CCC Energy Corps Initiative

Dear Reader,

FirstFuel Software has provided the following report and analysis of school energy usage and Prop39 savings opportunities by working in conjunction with the California Conservation Corps' on-site energy opportunity surveys.

FirstFuel Software helps educational institutions identify operational and retrofit savings opportunities to reduce energy consumption through a powerful analytics platform. More specifically, FirstFuel uses existing meter data from school buildings to identify, enable, and track energy savings with high accuracy, consistency and at scale. We are supplementing CCC's energy survey reports by providing rich building analysis of occupancy patterns, peak demand, seasonal and weather impact on usage, and energy end-use disaggregation. Across the state of California, FirstFuel has worked with several utilities and school districts to unlock building energy efficiency and cost savings through this type of analysis and insight.

FirstFuel's energy auditing is complimented by our in-house staff of building energy engineers with over 100 years of collective experience in sales, design and implementation of building energy efficiency projects with leading firms such as Johnson Controls, ICF and Honeywell. Our technology and approach have been validated by over 10 third parties, including PG&E, The General Services Adminstration, The Department of Defense, The Cadmus Group and Johnson Controls (read more here).

For more information about the report and our services please contact Brian Van Buskirk, VP of Partner Alliances at (503) 201-7397 or brianv@firstfuel.com

Thank you,

FirstFuel Software, Inc.
420 Bedford Street
Lexington, MA 02420
Fuel up on the latest FirstFuel news

FIRSTFUEL
BUILDING ENERGY ANALYTICS

RAPID BUILDING ASSESSMENT REPORT

PREPARED ON: 07/03/2014

PREPARED FOR:

Sample Report for Elementary School

123 Main St

Sacramento, CA, 94203

TABLE OF CONTENTS

I. INTRODUCTION

We estimate that you can save **$6,577 per year** by implementing our energy saving recommendations

CCC Energy Corps Initiative: Partnership between CCC and FirstFuel Software

The Clean Energy Jobs Act and Senate Bill 73 (California Proposition 39) has tasked the California Conservation Corps (CCC) with 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 partnered with the UC Davis Energy Efficiency Center to develop the Energy Opportunity Survey tool and training necessary for CCC Energy Corps crews to conduct AHRAE level 1+ Energy Opportunity Surveys at schools across the state. Before being deployed in the field, and to ensure consistent implementation, all CCC members are trained in the CCC's ASHRAE compliant survey process by either Sierra College or the UC Davis Energy Efficiency Center.

For each school Energy Opportunity Survey (energy audit), the CCC performs observations and measurements, records a detailed data set, and provides the data to the FirstFuel 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 FirstFuel Software for compilation, analysis, and Report generation.

FirstFuel takes Energy Corp's survey results and supplements the data with the school's whole building consumption data obtained from the Utility. This includes electric interval data for 1 year and monthly gas data, as well as hourly weather and climate data which is obtained from government certified weather stations. Using the above data inputs, FirstFuel's analysis leverages the two key variable drivers of energy use in a building - weather and occupancy, to disaggregate the whole building consumption into end use energy. The energy consumed for each end use is compared against like buildings in the local geography, as well as industry design parameters, to guide recommendations and estimate potential for energy savings.

Within the framework of the CEC's Proposition 39 Guidelines and recommendations, FirstFuel 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.

All participating schools will receive the following documents:

- An energy audit report compiled by FirstFuel Software
- 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 straight forward guideline of recommendations for achieving energy efficiency and cost savings on their campus.

Acknowledgements and Contact

This Energy Opportunity Survey report was compiled by FirstFuel Certified Energy Engineers. FirstFuel Software's staff, including the over six university professors, developed the methodologies and processes used to analyze data, make recommendations, and deliver the report. We would like to acknowledge the following FirstFuel Staff involved in developing this report.

Key FirstFuel Staff Contacts

- Kirk Moushegian, Client Project Manager
- Dave Camell, Energy Engineer Manager
- Kelly Vaden, Energy Engineer
- Daniel Foley, Energy Engineer
- Young Kim, Energy Engineer
- Vik Scoggins, Energy Engineer
- Andrew Klein, Energy Engineer

Special thanks also go to the staff at Corpsmembers of the California Conservation Corps; we would like to thank the LAUSD 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 are dedicated to creating the best energy intelligence service for buildings and we welcome your comments and feedback. Please feel free to contact us directly at (781) 862-6500 or by email at support@firstfuel.com.

Overview of the Report: Focus and Limitations

This document is a preliminary energy efficiency assessment is a Sample Report for Elementary School located in Sacramento, CA. This report was prepared by FirstFuel Software. 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.

An off-site remote audit is conducted by FirstFuel using the interval meter data from the site, and hourly weather and climate data to produce a full building analysis of energy use patterns. Using advanced machine learning and proprietary algorithms, FirstFuel is able to disaggregate consumption into end uses in order analyze and provide energy conservation recommendations.

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 12/28/2014. 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.

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.

CEC Recommended Measures and Cost Effectiveness

This FirstFuel Audit report is not limited to the 21 ECMs outlined in the CEC proposition 39 final guidelines. As such the analysis and presentment of the recommendations can be found in section V. Energy Savings Potential with the associated cost effectiveness calculations. However a full evaluation of all 21 measures can also be found in Appendix A along with the summary table of the CEC Calculator.

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.

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.

II. BUILDING EXECUTIVE SUMMARY

BUILDING INFORMATION

Sample Elementary School

Building Address : 123 Main St, Sacramento, CA, 94203, United States

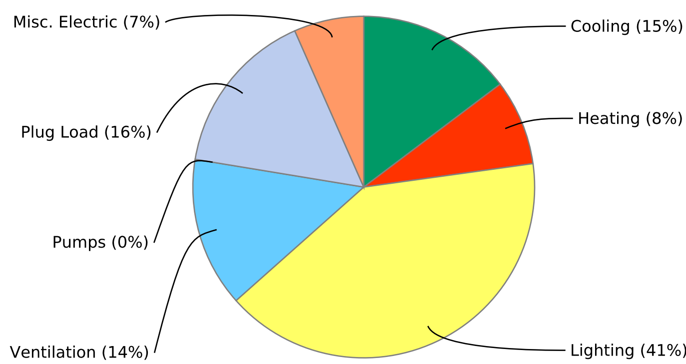
Assessment Period : 07/01/2012 - 06/30/2013

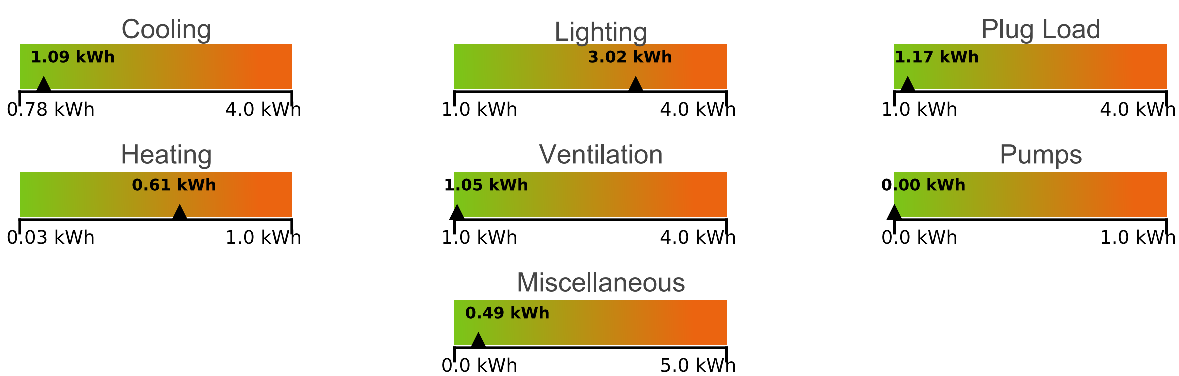
SIZE	33,326 GSF
ACTIVITY	K-8 School
HEATING TYPE	Propane
COOLING TYPE	Electricity

CURRENT ENERGY USE

TOTAL COST	**$39,576**	**PEAK DEMAND**	161 kW
ELECTRIC	247,351 kWh	**CARBON SAVINGS**	12 tonnes

Annual Electric Consumption by End-use per SqFt





II. BUILDING EXECUTIVE SUMMARY, CONT.

ENERGY SAVINGS POTENTIAL

TOTAL	$6,577
ELECTRICITY	41,105 kWh

RECOMMENDATIONS

OPERATIONAL SAVINGS	ENERGY SAVINGS (kWh)	ENERGY SAVINGS (Therms)	COST SAVINGS	COST	ROI (Years)
HVAC Scheduling Control	7,246	N/A	$1,159	$1,500 to $2,500	1.3 to 2.2
Plug Load Management	1,799	N/A	$288	$1,313 to $1,688	4.6 to 5.9
TOTAL	30,861 kBTU		$1,447		

RETROFIT SAVINGS	ENERGY SAVINGS (kWh)	ENERGY SAVINGS (Therms)	COST SAVINGS	COST	ROI (Years)
Parking Lot Lighting Retrofit with Controls	11,861	N/A	$1,898	$17,410 to $22,384	9.2 to 11.8
Lighting Retrofit	17,694	N/A	$2,831	$7,985 to $10,267	2.8 to 3.6
Upgrade to EE Motors	2,505	N/A	$401	$3,215 to $4,135	8.0 to 10.3
TOTAL	109,389 kBTU		$5,130		

III. BUILDING INFORMATION

BUILDING INFORMATION

Sample Elementary School
123 Main St, Sacramento, CA,
94203, United States

SIZE	33,326 GSF
ACTIVITY	K-8 School
HEATING TYPE	Electricity
COOLING TYPE	Electricity

OCCUPANCY(%)	100 %
YEAR CONSTRUCTED	1953
YEAR RENOVATED	N/A
ELECTRICITY COST	$39,576 at average cost/kWh of 16.0 cents

GENERAL OBSERVATIONS

- Sample Elementary School is a roughly 33,326 educational facility serving approximately 440 students in grades K-8. The school has a campus setting and consists of 18 structures, which have been incrementally added throughout the years. These structures consist of administration, classroom, gym, storage, lab/library, and other spaces. The first of oldest of these structures is the administration building, which was built in 1953.
- The building is heated and cooled using electricity. On the roofs of most of the facilities, there are rooftop units visible with DX cooling and likely, electric resistance heating. The trailer classrooms located on the site's southeast corner are likely heated and cooled with wall-mounted A/C units with electric heat. The maintenance and bus shops are located on the southeast corner of the site and they are likely not conditioned to the same extent that most areas of the site are.
- A facility assessment with an equipment inventory was provided. It indicated that interior lighting systems in the building consist of solely 32W T8 fixtures. On the exterior of the building, there is approximately 35,000 square feet of parking lot area that is minimally illuminated at night. Based on interval data demand profiles, it appears that this small amount of exterior lighting is included on the main building's meter. There is also more than 200,000 square feet of playgrounds and athletic fields which do not appear to be illuminated at night.
- Fuel tanks were observed on the premises, using street-level photography. Based on the building's weather response and demand profiles, it was observed that electric resistance heating is the primary heating source and it is assumed the propane tanks may be used for cooking equipment and as a fuel source for secondary heating purposes.

IV. CURRENT ENERGY USE

OVERVIEW

FirstFuel's analytics disaggregate energy consumption at the end-use level to provide comprehensive view into building energy use .The following pages break down your building's energy usage across several key parameters.

SUMMARY

ENERGY CONSUMPTION	TOTAL	PER SQFT	PER SQFT
Electric	247,351 kWh	7.42 kWh	25.32 kBTU
Total	843,963 kBTU	25.32 kBTU	25.32 kBTU
Peak Demand	161 kW	4.82 W	16.45 BTU/hr

END-USE BREAKDOWN

CONSUMPTION PARAMETER	DESCRIPTION
Annual Electric Demand Intensity	Energy Consumption for each metering interval throughout the year
Annual Energy Consumption	Energy consumption across prior 12 months, kWh and peak demand (kW)
Occupancy Analysis	Daily operating schedules derived from seasonal demand schedules
Daily Energy Consumption	Average daily load profile across different time periods
Seasonal Energy Consumption	Energy consumption for a typical day in each different season
End-Use Analysis	Range of energy consumption for various end-uses

ANNUAL ELECTRIC DEMAND INTENSITY

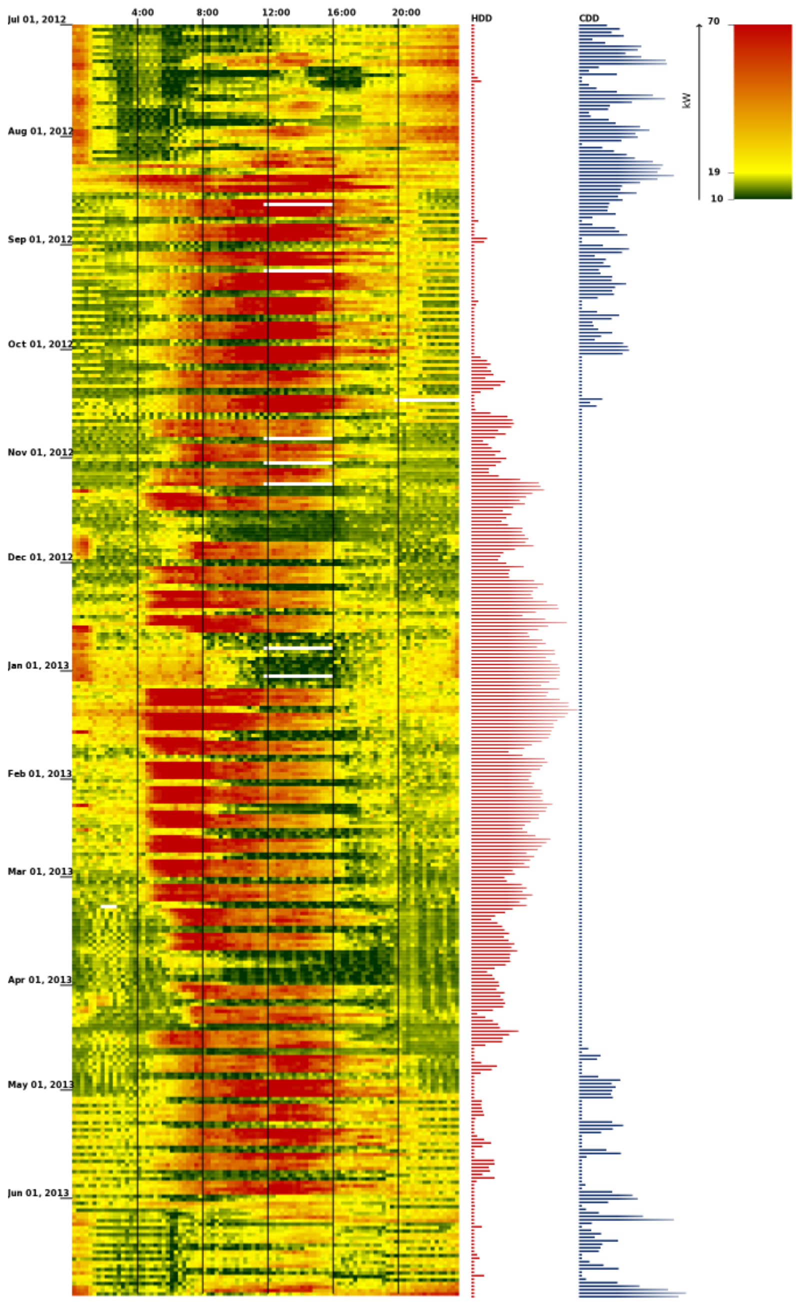
OVERVIEW

What does your power consumption look like at each interval meter read?

Horizontally this graph depicts the power consumption for each metering interval throughout each day. Vertically the days in the study period are depicted. Red indicates intervals of high intensity. Green indicates intervals of low intensity. Yellow indicates the average intensity. Heating and Cooling degree days are base 65F.

KEY DATA

Annual Electric Demand Intensity, per day



ANALYSIS

- From the annual demand intensity map, the start-up and shut-down of the building is clearly displayed by the transition from green to yellow in the early morning and afternoon hours. The unoccupied evening consumption, revealed by the yellow color in evening hours, contributes to the building's average occupied demand to average unoccupied demand ratio.
- The demand intensity chart shows how the building reaches daily demand highs earlier during the winter than during the shoulder and early/late summer months. The building appears to be mostly shut-down during the day on summer vacation days, however, there appears to be a spike in demand during the middle of the night. The cause of this behavior should be investigated.

ANNUAL ENERGY CONSUMPTION

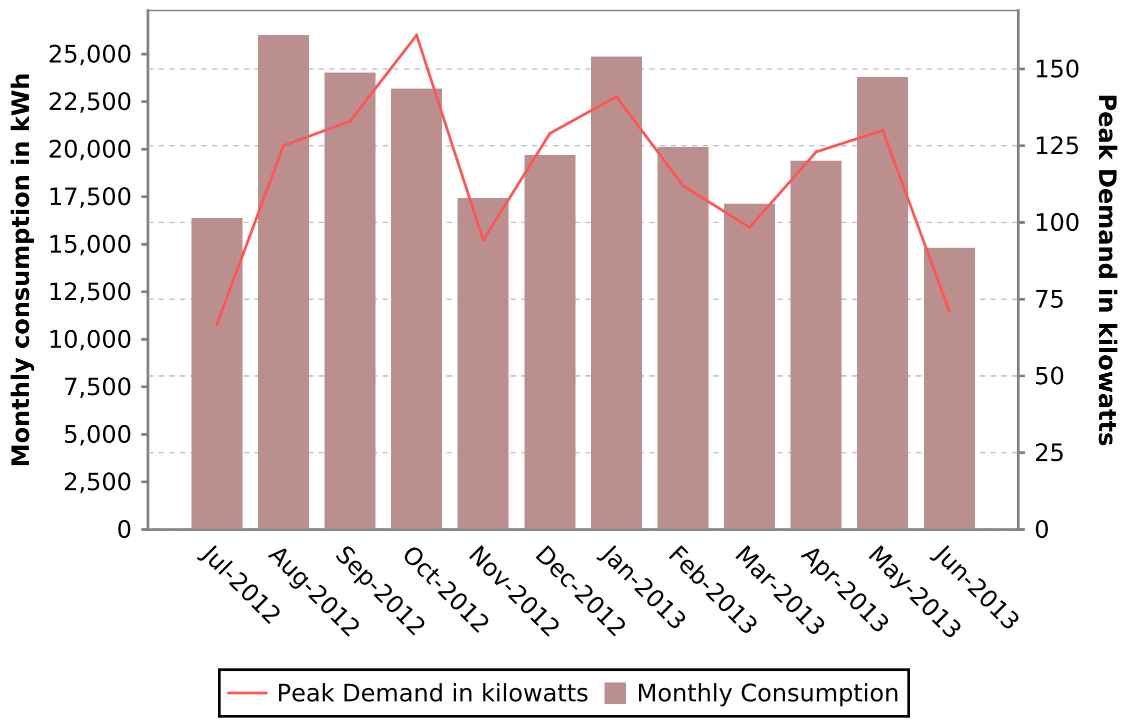
OVERVIEW

How does your energy consumption shift across the year?

The monthly electricity consumption reveals the variation of electricity consumption throughout the year. If energy consumption does not vary significantly on a month-to-month basis, this indicates a low weather-dependence of energy use, which could indicate for example a high base-load consumption, for example through the presence of a datacenter.

KEY DATA

Annual Electric Consumption, per month



ANALYSIS

- The monthly consumption chart shows that cooling and heating drive electricity consumption and that consumption is lowest in the shoulder months when temperatures are relatively mild.

WEATHER ANALYSIS

OVERVIEW

KEY DATA

ANALYSIS

This chart is proprietary analysis. A sample is available upon request by emailing info@firstfuel.com

OCCUPANCY ANALYSIS

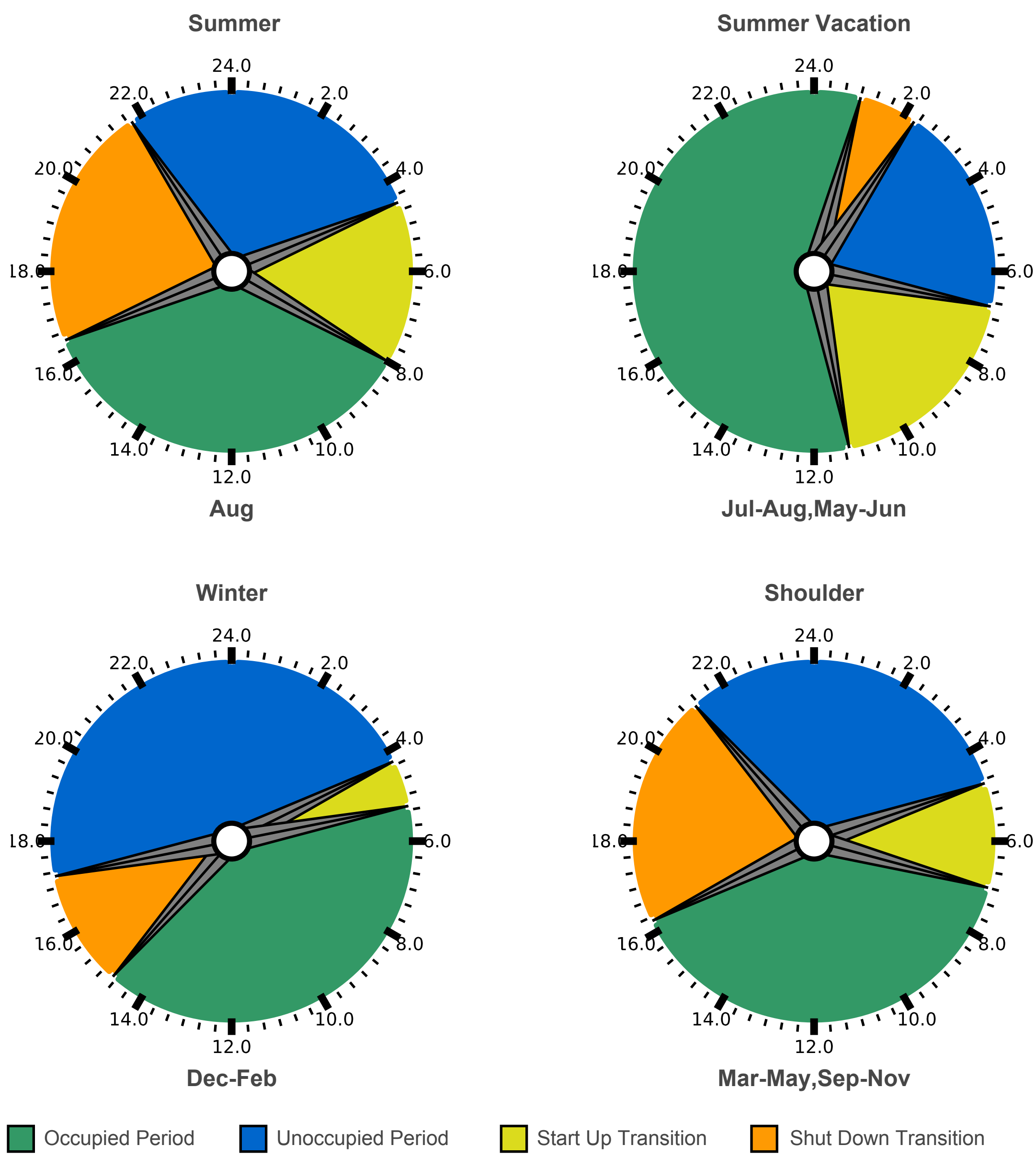
OVERVIEW

How does building occupancy influence your energy consumption?

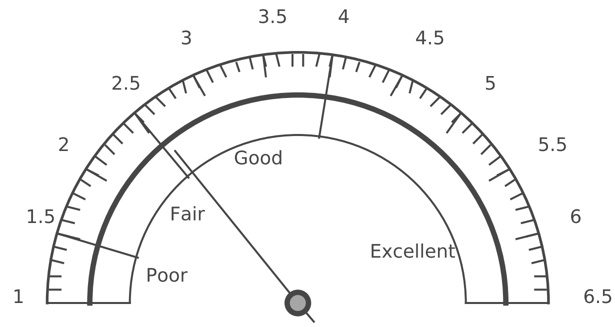
Your building meter data shows when your building turns on each day, when it is ready for occupancy, when building shutdown begins and when the building is "off" for the night. Analyzing these different periods can provide useful insight into general building efficiency levels (see "Occupied/Unoccupied Ratio") and more specific drivers of building inefficiency.

KEY DATA

Operational and Occupancy Schedule



Occupied/Unoccupied Ratio



ANALYSIS

- The unoccupied period for this building is shorter than expected when compared to buildings of this type.
- The HVAC systems may be starting earlier than necessary during the summer, shoulder, and winter months.
- In the summer and winter months, HVAC systems begin to shutdown at a later time than expected. In addition, the shutdown transition may be longer than necessary in the summer, shoulder, and winter months.
- The occupied/unoccupied ratio for this building is 2.55 and is a good indicator that this building makes good use of night setback routines and other simple conservation methods.

DAILY ENERGY CONSUMPTION

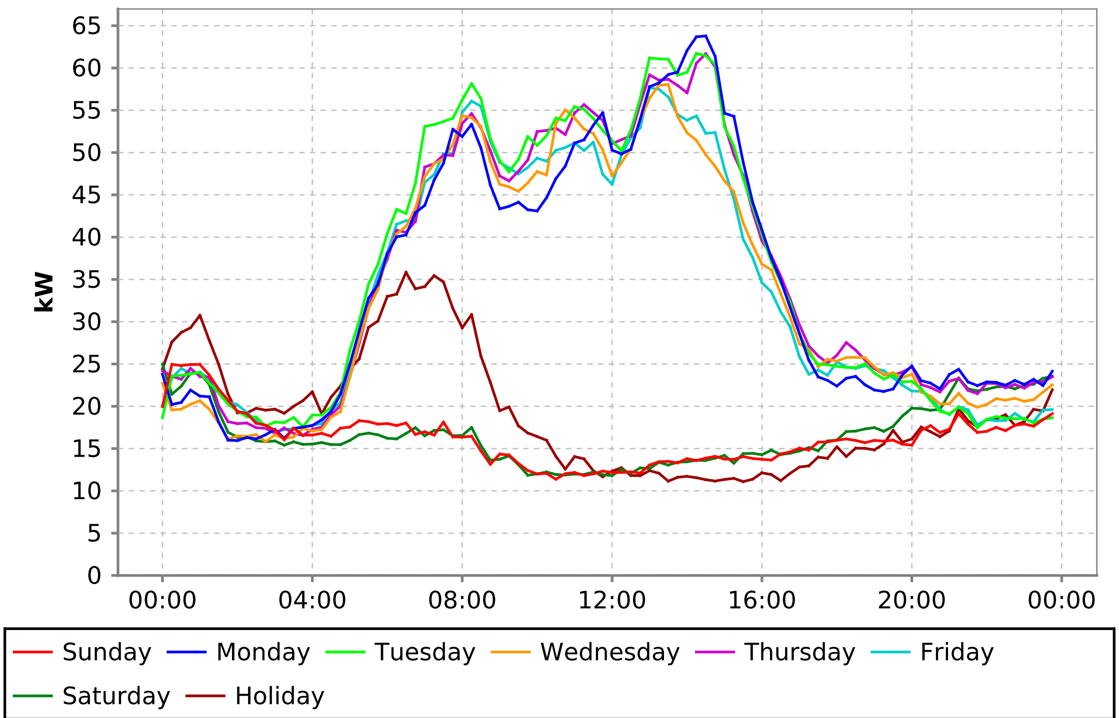
OVERVIEW

How does your energy consumption vary across the week?

The weekly demand chart reveals how energy is consumed on a typical week-day. The values are found by averaging the total energy consumption over 52 weekdays per year. This data provides insight into occupancy and operational irregularities that may be driving inefficiencies.

KEY DATA

Energy Consumption, by Day of the Week



ANALYSIS

- During the weekday, start-up occurs at approximately 4:15 am, which may be earlier than necessary for this school. Occupancy levels are reached at 6:15 am. Demand rises and falls through the day. There appears to be a dip in demand around what is likely lunchtime. The building begins to shut-down at 3:45 pm, which is common for schools of this type which feature some afternoon programs and occupancy. Shut-down is reached at approximately 6:00 pm. We recommend starting the building later and trimming the start-up and shut-down transitions to reduce energy consumption. This can still be done in this campus setting with multiple buildings.
- The building is shut-down on the weekends. There is a slight dip during the day, which likely is due to the exterior parking at the site. On holidays, however, there is a spike in demand at the time during which systems would be starting on normal school days. The rise in demand associated with this spike ends at 7:15 am or so and demand falls to unoccupied levels at 11:30 am.

- The days of the week chart is an average for each day throughout the year. Since this chart is an average, the operation of equipment observed above should not be considered as happening throughout the year. Please refer to the "Seasonal Occupied Days" for a proper view of the building's consumption pattern. The most value gained from this chart is seeing how equipment operates on days of the week, relative to one another.

SEASONAL ENERGY CONSUMPTION

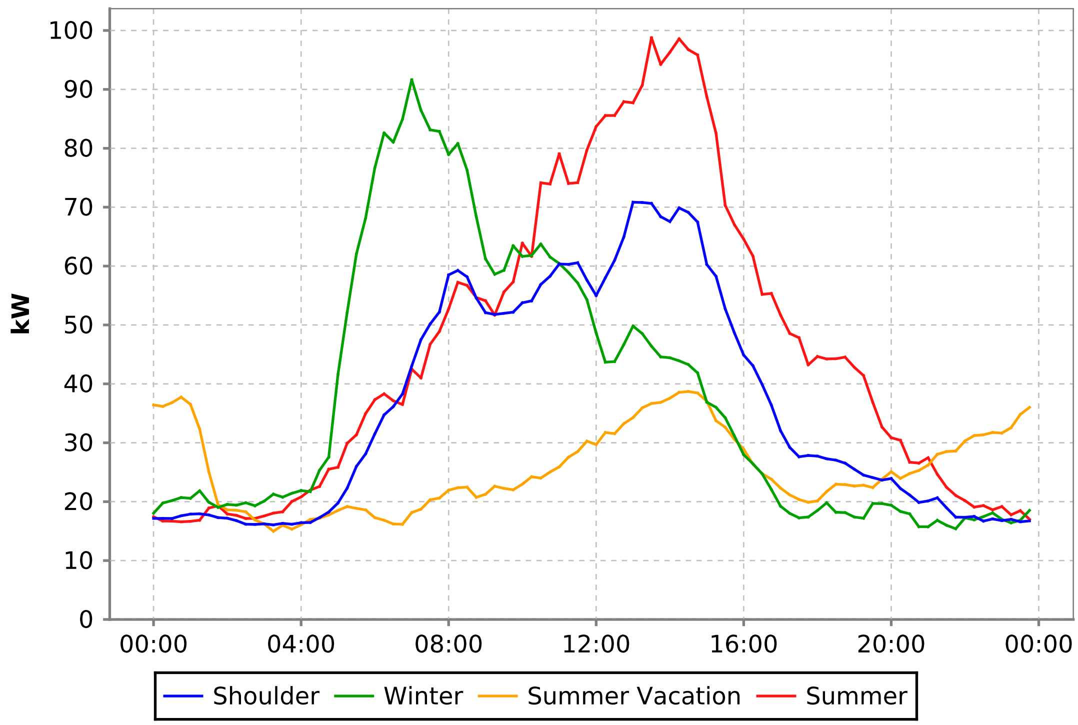
OVERVIEW

How does your energy consumption vary across different seasons?

The seasonal energy consumption reveals the consumption for a typical day in each different season. The seasonal analysis may reveal whether your building uses electric heating or heated water, or that your building has a very high electricity consumption in summer.

KEY DATA

Energy Usage, by Seasonal Occupied days



ANALYSIS

- According to the profile, it appears that there is some variation between operating schedules from season to season.
- A comparison of the summer load curve to the shoulder and winter curves clearly shows the electric load impact of air conditioning. The summer and winter curves show the way that the building's HVAC systems operate. During the winter months, heating comes on during the morning when the building occupants arrive and this level of heating subsides over the day as internal gains increase. During the summer, as internal gains increase and as the outside environment gets warmer, the facility's cooling systems ramp up.
- The way systems operate on summer vacation days is highly unusual. It appears that the building is mostly unoccupied, with a small rise in demand during the day, which is to be expected. However, demand levels rise in the early-late evening until dropping rapidly at 1:00 am. The cause of this behavior is unexplained, therefore we suggest investigating the cause of this rise and demand and eliminating it if it is not consistent with occupancy levels in the building.

END-USE CONSUMPTION

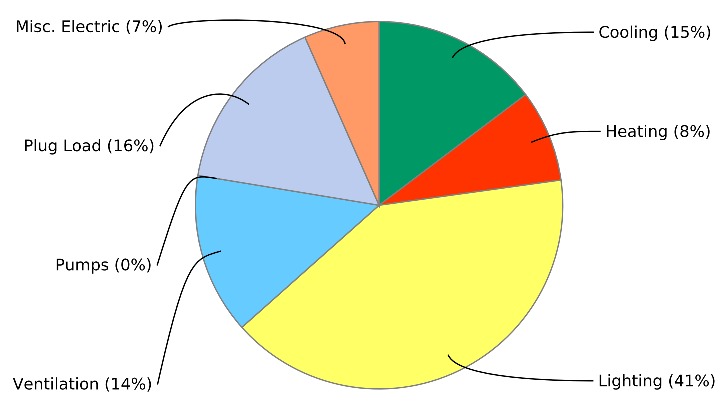
OVERVIEW

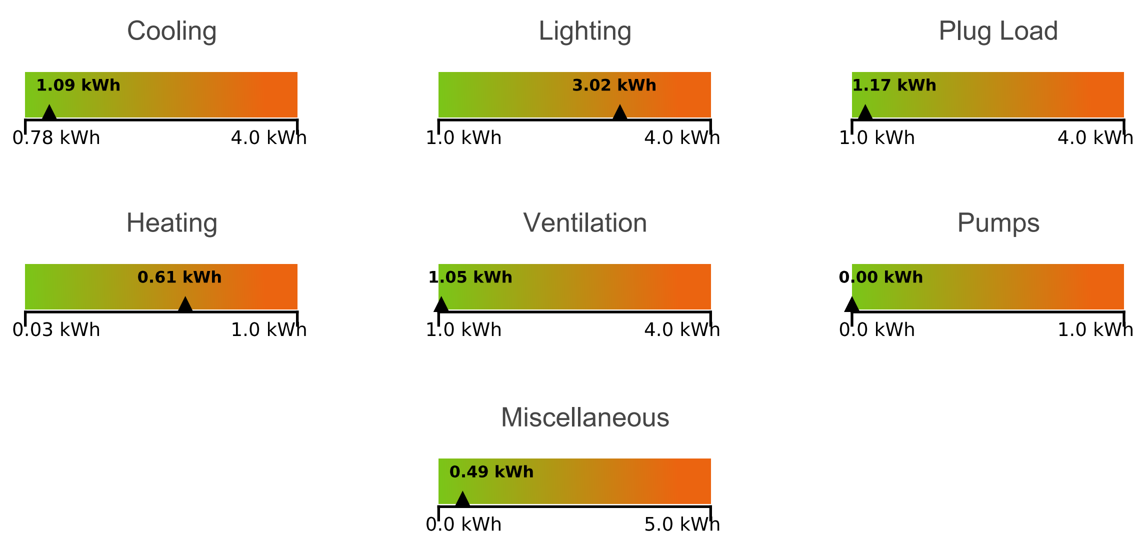
How is your total energy consumption used across different end-uses?

FirstFuel breaks up the total consumption into lighting, heating, cooling, ventilation, plug load, pumps and miscellaneous. In addition, our platform enables you to bench-mark energy end-use, enabling comparisons to similar building types in similar climate zones. The meters in the graph show how your end-use compares to others.

KEY DATA

Annual Electric End Use Distribution per SqFt





ANALYSIS

- Combined HVAC related heating, cooling, pumping, and ventilation consumption is low at 2.74 kWh/sqft. This end use summation reflects the fact that the buildings' HVAC systems are shut-down during unoccupied hours. This level of consumption is especially low considering the use of electric heat as the primary heating type at the facility. HVAC consumption can be reduced by employing high efficiency and/or variable speed drives and utilizing more efficient heating and cooling equipment.
- The lighting consumption is indicative of older vintage T8 lighting with occupancy based controls. Interior lighting is based ASHRAE 90.1-99 levels for the building type which equates to a maximum lighting power density of 0.77 W/sf. From the disaggregation we found that most of the lights are shut off at night.

- The plug load end-use is in a normal range. From the disaggregation it appears that while most of the plug loads are shut off during unoccupied hours, there appears to be unknown equipment operation occurring during the middle of the night and weekdays and during the morning on weekends that may be due to plug loads.

V. ENERGY SAVINGS POTENTIAL

OVERVIEW

This provides the reader with a detailed breakdown of top recommendations for energy savings. Recommendations are split between low/no-cost operational savings measures and retrofit, with associated savings potential for each recommendation.

	ENERGY	SAVINGS	CARBON (tonnes)	COST	ROI (Years)
ELECTRICITY	41,105 kWh	$6,577	12	$31,423 to $40,974	4.8 to 6.2
TOTAL	**140,250 kBTU**	**$6,577**	**12 tonnes**		

SAVINGS

OPERATIONAL SAVINGS	ENERGY SAVINGS (kWh)	ENERGY SAVINGS (Therms)	COST SAVINGS	COST	ROI (Years)
HVAC Scheduling Control	7,246	N/A	$1,159	$1,500 to $2,500	1.3 to 2.2
Plug Load Management	1,799	N/A	$288	$1,313 to $1,688	4.6 to 5.9
TOTAL	**30,861 kBTU**		**$1,447**		

RETROFIT SAVINGS	ENERGY SAVINGS (kWh)	ENERGY SAVINGS (Therms)	COST SAVINGS	COST	ROI (Years)
Parking Lot Lighting Retrofit with Controls	11,861	N/A	$1,898	$17,410 to $22,384	9.2 to 11.8
Lighting Retrofit	17,694	N/A	$2,831	$7,985 to $10,267	2.8 to 3.6
Upgrade to EE Motors	2,505	N/A	$401	$3,215 to $4,135	8.0 to 10.3
TOTAL	**109,389 kBTU**		**$5,130**		

OPERATIONAL RECOMMENDATION #1

OVERVIEW & SAVINGS POTENTIAL

ECM 16: HVAC Scheduling Control

ELECTRICITY	7,246 kWh
SAVINGS	$1,159
COST	$1,500 to $2,500
ROI	1.3 Yrs to 2.2 Yrs
SIR	6.51

Our analysis indicates that HVAC systems may be operational for longer hours than necessary. Across the year, the building is experiencing an average operational start time of 4:30 am, and run until an average time of 7:00 pm. Yet the building appears to be occupied from 6:30 am to 3:45 pm.

More detailed operational insight can be obtained by examining heating and cooling season operation separately.

In cooling mode, a significant portion of the HVAC systems begin operation at an average start time of 4:30 am, and run until an average time of 9:30 pm. Summer occupancy occurs between 8:00 am to 4:30 pm. This results in a startup transition time of 3.5 hours and a shut down transition time of 5 hours.

In heating mode, a significant portion of the HVAC systems begin operation at an average start time of 4:15 am, and run until an average time of 4:45 pm. Winter occupancy occurs between 6:00 am to 2:45 pm. This results in a startup transition time of 1.75 and a shut down transition time of 2.0.

Ideally, startup in all seasons should be limited to two hours, and shutdown should be limited to one hour.

While some advance run time for HVAC is required to precondition the building, returning it to occupied setpoint, we recommend that scheduled operating times be changed to more closely match the actual building use, with a minimal time allotted for early operation. If the systems are under BAS control, the BAS can be programmed to include an “optimum start” routine that will vary the HVAC start times each day based on actual indoor and outdoor temperatures. We recommend that the scheduled HVAC stop times be adjusted to match the occupancy schedule.

In some cases, if automatic controls are not installed, manual start/stop procedures can be improved by shifting responsibility for operating the equipment directly to occupants, or to use automated system to alert facilities personnel to manually turn systems on/off.

Also, based on the weather response curves, the HVAC systems operate at significant levels even during unoccupied hours. The most cost effective way to reduce the energy consumption of HVAC systems is to implement proper scheduling and unoccupied setback control so that the systems operate only as required. We recommend setpoints of 55F in unoccupied heating mode, and 85F in unoccupied cooling mode.

Some possible strategies for this solution include:

- Timeclocks in spaces with highly regular occupancy schedule
- Rundown timers for irregular/ infrequently occupied spaces
- Optimum-start controllers to determine system startup based on weather conditions.

NOTE: Savings reflect an 8% reduction in HVAC consumption and are based on scheduling equipment to delay startup/maintain unoccupied setpoints until two hours before occupancy, and to end operation and/or setback to unoccupied setpoints immediately at the end of occupied period. This would result in start up and shutdown transitions of two hours and one hour respectively.

SUPPORTING ANALYSIS

- Combined HVAC related heating, cooling, pumping, and ventilation consumption is low at 2.74 kWh/sqft. This end use summation reflects the fact that the buildings' HVAC systems are shut-down during unoccupied hours. This level of consumption is especially low considering the use of electric heat as the primary heating type at the facility. HVAC consumption can be reduced by employing high efficiency and/or variable speed drives and utilizing more efficient heating and cooling equipment.

- In the summer and winter months, HVAC systems begin to shutdown at a later time than expected. In addition, the shutdown transition may be longer than necessary in the summer, shoulder, and winter months.

- The way systems operate on summer vacation days is highly unusual. It appears that the building is mostly unoccupied, with a small rise in demand during the day, which is to be expected. However, demand levels rise in the early-late evening until dropping rapidly at 1:00 am. The cause of this behavior is unexplained, therefore we suggest investigating the cause of this rise and demand and eliminating it if it is not consistent with occupancy levels in the building.

- During the weekday, start-up occurs at approximately 4:15 am, which may be earlier than necessary for this school. Occupancy levels are reached at 6:15 am. Demand rises and falls through the day. There appears to be a dip in demand around what is likely lunchtime. The building begins to shut-down at 3:45 am, which is common for schools of this type which feature some afternoon programs and occupancy. Shut-down is reached at approximately 6:00 pm. We recommend starting the building later and trimming the start-up and shut-down transitions to reduce energy consumption. This can still be done in this campus setting with multiple buildings.

- The HVAC systems may be starting earlier than necessary during the summer, shoulder, and winter months.

OPERATIONAL RECOMMENDATION #2

OVERVIEW & SAVINGS POTENTIAL

ECM 19: Plug Load Management

ELECTRICITY	1,799 kWh
SAVINGS	$288
COST	$1,313 to $1,688
ROI	4.6 Yrs to 5.9 Yrs
SIR	1.08

Plug loads related to computer loads, copiers, microwaves, coffee machines and other related equipment can contribute to a significant percentage of a buildings energy usage. End use analysis indicates that plug loads in this facility are in the normal range, but there is unexplained equipment consumption occurring during the middle of the night that is likely due to plug loads. It is recommended that the facility utilize plug load controllers, such as personal computer power management and automatic plug load controls to limit the use of power consumption when in standby conditions.

If such plug load management systems are not feasible, there are several ways to reduce plug load operation via no-cost operational changes. One effective way is to check all computers, monitors, and printers to ensure that Energy Star features are enabled to provide automatic “sleep” mode or shutdown of equipment during times when not in use. In addition, we recommend that key building staff members be assigned the responsibility to walk through spaces at the end of each work day to make sure that equipment is manually shut off.

NOTE: Savings are based on achievement of an 40-60% reduction in plug load power requirements during certain unoccupied hours, predominately in the middle of the night, during the summer vacation and holidays, and a 20% reduction during weekend mornings throughout the year. This corresponds to an approximately 5.5% reduction in plug loads during the entire year.

SUPPORTING ANALYSIS

- The way systems operate on summer vacation days is highly unusual. It appears that the building is mostly unoccupied, with a small rise in demand during the day, which is to be expected. However, demand levels rise in the early-late evening until dropping rapidly at 1:00 am. The cause of this behavior is unexplained, therefore we suggest investigating the cause of this rise and demand and eliminating it if it is not consistent with occupancy levels in the building.
- The plug load end-use is in a normal range. From the disaggregation it appears that while most of the plug loads are shut off during unoccupied hours, there appears to be unknown equipment operation occurring during the middle of the night and weekdays and during the morning on weekends that may be due to plug loads.

RETROFIT RECOMMENDATION #1

OVERVIEW & SAVINGS POTENTIAL

ECM 8&9: Parking Lot Lighting Retrofit with Controls

ELECTRICITY	11,861 kWh
SAVINGS	$1,898
COST	$17,410 to $22,384
ROI	9.2 Yrs to 11.8 Yrs
SIR	1.76

In our experience, buildings of this vintage typically have 250W or 400W high pressure sodium or metal halide lighting fixtures installed in the parking lot. The opportunity to switch from high-pressure sodium (HPS) or metal halide (MH) lamps in parking lots to LED or induction fixtures should be examined.

Additionally, day light sensing and time clocks, building automation or both can contribute to reduced energy use for outside lighting

NOTE: Savings calculated are based on replacing the existing (250W HPS) lamps to 90W LED fixtures, and implementing lighting controls.

SUPPORTING ANALYSIS

- Exterior lighting accounts for approximately 8.0% of total consumption. There may be an opportunity to switch from high pressure sodium or metal halide lamps to LED or induction fixtures.

RETROFIT RECOMMENDATION #2

OVERVIEW & SAVINGS POTENTIAL

ECM 7: Lighting Retrofit

ELECTRICITY	17,694 kWh
SAVINGS	$2,831
COST	$7,985 to $10,267
ROI	2.8 Yrs to 3.6 Yrs
SIR	0.5

Buildings of this vintage often have 32W T8 lighting fixtures. Additionally, the end use analysis indicates that lighting systems in this facility are greater than 0.9 W/sqft, which correlates with older vintage T8 lighting fixtures. However these existing fixtures can be upgraded to new 28W T8 lights or high efficiency T8 lights which are 25W.
NOTE: Savings calculated are based on replacing the existing 32W T8 lighting with 25W high efficiency T8 fixtures.

SUPPORTING ANALYSIS

- The lighting consumption is indicative of older vintage T8 lighting with occupancy based controls. Interior lighting is based ASHRAE 90.1-99 levels for the building type which equates to a maximum lighting power density of 0.77 W/sf. From the disaggregation we found that most of the lights are shut off at night.

RETROFIT RECOMMENDATION #3

OVERVIEW & SAVINGS POTENTIAL

ECM 17: Upgrade to EE Motors

ELECTRICITY	2,505 kWh
SAVINGS	$401
COST	$3,215 to $4,135
ROI	8.0 Yrs to 10.3 Yrs
SIR	1.03

This recommendation is to replace the existing motors on a number of systems with new, premium-efficiency motors. Improved motor efficiency reduces electrical energy demand and consumption while providing the same power output as the older, less-efficient motors. It is recommended that motors which meet or exceed the NEMA specification for premium efficiency motors be installed. This measure may be eligible for a utility incentive, so contact the appropriate electric utility before purchasing motors.

NOTE: Savings reflect an approximately 8% improvement in fan motor efficiency for the rooftop air-handling units.

SUPPORTING ANALYSIS

- The steep rise and demand at temperatures above and below the heating-cooling switchover (54 degrees), as opposed to a more gradual rise, indicates that variable speed drives and/or high efficiency motors are not being fully utilized at the site.

Appendix A: CEC Recommended Measures and Cost Effectiveness

The scope of the energy efficiency measures and recommendations contained in this report are **not 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, subsets 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, may need additional analysis.

Selected Measures Based on the Energy Opportunity Survey and FirstFuel Analysis

The table below lists all the possible recommended ECMs by CEC and indicates those ECMs that are applicable to the school based on the survey data and FirstFuel's remote engineer's analysis.

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 and FirstFuel's analysis of the meter data.

	CEC Recommended Measures	Measure Applicable?	Comments
Lighting Energy Efficiency Measures:			
ECM1	Replace incandescent light with compact fluorescent (CFL)	No	Not found as significant
ECM2	Replace incandescent/down light/flood with light-emitting diode (LED) light	No	No Incandescent lamps were located at school
ECM3	Replace incandescent Exit Sign with LED Exit sign	No	Information unavailable
ECM4	Replace CFL Exit Sign with LED Exit sign	No	Information unavailable
ECM5	Convert T12 fluorescent lamps to T8 with electronic ballast	No	No T12 were located at the school
ECM6	Convert T12 to linear LED lamps	No	No T12 were located at the school ECM7
ECM7	Replace 32 Watt T8 lamps with 28 Watt T8 Lamps	Yes	Refer to **Lighting Retrofit** - Interior 32W to 25W T8
ECM8	Replace exterior mercury vapor lights with induction or LED lights	Yes	Refer to **Parking Lot Lighting Retrofit with Controls** 250W HPS to 90W LED
ECM9	Replace exterior high pressure sodium lights with induction or LED lights	Yes	Refer to **Parking Lot Lighting Retrofit with Controls** 250W HPS to 90W LED
ECM10	Install occupancy control for intermittently occupied rooms	No	Information unavailable or not sure

HVAC Measures:			
ECM11	Replace old packaged/split HVAC unit with high efficiency HVAC	No	
ECM12	Replace old heat pump with high efficiency heat pump	No	No Heatpumps 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
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 thermostat	Yes	4 non-programmable thermostats located at the school. Refer to **HVAC Scheduling Control**
ECM17	Install variable speed drive for pumps and fans	Yes	Refer to **Upgrade to EE Motors**
ECM18	Replace storage water heater with instantaneous water heater	No	No gas fired tanks were located in the school
Plug – Load Efficiency Measures:			
ECM19	Install smart strip/PC management to control computers/printers	Yes	30 unique rooms with plugloads were located Refer to **Plug Load Management**
ECM20	Install vending machine occupancy control.	No	No vending machine located at school
Simple PV Self-Generated Project:			
ECM21	School-owned PV system	No	PV is outside scope of this report

CEC Measure Output Table

The Table below 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 SIR to qualify according to the CEC's Proposition Guidelines.

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	0.00	-	-	-	-	$ -	$ -	$ -	-	-
ECM 2	Replace incandescent light with LED	0.00	-	-	-	-	$ -	$ -	$ -	-	-
ECM 3&4	Convert incandescent/CFL exit sign to LED exit sign	0.00	-	-	-	-	$ -	$ -	$ -	-	-
ECM 5&6	Convert T12 fluorescent to T8 with electronic ballast or LED Lamps	0.00	-	-	-	-	$ -	$ -	$ -	-	-
ECM7	Lighting Retrofit - Interior 32W to	7.09	17,657	-	(1.1)	-	$ 2,295	$ 22,352	$ 530	9.5	0.50
ECM8&9	Parking Lot Lighting Retrofit - 250W HPS to 90W LED	3.16	12,434	-	-	-	$ 1,616	$ 15,543	$ 373	9.4	1.76
ECM 10	Install occupancy control for intermittenly occupied rooms	0.00	-	-	-	-	$ -	$ -	$ -	-	-
ECM 11	Replace old packaged/split HVAC unit with high efficiency HVAC	0.00	-	-	-	-	$ -	$ -	$ -	-	-
ECM 12	Replace old heat pump with high efficiency heat pump	0.00	-	-	-	-	$ -	$ -	$ -	-	-
ECM 13A	Replace boiler with high efficiency condensing boiler	0.00	-	-	-	-	$ -	$ -	$ -	-	-
ECM 13B	Replace furnace with high efficiency condensing furnace	0.00	-	-	-	-	$ -	$ -	$ -	-	-
ECM 14	Seal existing HVAC leaky duct	0.00	-	-	-	-	$ -	$ -	$ -	-	-
ECM 15	Install variable speed drive for pumps	0.00	-	-	-	-	$ -	$ -	$ -	-	-
ECM 16	HVAC Scheduling Control	4.50	7,245	-	-	-	$ 1,124	$ 2,500	$ 580	1.7	6.51
ECM 17	Replace old motor with premium efficiency motor	1.0	2,504.0	-	(8.3)	-	372.2	7,000.0	200.3	18.3	1.03
ECM 18	Replace storage water heater with gas-fired tankless water heater	0.00	-	-	-	-	$ -	$ -	$ -	-	-
ECM 19	Install smart strip/PC management to control computers/printers	6.90	9,551	-	-	-	$ 1,195	$ 5,581	$ 764	4.0	1.08
ECM 20	Install vending machine occupancy	0.00	-	-	-	-	$ -	$ -	$ -	-	-
ECM 21	Install photovoltaic system	0.00	-	-	-	-	$ -	$ -	$ -	-	-
	Total	22.65	49,391	-	(9.4)	-	$ 6,603	$ 52,976	$ 2,447	7.7	0.24

Appendix B: 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, data algorithms, and simple engineering calculations.

The section is divided into five sub sections:

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

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. The current school's percentage of HVAC electric consumption is 23% and for lighting electric consumption is 41%.

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.

Building Interior Lighting Inventory

Building ID	Building Type	Lamp Type	Lamp Wattage	Lamps per Fixture	Number of Fixtures	Total Power (kW)	Total Annual Energy Use (kWh)	Total Annual Operating Costs ($)
B1	Admin	T8	32	2	27	1.73	3732	$579
B4	Storage	T8	32	2	12	0.77	1659	$257
B5	Storage	T8	32	2	12	0.77	1659	$257
B6	Storage	T8	32	2	12	0.77	1659	$257
B7	Lab/Library	T8	32	2	12	0.77	1659	$257
B8	Classrooms	T8	32	2	48	3.07	6636	$1029
B9	Classrooms	T8	32	2	79	5.06	10921	$1694
B10	Gym	T8	32	2	77	4.93	10644	$1651
B11	Classrooms	T8	32	2	66	4.22	9124	$1415
B12	Classrooms	T8	32	2	24	1.54	3318	$515

B13	Storage/Classrooms	T8	32	2	66	4.22	9124	$1,415
B14	Classrooms	T8	32	2	12	0.77	1659	$257
B15	Classrooms	T8	32	2	10	0.64	1382	$214
B16	Classrooms	T8	32	2	10	0.64	1382	$214
B17	Classrooms	T8	32	2	20	1.28	2765	$429
Total/Avg					507	32.45	70088	$10,872

Building Exterior Lighting Inventory

Building ID	Building Type	Lamp Type	Lamp Wattage	Lamps per Fixture	Number of Fixtures	Total Power (kW)	Total Annual Energy Use (kWh)	Total Annual Operating Costs ($)
B1	Admin	CFL	32	1	5	0.16	818	$127
B1	Admin	HPS	100	1	1	0.10	511	$79
B2	Maintenance	HPS	100	1	1	0.10	511	$79
B5	Storage	MH	100	1	1	0.10	511	$79
B6	Storage	MH	100	1	1	0.10	511	$79
B7	Lab/Library	MH	100	1	2	0.20	1022	$159
B8	Classrooms	MH	100	1	1	0.10	511	$79
B9	Classrooms	CFL	32	1	5	0.16	818	$159
B9	Classrooms	MH	100	1	1	0.10	511	$79
B10	Gym	CFL	32	1	12	0.38	1962	$304
B10	Gym	HPS	100	1	1	0.10	511	$79
B10	Gym	MH	100	1	4	0.40	2044	$317
B10	Gym	MH	100	1	1	0.10	511	$79
B11	Classrooms	MH	100	1	2	0.20	1022	$159
B11	Classrooms	CFL	32	1	4	0.13	654	$101
B11	Classrooms	INC	100	1	1	0.10	511	$79
B12	Classrooms	MH	100	1	1	0.10	511	$79
B13	Storage/classrooms	CFL	32	1	8	0.26	1308	$203
B13	Storage/classrooms	MH	100	1	2	0.20	1022	$159
B14	Classrooms	MH	100	1	1	0.10	511	$79
B15	Classrooms	MH	100	1	1	0.10	511	$79
B16	Classrooms	MH	100	1	1	0.10	511	$79
B17	Classrooms	MH	100	1	2	0.20	1022	$159
B18	Classrooms	MH	100	1	2	0.20	1022	$159
B18	Classrooms	HAL	100	2	1	0.20	1022	$159
Total/Avg						3.99	20,379	$3,161

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. The 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. 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.

Building Level HVAC Equipment Inventory

Building ID	Building Type	Unit Type	Unit Capacity" (Tons)	Annual cooling Energy Use (kWh)	Annual Energy Use for Heating (kWh)	Total Annual Energy Use (kWh)	Total Annual Operating Costs ($)
B1	Admin	PACKAGED	4	1646	0	1646	255
B1	Admin	PACKAGED	4	1646	0	1646	255
B1	Admin	PACKAGED	4	1646	0	1646	255
B4	Storage	PACKAGED	4	1646	0	1646	255
B5	Storage	PACKAGED	4	1646	0	1646	255
B6	Storage	PACKAGED	4	1646	0	1646	255
B7	Lab/Library	PACKAGED	4	1646	0	1646	255
B7	Lab/Library	PACKAGED	4	1646	0	1646	255
B8	Classrooms	PACKAGED	4	1646	0	1646	255
B8	Classrooms	PACKAGED	4	1646	0	1646	255
B9	Classrooms	PACKAGED	4	1646	0	1646	255
B9	Classrooms	PACKAGED	4	1646	0	1646	255
B9	Classrooms	PACKAGED	4	1646	0	1646	255
B9	Classrooms	PACKAGED	4	1646	0	1646	255
B10	Gym	PACKAGED	4	1646	0	1646	255
B10	Gym	PACKAGED	4	1646	0	1646	255
B11	Classrooms	PACKAGED	4	1646	0	1646	255
B11	Classrooms	PACKAGED	4	1646	0	1646	255
B12	Classrooms	PACKAGED	4	1646	0	1646	255
B12	Classrooms	PACKAGED	4	1646	0	1646	255
B13	Storage/ classrooms	PACKAGED	4	1646	0	1646	255
B13	Storage/ classrooms	PACKAGED	4	1646	0	1646	255
B13	Storage/ classrooms	PACKAGED	4	1646	0	1646	255
B13	Storage/ classrooms	PACKAGED	4	1646	0	1646	255

B14	Classrooms	PACKAGED	4	1646	0	1646	255
B15	Classrooms	PACKAGED	4	1646	0	1646	255
B16	Classrooms	PACKAGED	4	1646	0	1646	255
B17	Classrooms	PACKAGED	4	1646	0	1646	255
B17	Classrooms	PACKAGED	4	1646	0	1646	255
B18	Classrooms	PACKAGED	4	1646	0	1646	255
B18	Classrooms	PACKAGED	4	1646	0	1646	255
Total/Average				51017	0	51017	7914

Plug Loads

Plug loads, such as computers, copiers, and other office equipment; represent over 6% of all electricity use in a typical California school. Based on FirstFuel's analytics, plug load represents a total of 16% of electrical consumption for this school.

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.

Plug Load Summary

Load Source	Quantity	Total Power (kilo Watts)
Laptop	1	0.07
Printer	18	0.54
Stamper	1	0
Copier	7	6.3
Computer	61	10.07
Refrigerator	3	2.18
Mini-Heater	2	3
Computers	45	7.43
Paper Shredder	1	0
Christmas Lights	1	0
Fan	1	0
Printers	2	0.06
Projector	7	5.78
Space Fan	1	0.05
Mini-fridge	8	1.06
Microwave	9	8.2
Laminator	1	0.8
Water Cooler	1	0
Washer	1	0.5
Dryer	1	2.4
Dishwasher	1	0
Fax/Copier	1	0.9

Oven	1	0
Ac unit	1	0
Air Purifier	1	0.02
Comp. Speakers	2	0.04
Keyboard	1	0
Total	49.38	1646

2. Gas End Use Characteristics

No gas usage was reported or observed at the school.

3. 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.

4. 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 the Washington State University's CheckList for information on resources that the school can use to investigate further O&M and Energy Efficiency measures.

Appendix C: 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

[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

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]

LED Fixtures Sources (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

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

Mercury vapor lamp
Source:
https://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

Induction lamp
Source:
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
[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]

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:

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/

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.supplyhouse.com/High-Efficiency-Gas-Boilers-1735000 ;
http://www.alliantgas.com/why-propane/home-heating-systems/

[7] http://energy.gov/energysaver/articles/central-air-conditioning
[8] http://energy.gov/energysaver/articles/furnaces-and-boilers

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. Tight Sealed Air Duct

Sources:

http://www.energystar.gov/index.cfm?c=behind_the_walls.btw_ducts;

http://www.alliedcompletefurnace.com/insulation.html

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

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

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; http://yourhome.honeywell.com/home/products/thermostats/

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

[11] http://www1.eere.energy.gov/manufacturing/tech_assistance/pdfs/whentopurchase_nema_motor_systemts1.pdf

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/

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

[12] http://www.energystar.gov/certified-products/detail/water_heater_whole_home_gas_tankless

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.

Simple Photovoltaic (PV) Self-Generation Project

Right: CoolMiser 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

Right: Onsite PV System

Source:

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

Appendix D: 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 E: Costs 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[13]

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.
- 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

[13] 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/

- 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 F: California Lighting Technology Center – Lighting Best Practices Guide

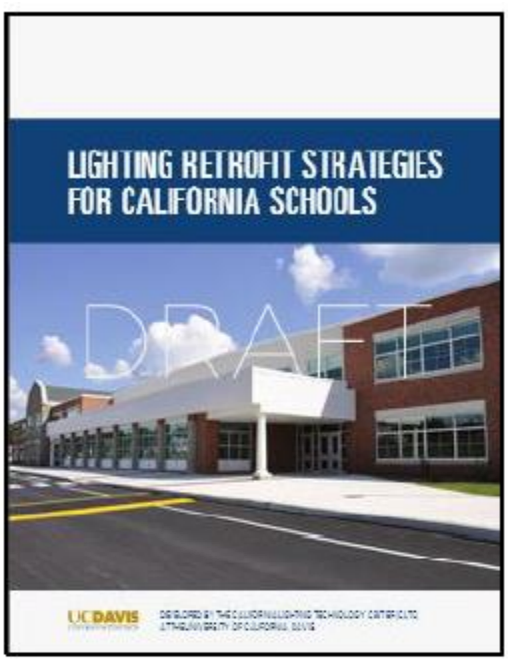
CALIFORNIA LIGHTING TECHNOLOGY CENTER

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

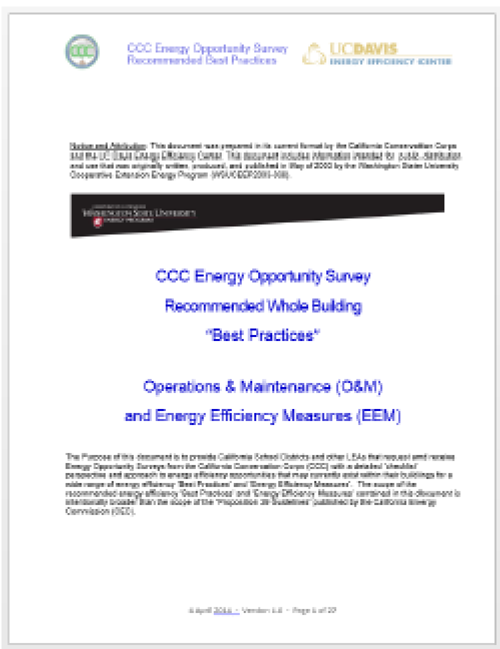
The CLTC will produce this both in hard copy and maintain an electronic document available 'on-line' with frequent updates.



Appendix G: 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

UC DAVIS

CCC Energy Opportunity Survey

Recommended Whole Building

"Best Practices"

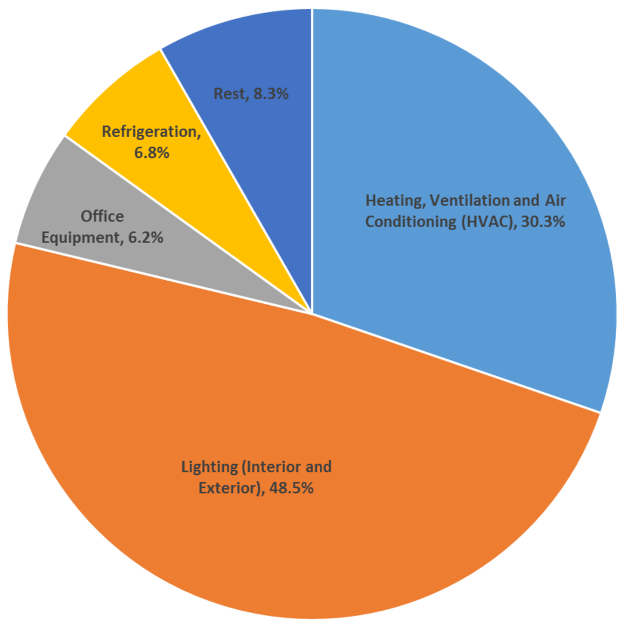
Operations & Maintenance (O&M)

and Energy Efficiency Measures (EEM)

Appendix H: Overview of Energy Use in California Schools

The following pie chart shows the average distribution of electric and natural gas energy use for California schools based on a commercial End Use Survey (CEUS) published by Intron, Inc. in 2006.

Typical electrical 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 electrical 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.

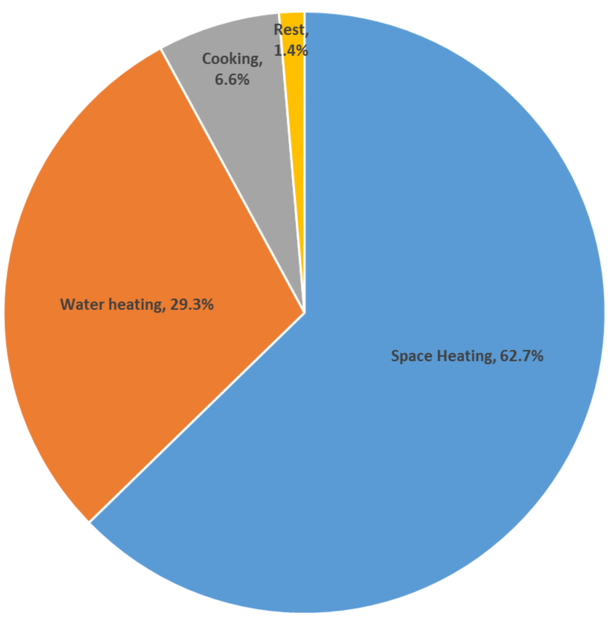
Appendix I: Energy Opportunity Survey Data Limitations and Completeness

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 O&M 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 FirstFuel by the school.

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 Position 39 guidelines, which encompass the great majority of all potential energy savings opportunities. However where additional savings were identified through FirstFuel's analytics engines these are also listed with the associate costs, savings and cost efficiency scale.

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 relies on FirstFuel's analysis of the meter data patterns and best 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.