator with all the required inputs is provided to the school along with the report. Some of the inputs are placeholders and the school needs to adjust the numbers based on the 'hard bids' received and rebates that are applicable.

4.3 Assumed costs and rebates

The assumed costs and rebates for calculating the cost effectiveness of the measures were based on engineering estimates. The engineering estimates provide a good 'ball park' value, but prior to submitting the Form B, the schools need to acquire actual 'bid values' on the measures. The rebates included, were based on general custom rebate values for PG&E. Further information is available on the utility websites that provide energy to this school, and are subject to change. We highly encourage checking for the most recent values. The assumed costs and rebates are included in Appendix "C".

4.4 Results of Recommended Energy Conservation Measures

This section shows the potential energy savings of each recommended energy conservation measure (ECM) based on the CEC Calculator.

ECM7: Replace 32 Watt T8 Lamps with 28 Watt T8 Lamps

Based on the CCC survey shows there are a total of 1,416, 32-watt T8s located at the school. According to the CEC calculator, replacing these with 28-watt T8s would save an estimated **$2,906.4 per year** in electricity costs. The table below provides more saving details of the ECM and is the output of the CEC calculator.

Table 14: ECM7 CEC Calculator Energy Savings Summary

Energy Savings Summary			
This measure saves	1.84	**kW peak demand**	
and	16,249	**kWh energy use.**	
and	-96.4	therms natural gas	
or	0.0	gallons of	NA
or	$2,906.4	**energy cost annually.**	
Simple Payback is	4.2	**years.**	
Saving to Investment Ratio	1.02		

The following table provides information on the location and wattage of the T8 fluorescent lamps to assist in the implementation of ECM7.

Table 15: Location of T8 Fluorescent Lamps

Building ID	Building Type	Lamp Type	Lamp Wattage (W)	Total number of lamps
B1	admin	T8	32	24
B2	gym	T8	32	94
B2	gym	T8	32	192
B3	classes	T8	32	188
B4	classes	T8	32	188
B5	classes	T8	32	192
B6	classes	T8	32	188
B7	classes	T8	32	172
B8	multi-purpose	T8	32	178
Total				**1,416**

ECM11: Replace Old Packaged/Split HVAC Units with High Efficiency HVAC

Based on the CCC survey shows there are a total of 11 under 5.4 ton, packaged HVAC units at the school amounting to a total of 126 tons. According to the CEC calculator, replacing these old units with high efficiency units would save an estimated **$11,709.8 per year** in energy costs. The table below provides more saving details of the ECM and is the output of the CEC calculator.

Table 16: ECM11 CEC Calculator Energy Savings Summary

Energy Savings Summary			
This project saves	18.02	kW peak demand	
and	67,274	kWh electricity use.	
and	-764.3	therms natural gas	
or	0.0	gallons of	Fuel Oil
or	$11,709.8	**energy cost annually.**	
Simple Payback is	21.1	**years.**	
Saving to Investment Ratio	0.92		

The following table provides information on the location and capacity of the packaged units to assist with ECM11.

Table 17: Location of Packaged Units

Building ID	Building Type	Unit Type	Unit Capacity* (tons)
B3	classes	Package	3
B3	classes	Package	4
B3	classes	Package	4
B3	classes	Package	4
B3	classes	Package	4
B3	classes	Package	4
B3	classes	Package	4
B4	classes	Package	3
B4	classes	Package	4
B4	classes	Package	4
B4	classes	Package	4
B4	classes	Package	4
B4	classes	Package	4
B4	classes	Package	4
B5	classes	Package	4
B5	classes	Package	4
B5	classes	Package	4
B5	classes	Package	4
B6	classes	Package	4
B6	classes	Package	4
B6	classes	Package	4
B6	classes	Package	4
B6	classes	Package	4
B6	classes	Package	4
B6	classes	Package	4

B7	classes	Package	4
B7	classes	Package	5
B7	classes	Package	5
B7	classes	Package	5
B8	multi-purpose	Package	4
B8	multi-purpose	Package	5
Total			**126**

ECM16: Replace manual thermostat with programmable/smart thermostat

According to the CCC survey there were a total of 36 non-programmable thermostats at the school. According to the CEC calculator, replacing these old units with programmable units would save an estimated **$1,676 per year** in energy costs. The table below provides more saving details of the ECM and is the output of the CEC calculator.

Table 18: ECM16 CEC Calculator Energy Savings Summary

Energy Savings Summary			
This project saves	-2.39	kW peak demand	
and	6,840	kWh electricity use.	
and	470.3	therms natural gas	
or	0.0	gallons of	Fuel Oil
or	$1,676.0	**energy cost annually.**	
Simple Payback is	1.2	**years.**	
Saving to Investment Ratio	9.32		

ECM19: Install Smart Strip/PC Management to Control Computers/Printers

Based on the CCC survey and inventory of plug loads, there are atleast 55 rooms with plugloads. According to the CEC calculator, installing one smart strip per each of these rooms would save an estimated **$1,197.4 per year** in energy costs. The table below provides more saving details of the ECM and is the output of the CEC calculator.

Table 19: ECM19 CEC Calculator Energy Savings Summary

Energy Savings Summary			
This measure saves	0	**kW peak demand**	
and	8,482	**kWh energy use.**	
and	-124.1	therms natural gas	
or	0.0	gallons of	NA
or	$1,197.4	**energy cost annually.**	
Simple Payback is	1.7	**years.**	
Saving to Investment Ratio	2.43		

ECM20: Install vending machine occupancy controls

1 vending machine was located on the campus. Installing the measure would save $50 a year. The table below provides more saving details of the ECM and is the output of the CEC calculator.

Table 20: ECM20 CEC Calculator Energy Savings Summary

Energy Savings Summary			
This measure saves	0	**kW peak demand**	
and	293	**kWh energy use.**	
and	-4.3	therms natural gas	
or	0.0	gallons of	NA
or	$50	**energy cost annually.**	
Simple Payback is	4.5	**years.**	
Saving to Investment Ratio	1.20		

4.5 CEC Measure Output Table

Table 29 is the CEC calculator's output summary based on the assumed costs for the selected measures. All line items that have an SIR over 1.05 are independently qualified to receive CEC funds. The overall package also qualifies if it exceeds the SIR of 1.05. The school needs to decide on the measures that best suits its needs, and insure that the ECMs selected have a sufficiently high average SIR to qualify according to the CEC's Proposition Guidelines.

Table 21: Output Summary of the CEC Calculator

ECM	Energy Efficiency Project	Demand Savings	kWh Savings	Therm Savings	Propane Savings	Fuel Oil Savings	Cost Savings	Project Cost	Utility Rebate	Simple Payback	SIR
		kW	kWh	Therms	Gallons	Gallons	$	$	$	Years	
ECM 1	**Replace incandescent light with compact fluorescent light**	-	-	-	-	-	$ -	$ -	$ -	-	-
ECM 2	**Replace incandescent light with LED light**	-	-	-	-	-	$ -	$ -	$ -	-	-
ECM 3&4	**Convert incandescent/CFL exit sign to LED exit sign**	-	-	-	-	-	$ -	$ -	$ -	-	-
ECM 5&6	**Convert T12 fluorescent to T8 with electronic ballast or LED Lamps**	-	-	-	-	-	$ -	$ -	$ -	-	-
ECM 7	**Replace 32 Watt T8 lamps with 28 Watt T8 Lamps**	1.84	16,249	(96)	-	-	$ 2,906.40	$ 12,744.00	$ 487.46	4.22	1.02
ECM 8&9	**Replace exterior mercury vapor/HPS with LED/Induction lights**	-	-	-	-	-	$ -	$ -	$ -	-	-
ECM 10	**Install occupancy control for intermittenly occupied rooms**	-	-	-	-	-	$ -	$ -	$ -	-	-
ECM 11	**Replace old packaged/split HVAC unit with high efficiency HVAC**	18.02	67,274	(764)	-	-	$ 11,709.82	$ 252,000.00	$ 5,381.88	21.06	0.92
ECM 12	**Replace old heat pump with high efficiency heat pump**	-	-	-	-	-	$ -	$ -	$ -	-	-
ECM 13A	**Replace boiler with high efficiency condensing boiler**	-	-	-	-	-	$ -	$ -	$ -	-	-
ECM 13B	**Replace furnace with high efficiency condensing furnace**	-	-	-	-	-	$ -	$ -	$ -	-	-
ECM 14	**Seal existing HVAC leaky duct**	-	-	-	-	-	$ -	$ -	$ -	-	-
ECM 15	**Install variable speed drive for pumps and fans**	-	-	-	-	-	$ -	$ -	$ -	-	-
ECM 16	**Replace manual thermostat with programmable/smart thermostat**	(2.39)	6,840	470	-	-	$ 1,675.99	$ 2,520.00	$ 547.20	1.18	9.32
ECM 17	**Replace old motor with premium efficiency motor**	-	-	-	-	-	$ -	$ -	$ -	-	-
ECM 18	**Replace storage water heater with gas-fired tankless water heater**	-	-	-	-	-	$ -	$ -	$ -	-	-
ECM 19	**Install smart strip/PC management to control computers/printers**	-	8,482	(124)	-	-	$ 1,197.42	$ 2,750.00	$ 678.59	1.73	2.43
ECM 20	**Install vending machine occupancy control**	-	293	(4)	-	-	$ 50.17	$ 250.00	$ 23.45	4.52	1.20
ECM 21	**Install photovoltaic system**	-	-	-	-	-	$ -	$ -	$ -	-	-
	Total	**17.47**	**99,138**	**(519)**	**-**	**-**	**$ 17,539.80**	**$ 270,264.00**	**$ 7,118.57**	**15.00**	**1.00**

Appendix A: Brief overview of CEC suggested Energy Conservation Measures (ECMs)

This appendix provides a brief discussion regarding the different measures recommended by the CEC. The section is provided to familiarize schools with context of each of the recommended measures.

Lighting Measures

ECM 1: Replace incandescent bulbs with compact fluorescent lamps (CFLs)

Replacing traditional incandescent light bulbs with modern compact fluorescent lamp (CFL) style bulb will allow for the same output with less wattage, and less electricity consumption. A 23-watt CFL bulb will deliver the same performance in lumens as a 100-watt incandescent light bulb, while using approximately 75% less energy. 1

Left to right: LED, CFL, Incandescent
Source: *http://www.energy.ca.gov/lightbulbs/lightbulb_faqs.html*

ECM 2: Replace incandescent bulbs with light-emitting diode (LED) lamps

Replacing traditional incandescent lights with light-emitting diode (LED) lights provides the same performance while consuming significantly less electricity. A 12-watt LED bulb will deliver the same performance as a 60-watt incandescent bulb, using between 75-80% less energy. 2

ECM 3 & 4: Convert incandescent/CFL exit sign to LED exit sign

Converting your building's emergency exit sign's bulbs from incandescent or compact fluorescent lamps (CFL) to light-emitting diode (LED) bulbs will provide the same performance while using much less electricity. Incandescent and CFL powered exit signs use 350 kWh and 140 kWh per year, respectively. An exit sign using LED bulbs only uses 44 kWh annually, have a service life for over 10 years, and shine brighter than incandescent or CFL bulbs. [3]

Source: *http://www.utopialighting.com/home.php?cat=33*

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[1] *http://blog.insofast.com/tag/federal-energy-tax-credits/*

[2] *http://energy.gov/energysaver/articles/how-energy-efficient-light-bulbs-compare-traditional-incandescents*

[3] *https://www.energystar.gov/ia/business/small_business/led_exitsigns_techsheet.pdf*

ECM 5 & 6: Convert T12 fluorescent to T8 with electronic ballast or LED lamps

Converting T12 fluorescent lights to T8 lights with electronic ballasts yields energy savings. The following table presents how much electricity is saved by replacing T12 lights with T8 lights of certain wattages.

Old T12 Light	New T8 Light	Annual Savings
34 watts	32 watts	66 kWh
34 watts	28 watts	78 kWh
40 watts	32 watts	82 kWh
40 watts	28 watts	93 kWh

T12 and T8 fixtures

T12 lights can also be replaced with light-emitting diode (LED) lights. The following table (based on CEC Calculator) shows annual electricity savings for various T12 wattages replaced by a 15-watt LED light:

Old T12 Light	LED Light	Annual Savings
34 watts	15 watts	46 kWh
40 watts	15 watts	61 kWh

LED fixtures
Source (both pictures): [*http://www.hoveyelectric.com/hovey-electric-power-blog/bid/73754/T5-vs-T8-vs-LED-The-Best-Options-For-Replacing-Aging-T-12-Fixtures*](http://www.hoveyelectric.com/hovey-electric-power-blog/bid/73754/T5-vs-T8-vs-LED-The-Best-Options-For-Replacing-Aging-T-12-Fixtures)

ECM 7: Replace 32 watt T8 lamps with 28 watt T8 lamps

Upgrading to a low-wattage T8 lamp will yield annual savings. According to the CEC Calculator, replacing a 32-watt T8 lamp with a 28-watt T8 lamp will reduce electricity consumption by 11 kWh per year.

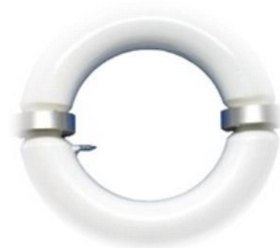
ECM 8 & 9: Replace exterior mercury vapor/HPS with LED/induction lights

For a site exterior lighting system, replacing traditional high pressure sodium (HPS) lights with LED lights provides a chemically safe, and energy efficient alternative. LED lights do not contain mercury, lead, or other hazardous chemicals. Furthermore, a 183-watt HPS system's efficacy is 61 lumens per watt, while a 153-watt LED system's efficacy is 67 lumens per watt. [4]

[4] http://apps1.eere.energy.gov/buildings/publications/pdfs/alliances/outdoor_area_lighting.pdf

Mercury vapor lamp
Source:
[*http://www.1000bulbs.com/product/1821/MV0400-0001E.html*](http://www.1000bulbs.com/product/1821/MV0400-0001E.html)

High pressure sodium lamp
Source:
[*http://www.hiwtc.com/products/high-pressure-sodium-lamp-197655-9233.htm*](http://www.hiwtc.com/products/high-pressure-sodium-lamp-197655-9233.htm)



Induction lamp
Source:
[*http://www.lightsoftherockies.net/Induction_Main.html*](http://www.lightsoftherockies.net/Induction_Main.html)

ECM 10: Install occupancy control for intermittently occupied rooms

Installing occupancy control systems, such as motion sensors, can reduce a building's energy demand should certain rooms be used intermittently. These systems can detect activity, turn on the lights when the room is in use, and turn them off when the room is vacant. A study done by the California Energy Commission estimated 25-50% energy savings in commercial buildings.[5]

Occupancy Sensors[6]

[5] [*http://www.lrc.rpi.edu/resources/pdf/dorene1.pdf*](http://www.lrc.rpi.edu/resources/pdf/dorene1.pdf)
[6] http://www.leviton.com/OA_HTML/SectionDisplay.jsp?section=62870&minisite=10251

HVAC and Mechanical Measures

ECM 11: Replace old packaged/split HVAC unit (up to 65KBtu) with high-efficiency HVAC

Replacing old (10 or more years old) packaged/split HVAC units with new high-efficiency models can save 20% to 50% in energy costs. The table below (based on CEC Calculator) presents the savings per ton of specific SEER models once replaced with high-efficiency HVAC systems.[7]

SEER	Electricity	Fuel Oil
13	384 kWh	1.3 gal
14	468 kWh	2.4 gal

Old HVAC (left) and Efficient New HVAC (right)
Sources: *http://www.hvacmechanicalsystems.com/files/hvac_old_unit_remove_22.JPG; http://climatetech.biz/images/products/packaged_units/GPC13_crossection.jpg*

ECM 12: Replace old heat pump (up to 65 kBtu) with high-efficiency heat pump

Old heat pumps should be replaced with high-efficiency heat pumps. High efficiency heat pumps are better dehumidifiers than older pumps, which reduces energy usage. The following table (based on CEC Calculator) presents the annual savings per ton of specific SEER models once replaced with high-efficiency heat pumps:

SEER	Electricity
13	707 kWh
14	846 kWh
15	916 kWh

Old heat pump (left) and efficient heat pump (right)
Sources: http://www.leinbachservices.com/do-i-really-need-a-supertune-on-my-air-conditioner/new-2-ac-install-4-30-13-2/; http://detectenergy.com/tag/heat-pump/

[7] http://energy.gov/energysaver/articles/central-air-conditioning

ECM 13A: Replace ECM 13A: Replace boiler with high- efficiency condensing boiler

ECM 13B: Replace furnace with high-efficiency condensing furnace

Old furnaces and boilers should be replaced with new, high-efficiency condensing furnaces and boilers. Candidates for replacement are coal burners which were changed to oil or gas, and gas furnaces with pilot lights. The AFUE rating of a condensing furnace or boiler can be over 10% higher than a non-condensing model.[8] The following table (based on CEC Calculator) presents the savings on boilers and furnaces based on AFUE ratings:

AFUE Percentage Rating	Fuel Oil
AFUE92-94	3.53 gal/KBTU/hr
AFUE95-97	4.17 gal/KBTU/hr

High Efficiency Condensing Boiler & Furnace
Sources: http://www.pexsupply.com/High-Efficiency-Gas-Boilers-1735000; http://www.alliantgas.com/why-propane/home-heating-systems/

ECM 14: Seal existing leaky ducts

A significant amount of air used by ducts is lost due to leaks, which can lead to higher utility bills and insufficient heating or cooling. Sealing duct leaks could greatly reduce costs. According to the CEC calculator, when ducts are properly sealed, 24 kWh of energy use and 3.6 gallons of fuel oil are saved per ton of AC.[9]

Leaky Air Duct vs. Tightly Sealed Air Duct
Sources: http://www.energystar.gov/index.cfm?c=behind_the_walls.btw_ducts; http://www.alliedcompletefurnace.com/insulation.html

[8] http://energy.gov/energysaver/articles/furnaces-and-boilers

[9] http://www.energystar.gov/index.cfm?c=home_improvement.hm_improvement_ducts

ECM 15: Install variable speed drive for pumps and fans

Replacing single-speed drive for a fan or pump with a variable-speed drive would reduce costs, as lower speeds can be used when sufficient. A 10% reduction in speed reduces the device's electrical usage by around 25%. According to the CEC calculator, installing variable speed drives can result in savings of 101 kWh and 3.1 gallons of fuel oil per horsepower.[10]

Right: Variable Speed Drive
Source: http://www.pandsautomation.com/variable-speed-drives

ECM 16: Replace manual thermostat with programmable thermostat

Replacing manual thermostats with programmable thermostats can result in energy savings. According to the CEC calculator, by replacing a building's thermostat to a programmable one, 740 kWh of energy use and 88.1 gallons of fuel oil can be saved.

Manual thermostat vs. programmable thermostat
Sources: http://www.honeywellstore.com/store/products/honeywell-yct87k1003-the-round-heat-only-manual-thermostat.htm;

[10] https://www.energystar.gov/index.cfm?c=power_mgt.datacenter_efficiency_vsds

ECM 17: Replace old motor with premium efficiency motor

Replacing standard motors with premium efficiency motors saves 3105 kWh and $250 per year for 10 horsepower motors, 5160 kWh and $410 per year for 25 horsepower motors, 8630 kWh and $690 per year for 50 horsepower motors, 15680 kWh and $1255 per year for 100 horsepower motors, and 29350 kWh and $2350 per year for 200 horsepower motors.[11]

Right: Premium efficiency motor
Source: http://www.baltimoreaircoil.com/english/parts-services/bac-parts/fans-and-drives/premium-efficiantinverter-duty-motors

ECM 18: Replace storage water heater with gas- fired 'tankless' water heater

Storage water heaters continuously consume energy, even when water is not being used. Gas-fired tankless water-heaters only heat water as it is being used, so replacing storage water heaters with tankless greatly cuts down on energy usage.[12]

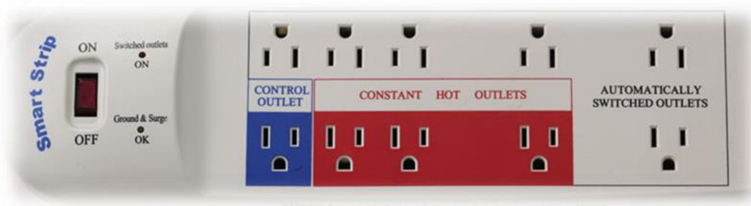
Storage Heater vs. Tankless Heater
Sources: http://ronaldtcurtisplumbing.com/1253/new-water-heater-for-sun-city-lincoln-home-owner/; http://atozleakdetection.com/tankless-water-heaters/

[11] http://www1.eere.energy.gov/manufacturing/tech_assistance/pdfs/whentopurchase_nema_motor_systemts1.pdf
[12] http://www.energystar.gov/certified-products/detail/water_heater_whole_home_gas_tankless

Plug – Load Efficiency Measures:

ECM 19: Install smart strip/PC management to control computers/printers

Computers and other electronic appliances running on standby mode waste energy. By installing a smart strip or other type of management system, energy can be saved. According to the CEC Calculator, one smart strip can save 154 kWh each year, with $4.60 saved annually.



Smart Strip
Source: http://www.lafcpug.org/reviews/review_bits_limited.html

ECM 20: Install vending machine occupancy control

Installing occupancy control systems in existing vending machines can result in energy savings. According to the CEC Calculator, in a snack vending machine, an occupancy control system saves 293 kWh and a beverage vending will save 1,407 kWh.

CoolerMiser occupancy sensor control system
Source:http://store.usatech.com/coolermisercm150wallmountedwsensor.aspx

Simple Photovoltaic (PV) Self- Generation Project

ECM 21: Install PV System

Installing photovoltaic (PV) systems on site can be a fruitful long-term project that allows the user to generate their own electricity directly from sunlight. However, the installation does pose very high initial costs, with long term ROI. The average cost of a system under 10 kW is $5.82/watt in California. Government rebates are also available to offset these costs. As the CEC's Proposition 39 Guidelines suggest, PV systems should only be considered once all other feasible and applicable ECMs are implemented. [13]

Onsite PV system
Source:http://stateenergyreport.com/2012/11/07/power-purchase-agreements-expand-solar-development/

[13] http://www.californiasolarstatistics.ca.gov/

Appendix B: Prior UC Davis Research on Best Practices in Schools

During July-September 2012, the UC Davis Energy Efficiency Center undertook case study research examining energy efficiency programs in k-12 schools and utility programs.

Specific focus areas for the study included:

- Understanding institutional structures and decision-making for energy-related upgrades at schools
- Determining best practices utilized by school districts and/or utilities
- Understanding how large school districts have overcome institutional barriers to implementing energy efficiency
- Researching potential behavior-based programs to include "end-users" at schools
- Distilling lessons learned from other large campus-based entities that might apply to schools

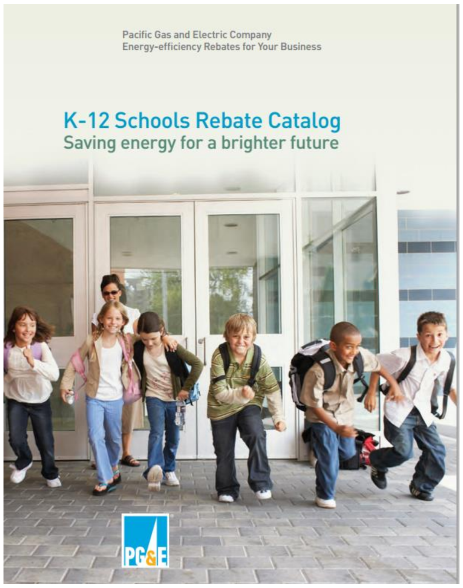
The study reinforced many of the important lessons of energy efficiency programs such as commissioning, retro-commissioning, and facility upgrades. Perhaps more interestingly, however, the study has shown the vast opportunity that exists for behavior-based approaches. Key recommendations of this study include:

- The potential opportunity is enormous—with more than $3 billion annually spent on school's energy needs, even a small reduction in energy usage produces millions of dollars in savings which can be used to more directly benefit students.
- Schools have a captive, mutually reinforcing audience—use it to promote and leverage behavior change.
- Develop strong utility/school district relationships.
- Consider behavior-based programs focusing on operations and maintenance as well as programs focusing on building occupants
- Consider a robust role for third-party administrators.
- Consider strong on-bill financing programs.
- Consider partnerships with NGOs who can help leverage work with schools.
- Empower and develop great leaders to create charismatic political and operational leadership focusing on energy efficiency.
- Learn from the successes of others.

The full publication, which elaborates on all of these recommendations, is available here:
http://eec.ucdavis.edu/files/03-21-2013-Approaches-to-Finding-Savings-Efficiency-in-Schools-1.pdf

Appendix C: Cost and Rebate Estimates

The section includes a summary of available rebates offered by the utility serving the school. Specific rebates change periodically and need to be verified with the utility. Current rebate catalog for PG&E specific to K-12 schools can be downloaded at the following link: http://www.pge.com/includes/docs/pdfs/mybusiness/energysavingsrebates/rebatesincentives/schools_catalog.pdf



Non-residential rebate summary for PG&E

This section reproduces the summary of electric and gas rebates for PG&E compiled by DSIRE[14].

Overall non-residential sector Electric Rebates Summary for PG&E:

- Custom Lighting: $0.05/kWh saved
- Custom Air Conditioning and Refrigeration: $0.09 - $0.15/kWh saved
- Business Computing: $15/Sensor or Power Management Software
- Electric Food Service Equipment: $50 - $1,250/unit
- Refrigeration Equipment: $25 - $1,000/unit
- Night Cover for Display Cases: $3.50/linear ft. Insulation for Bare Suction Lines: $2/linear ft. Package Terminal Air Conditioner & Heat Pumps: $100/unit
- Variable Frequency Drives (VFDs) for HVAC Fans: $80/hp
- Variable Speed Motor Air Handler System: $50/unit
- Efficient Lighting Upgrades: $17 - $200/fixture
- Lamps: $1 - $20
- Occupancy Sensors: $15 - $55/sensor
- LED Exit Sign: $15 - $27
- Time Clocks: $36/unit
- Greenhouse Heat Curtain: $0.20/sq. ft.

[14] Established in 1995, DSIRE is currently operated and funded by the N.C. Solar Center at N.C. State University, with support from the Interstate Renewable Energy Council, Inc. DSIRE is funded in part by the U.S. Department of Energy. http://dsireusa.org/about/

- Infrared Film for Greenhouses: $0.05/sq. ft.
- Equipment Insulation: $2 - $4/ln. or sq. ft.
- Attic Insulation: $0.15
- Wall Insulation: $0.50
- Window Film: $1.35/sq. ft.
- Room AC: $50
- Electric Storage Water Heater: $30
- Heat Pump Water Heater: $500/unit
- Clothes Washer: $50
- Refrigerator: $75

Overall non-residential sector Gas Rebates Summary for PG&E:

- Equipment Insulation: $2 - $4/sq. ft.
- Pipe Insulation: $2 - $3/linear ft.
- Steam Traps: $50 - $290/unit
- Pool Heating: $2/Mbtuh
- Attic/Roof/Ceiling Insulation: $0.15/sq. ft.
- Domestic Hot Water Boiler: $1.50/MBtu/h
- Natural Gas Storage Water Heaters: $200/unit Steam/Water Process Boiler: $2.00/MBtu/h
- Steam/Water Boiler for Space Heating: $0.25-$2.00/MBtu/h
- Direct Contact Water Heater: $2/MBtu/h Furnaces: $150 - $300/unit
- Ozone Laundry System: $39/lb
- Cooking Equipment: $125 - $2,000/unit
- Custom Natural Gas: $1/therm saved

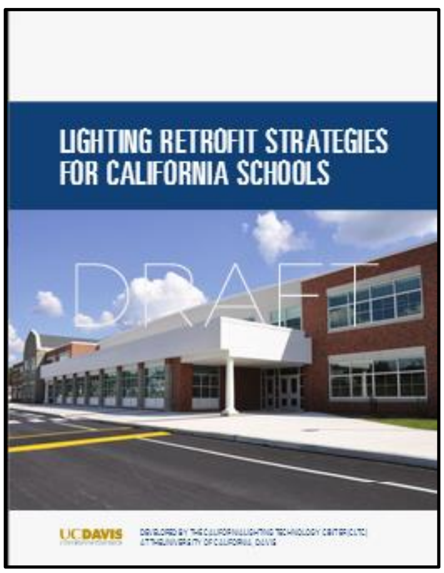
Appendix D: California Lighting Technology Center – Lighting Best Practices Guide

The California Lighting Technology Center (CLTC) is a not-for-profit RD&D facility dedicated to advancing energy-efficient lighting and daylighting technologies. Part of the Department of Design at the University of California, Davis, the CLTC includes full-scale laboratories for research and development, and it provides instruction to both undergraduate and graduate students of lighting design.

Working in partnership with designers, manufacturers, end users, utilities, government agencies, and others, CLTC conducts prototype and product testing, technology demonstrations and case studies. CLTC also provides resources for applying best practices to lighting design and installation. The center's faculty and staff provide curriculum and instruction for education and training courses, in addition to conducting workshops, seminars and outreach activities.

In response to the Proposition 39 efforts, the CLTC has developed a ***"Lighting Retrofit Strategies for California Schools guide"***. This is a 'living' document that will be continually updated. The latest version of the guide can be downloaded here: https://ucdavis.box.com/s/aqgpm7i6faeowsa39wda

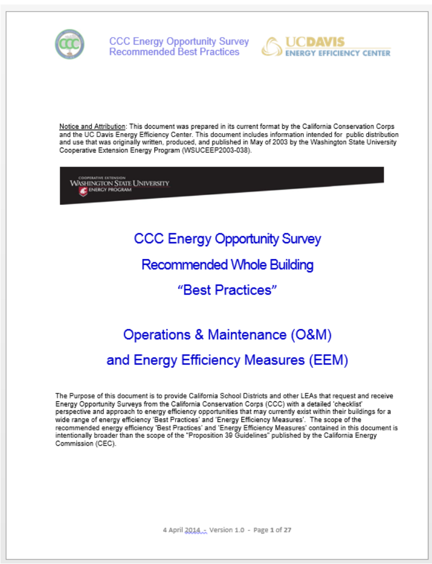
The CLTC will produce this both in hard copy and maintain an electronic document available 'on-line' with frequent updates.



Appendix E: Washington State University's Checklist

Washington State University's Energy program has developed an industry accepted and widely used O&M and Energy Efficiency Measures Checklist to assist energy auditors. A part of that document has been reproduced, edited, and adapted into a simplified format for use by schools.

The Purpose of this document is to provide California School Districts and other LEAs that request and receive Energy Opportunity Surveys from the California Conservation Corps (CCC) with a detailed 'checklist' perspective and approach to further energy efficiency opportunities that may currently exist within their buildings for a wide range of energy efficiency 'Best Practices' and 'Energy Efficiency Measures'. The scope of the recommended energy efficiency 'Best Practices' and 'Energy Efficiency Measures' contained in this document is intentionally broader than the scope of the "Proposition 39 Guidelines" published by the California Energy Commission (CEC).



CCC Energy Opportunity Survey
Recommended Best Practices

UCDAVIS ENERGY EFFICIENCY CENTER

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Cooperative Extension Washington State University Energy Program

CCC Energy Opportunity Survey

Recommended Whole Building

"Best Practices"

Operations & Maintenance (O&M)

and Energy Efficiency Measures (EEM)

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