LEVEL II ENERGY AUDIT

A Bureau Veritas Group Company

SACRAMENTO CITY UNIFIED SCHOOL DISTRICT

5735 47th Avenue
Sacramento, California 95824

DLR GROUP

1050 20th Street, Suite 250
Sacramento, California 95985

ZERO NET ENERGY ASHRAE LEVEL II AUDIT

SUTTER MIDDLE SCHOOL

3105 I Street

Sacramento, California 95816

PREPARED BY:
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EMG PROJECT #:

136988.19R000-086.268

DATE OF REPORT:

October 28, 2019

ONSITE DATE:

August 8-9, 2019

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Certification

EMG has completed an Energy Audit of Sutter Middle School located at 3105 I Street in Sacramento, California 95816. EMG visited the site on August 8-9, 2019.

The assessment was performed at the Client's request using methods and procedures consistent with ASHRAE Level II Energy Audit and using methods and procedures as outlined in EMG's Proposal.

This report has been prepared for and is exclusively for the use and benefit of the Client identified on the cover page of this report. The purpose for which this report shall be used shall be limited to the use as stated in the contract between the client and EMG.

This report, or any of the information contained therein, is not for the use or benefit of, nor may it be relied upon by any other person or entity, for any purpose without the advance written consent of EMG. Any reuse or distribution without such consent shall be at the client's or recipient's sole risk, without liability to EMG.

Estimated installation costs are based on EMG's experience on similar projects and industry standard cost estimating tools including *RS Means and Whitestone CostLab*. In developing the installed costs, EMG also considered the area correction factors for labor rates for Sacramento, California 95816. Since actual installed costs may vary widely for particular installation based on labor & material rates at time of installation, EMG does not guarantee installed cost estimates and shall in no event be liable should actual installed costs vary from the estimated costs herein. We strongly encourage the owner to confirm these cost estimates independently. EMG does not guarantee the costs savings estimated in this report. EMG shall in no event be liable should the actual energy savings vary from the savings estimated herein.

EMG certifies that EMG has no undisclosed interest in the subject property and that EMG's employment and compensation are not contingent upon the findings or estimated costs to remedy any deficiencies due to deferred maintenance and any noted component or system replacements.

Any questions regarding this report should be directed to Kaustubh Anil Chabukswar at 800.733.0660, ext. 7512.

Prepared by: Noah Strafford
Energy Auditor
Project Manager

Reviewed by:

Bhaskar Ale, CEM

Technical Report Reviewer for

Kaustubh Anil Chabukswar, CEM CRM
Program Manager

1. Executive Summary

The purpose of this Energy Audit is to provide Sacramento City Unified School District and Sutter Middle School with a baseline of energy usage and the relative energy efficiency of the facility and specific recommendations for Energy Conservation Measures. Information obtained from these analyses may be used to support a future application to an Energy Conservation Program, Federal & Utility grants towards energy conservation, support performance contracting, justify a municipal bond funded improvement program, or as a basis for replacement of equipment or systems.

Bldg #	Structures Assessed	Building Type	EMG Calculated Area (SF)	Estimated Occupancy
1	001 Music	School Building	5,914	80
2	002 Gymnasium & Cafeteria	School Building	29,647	380
3	003 Administration & Classrooms	School Building	45,025	585
4	004 Art	School Building	11,669	160
5	P01 Modular Classrooms 114-117	Portable School Building	3,840	50
6	P02 Modular Classrooms 118-119	Portable School Building	1,920	25
7	P03 Modular Classroom 120	Portable School Building	960	15
8	P04 Modular Classroom 121	Portable School Building	960	15

The study included a review of the building's construction features, historical energy and water consumption and costs, review of the building envelope, HVAC equipment, heat distribution systems, lighting, and the building's operational and maintenance practices.

1.1. Energy Conservation Measures

EMG has identified nine Energy Conservation Measures (ECMs) for this property. The savings for each measure is calculated using standard engineering methods followed in the industry, and detailed calculations for ECM are provided in Appendix for reference. A 10% discount in energy savings was applied to account for the interactive effects amongst the ECMs. In addition to the consideration of the interactive effects, EMG has applied a 15% contingency to the implementation costs to account for potential cost overruns during the implementation of the ECMs.

The following table summarizes the recommended ECMs in terms of description, investment cost, energy consumption reduction, and cost savings.

Summary of Financial Information for Recommended Non-Renewable Energy Conservation Measures

ITEM	ESTIMATE
Net Initial ECM Investment *(Current Dollars Only)*	$178,579 *(In Current Dollars)*
Estimated Annual Cost Savings *(Current Dollars Only)*	$22,559 *(In Current Dollars)*
ECM Effective Payback	7.92 years
Estimated Annual Energy Savings	22.38%
Estimated Annual Energy Utility Cost Savings *(Excluding Water)*	15.81%
Estimated Annual Water Cost Saving	25.3%

Solar Photovoltaic (PV) Screening for SUTTER MIDDLE SCHOOL

SOLAR ROOFTOP PHOTOVOLTAIC ANALYSIS		
Estimated Number of Panels	442	
Estimated KW Rating	139	KW
Potential Annual kWh Produced	213,530	kWh
% of Current Electricity Uses	41.4%	
FINANCIAL SUMMARY		
Investment Cost	$486,850	
Estimated Energy Cost Savings	$32,896	
Payback without Incentives	14.8	Years
Incentive Payback but without SRECs	8.9	Years
Payback with All Incentives	8.9	Years

Key Metrics to Benchmark the Subject Property's Energy Usage Profile

- Building Site Energy Use Intensity - The sum of the total site energy use in thousands of Btu per unit of gross building area. Site energy accounts for all energy consumed at the building location only not the energy consumed during generation and transmission of the energy to the site.
- Building Source Energy Use Intensity – The sum of the total source energy use in thousands of Btu per unit of gross building area. Source energy is the energy consumed during generation and transmission in supplying the energy to your site.
- Building Cost Intensity - This metric is the sum of all energy use costs in dollars per unit of gross building area.
- Greenhouse Gas Emissions - Although there are numerous gases that are classified as contributors to the total for Greenhouse Emissions, the scope of this energy audit focuses on carbon dioxide (CO_2). Carbon dioxide enters the atmosphere through the burning of fossil fuels (oil, natural gas, and coal), solid waste, trees and wood products, and also as a result of other chemical reactions (e.g., manufacture of cement).

SITE ENERGY USE INTENSITY (EUI)	RATING
Current Site Energy Use Intensity (EUI)	26 kBtu/ft^2
Post ECM Site Energy Use Intensity (EUI)	20 kBtu/ft^2
SOURCE ENERGY USE INTENSITY (EUI)	**RATING**
Current Source Energy Use Intensity (EUI)	68 kBtu/ft^2
Post ECM Source Energy Use Intensity (EUI)	57 kBtu/ft^2
BUILDING COST INTENSITY (BCI)	**RATING**
Current Building Cost Intensity	\$0.91/ft^2
Post ECM Building Cost Intensity	\$0.77/ft^2

Summary of the Greenhouse Gas Reductions from Recommended Non-Renewable Energy Conservation Measures

The following table provides a summary of the projected Greenhouse Gas Emissions reductions as a result of the recommended Energy Conservation Measures:

GREENHOUSE GAS EMISSIONS REDUCTION	
Estimated Annual Thermal Energy Reduction	584 MMbtu
Total CO_2 Emissions Reduced	39.76 MtCO_2/Yr
Total Cars Off the Road (Equivalent)*	7
Total Acres of Pine Trees Planted (Equivalent)*	9

**Equivalent reductions per DOE emissions calculation algorithms*

Zero Net Energy Analysis for Renewable and Non-Renewable Recommended Measures

ZERO NET ENERGY ANALYSIS	
Building Annual Net Energy Consumption	2,607,588 kBtu
Total Annual Energy Savings for Non-Renewable Energy Measures	583,584 kBtu
Total Annual Energy Savings from Renewable Energy Measures	728,564 kBtu
Total Annual Energy Savings	1,312,148 kBtu
Net Energy Consumption from Grid Post Implementation	1,295,439 kBtu
% Energy Reduction (Annual Energy-Net Energy) / (Annual Energy)	50%

Energy Conservation Measures Screening:

EMG screens ECMs using two financial methodologies. ECMs which are considered financially viable must meet both criteria.

1. Simple Payback Period –The number of years required for the cumulative value of energy or water cost savings less future non-fuel or non-water costs to equal the investment costs of the building energy or water system, without consideration of discount rates. ECMs with a payback period greater than the Expected Useful Life (EUL) of the project are not typically recommended, as the cost of the project will not be recovered during the lifespan of the equipment. These ECMs are recommended for implementation during future system replacement. At that time, replacement may be evaluated based on the premium cost of installing energy efficient equipment.

$$Simple\ Payback = \frac{Initial\ Cost}{Annual\ Savings}$$

2. Savings-to-Investment Ratio (SIR) – The savings-to-investment ratio is the ratio of the present value savings to the present value costs of an energy or water conservation measure. The numerator of the ratio is the present value over the estimated useful life (EUL) of net savings in energy or water and non-fuel or non-water operation and maintenance costs attributable to the proposed energy or water conservation measure. The denominator of the ratio is the present value of the net increase in investment and replacement costs less salvage value attributable to the proposed energy or water conservation measure. It is recommended that energy efficiency recommendations should be based on a calculated SIR, with larger SIRs receiving a higher priority. A project is typically only recommended if SIR is greater than or equal to 1.0, unless other factors outweigh the financial benefit.

$$SIR = \frac{Present\ Value\ (Annual\ Savings, i\%, EUL)}{Initial\ Cost}$$

List of Recommended Energy Conservation Measures For Sutter Middle School

ECM #	Description of ECM	Projected Initial Investment	Estimated Annual Energy Savings		Estimated Annual Water Savings	Estimated Cost Savings	Estimated Annual O&M Savings	Total Estimated Annual Cost Savings	Simple Payback	S.I.R.	Life Cycle Savings	Expected Useful Life (EUL)
			Natural Gas	Electricity								
		$	Therms	kWh	kgal	$	$	$	Years		$	Years
No/Low Cost Recommendations												
1	Install Low Flow Faucet Aerators Location: Restrooms And Classrooms	$548	354	0	75	$1,272	$0	$1,272	0.43	19.78	$10,298	10.00
Totals for No/Low Cost Items		**$548**	**354**	**0**	**75**	**$1,272**	**$0**	**$1,272**	**0.43**			
Capital Cost Recommendations												
1	Install On-Demand Ventilation on Air Handlers Location: Rooftop Air Handlers In Building 002, 003	$3,632	1,720	908	0	$2,492	$125	$2,617	1.39	6.15	$18,689	10.00
2	Install Low Flow Shower Heads Location: Restrooms And Locker Rooms	$2,092	218	0	39	$712	$0	$712	2.94	2.90	$3,978	10.00
3	Upgrade Building Lighting to LED and Install Automatic Lighting Controls Location: Building Interior And Exterior	$34,683	0	35,288	0	$5,436	$2,032	$7,468	4.64	2.57	$54,471	15.00
4	Install Variable Frequency Drives (VFD) Location: 003 Admin And Classrooms - Ahu	$7,395	0	8,764	0	$1,350	$0	$1,350	5.48	2.18	$8,723	15.00
5	Install Low Flow Tankless Restroom Fixtures Location: Restrooms	$40,553	0	0	537	$5,657	$0	$5,657	7.17	1.67	$26,986	15.00
6	Control External Air Leakage In Commercial Buildings Location: Buildings 001, 002 And 004	$11,535	605	2,871	0	$1,269	$63	$1,332	8.66	1.38	$4,370	15.00
7	Install Energy Recovery Wheel on Air Handling Unit Location: 003 Admin And Classrooms	$10,100	335	3,018	0	$924	$0	$924	10.94	1.09	$926	15.00
8	Re-Commission The Building & Its Control Systems Location: Throughout	$44,748	990	15,450	0	$3,734	$0	$3,734	11.98	1.00	-$175	15.00
Total For Capital Cost		**$154,738**	**3,869**	**66,299**	**576**	**$21,574**	**$2,220**	**$23,794**	**6.50**			
	Interactive Savings Discount @ 10%		-422	-6,630	-65	-$2,285	-$222	-$2,507				
	Total Contingency Expenses @ 15%	$23,293										
Total for Improvements		**$178,579**	**3,800**	**59,669**	**586**	**$20,561**	**$1,998**	**$22,559**	**7.92**			

In addition to the above measures, EMG has identified the following measure(s) but has not recommended as they fail to meet the above-mentioned financial criteria of SIR>1.0. Thus, EMG has classified the measure(s) as recommended for consideration.

List of Recommended For Consideration Energy Conservation Measures For Sutter Middle School

ECM #	Description of ECM	Initial Investment	Annual Energy Savings		Annual Water Savings	Cost Savings	Estimated Annual O&M Savings	Total Estimated Annual Cost Savings	Payback	S.I.R.	Life Cycle Savings	Expected Useful Life (EUL)
		$	Natural Gas	Electricity	kgal	$	$	$	Years		$	Years
1	Replace External Windows Location: Buildings 001, 002, 004 - Storefront	$188,810	2,439	21,568	0	$6,658	$67	$6,725	28.08	0.62	-$71,713	25.00
Total for Improvements		**$188,810**	**2,439**	**21,568**	**0**	**$6,658**	**$67**	**$6,725**	**28.08**			

2. Introduction

The purpose of this Energy Audit is to provide Sutter Middle School and Sacramento City Unified School District with a baseline of energy usage, the relative energy efficiency of the facility, and specific recommendations for Energy Conservation Measures. Information obtained from these analyses may be used to support a future application to an Energy Conservation Program, Federal and Utility grants towards energy conservation, as well as support performance contracting, justify a municipal bond-funded improvement program, or as a basis for replacement of equipment or systems.

The energy audit consisted of an onsite visual assessment to determine current conditions, itemize the energy consuming equipment (i.e. Boilers, Make-Up Air Units, DWH equipment); review lighting systems both exterior and interior; and review efficiency of all such equipment. The study also included interviews and consultation with operational and maintenance personnel. The following is a summary of the tasks and reporting that make up the Energy Audit portion of the report.

The following is a summary of the tasks and reporting that make up the Energy Audit portion of the report.

Energy and Water Using Equipment

- EMG has surveyed the common areas, office areas, rooms, maintenance facilities and mechanical rooms to document utility-related equipment, including heating systems, cooling systems, air handling systems and lighting systems.

Building Envelope

- EMG has reviewed the characteristics and conditions of the building envelope, checking insulation values and conditions. This review also includes an inspection of the condition of walls, windows, doors, roof areas, insulation and special use areas

Recommendations for Energy Savings Opportunities

- Based on the information gathered during the on site assessment, the utility rates, as well as recent consumption data and engineering analysis, EMG has identified opportunities to save energy and provide probable construction costs, projected energy/utility savings and provide a simple payback analysis.

Analysis of Energy Consumption

- Based on the information gathered during the on-site assessment, EMG has conducted an analysis of the energy usage of all equipment, and identified which equipment is using the most energy and what equipment upgrades may be necessary. As a result, equipment upgrades, or replacements are identified that may provide a reasonable return on the investment and improve maintenance reliability.

Energy Audit Process

- Interviewing staff and review plans and past upgrades
- Performing an energy audit for each use type
- Performing a preliminary evaluation of the utility system
- Analyzing findings, utilizing ECM cost-benefit worksheets
- Making preliminary recommendations for system energy improvements and measures
- Estimating initial cost and changes in operating and maintenance costs based on implementation of energy efficiency measures
- Ranking recommended cost measures, based on the criticality of the project and the largest payback

Reporting

The EMG Energy Audit Report includes:

- A comprehensive study identifying all applicable Energy Conservation Measures (ECMs) and priorities, based on initial cost and payback
- A narrative discussion of building systems/components considered and a discussion of energy improvement options;
- A summary of ECMs including initial costs and simple paybacks, based on current utility rates and expected annual savings.

3. Facility Overview and Existing Conditions

3.1. Building Occupancy and Point of Contact

FACILITY SCHEDULE	
Hours of Operations / Week	40
Operational Weeks / Year	37
Estimated Facility Occupancy	1310
% of Male Occupants	50%

POINT OF CONTACT	
Point of Contact Name	Mario Vargas
Point of Contact Title	Plant Manager
Point of Contact – Contact Number	916.764.5207

3.2. Building Heating, Ventilating and Air-Conditioning (HVAC)

Description:

Heating and Cooling to the main school building 003 admin and classrooms is provided primarily by split system utilizing natural gas furnaces. An air handler, fed by a hydronic boiler and rooftop condensing unit, serves building 003 for additional heating and cooling. Building 001 is served by 4x split systems with fan coil for heating and cooling. Building 002 is heated by a mixture of hydronic unit heaters and 1x fan coil unit, all fed by a central condensing boiler. Cooling to building 002 is provided by 4x central split AC systems. Building 004 utilizes central split AC systems with natural gas furnaces. Portable classrooms P01-P04 are heated and cooled by wall mounted heat pumps. Supplementary heating is provided by ductless mini-split units.

The Mechanical Equipment Schedule in Appendix contains a summary of the HVAC Equipment at the property.

BUILDING CENTRAL HEATING SYSTEM	
Primary Heating System	Central Hot Water Boilers
Secondary Heating System	Furnace, Heat Pump
Hydronic Distribution System	Two Pipe
Primary Heating Fuel	Natural Gas
Heating Mode Set-point	69
Heating Mode- Set-back Temperature	53

BUILDING COOLING SYSTEM	
Primary Cooling System	Split System
Secondary Cooling System	Heat Pump
Hydronic Distribution System	NA
Cooling Mode Set-point	73 °F
Cooling Mode- Set-back Temperature	93 °F

AIR DISTRIBUTION SYSTEM	
Building Ventilation	Mixed: AHU & Roof-top Exhaust Fans
On-Demand Ventilation System in Use?	No
Energy Recovery Wheel / Enthalpy Wheel Exhaust Fans	No

DOMESTIC HOT WATER SYSTEM	
Primary Domestic Water Fuel	Natural Gas

3.3. Lighting

Description:

The lighting in the school building primarily consists of T8 linear fluorescent lamp fixtures in classrooms and hallways. The fixtures were observed to be operating on bi-level mode in the classrooms. The exterior lights were HID and LED fixtures.

The detailed lighting schedule and the proposed LED alternative is provided in Appendix.

4. Utility Analysis

Establishing the energy baseline begins with an analysis of the utility cost and consumption of the building. Utilizing the historical energy data and local weather information, we evaluate the existing utility consumption and assign it to the various end-uses throughout the buildings. The Historical Data Analysis breaks down utilities by consumption, cost and annual profile.

This data is analyzed, using standard engineering assumptions and practices. The analysis serves the following functions:

- Allows our engineers to benchmark the energy and water consumption of the facilities against consumption of efficient buildings of similar construction, use and occupancy.
- Generates the historical and current unit costs for energy and water
- Provides an indication of how well changes in energy consumption correlate to changes in weather.
- Reveals potential opportunities for energy consumption and/or cost reduction. For example, the analysis may indicate that there is excessive, simultaneous heating and cooling, which may mean that there is an opportunity to improve the control of the heating and cooling systems.

By performing this analysis and leveraging our experience, our engineers prioritize buildings and pinpoint systems for additional investigation during the site visit, thereby maximizing the benefit of their time spent on-site and minimizing time and effort by the customer's personnel.

Based upon the utility information provided about the Sacramento City Unified School District, the following energy rates are utilized in determining existing and proposed energy costs.

Utility Rates used for Cost Analysis

ELECTRICITY (BLENDED RATE)	NATURAL GAS	WATER / SEWER
$0.15 /kWh	$1.37/therm	$ 10.53 /kGal

The data analyzed provides the following information: 1) breakdown of utilities by consumption, 2) cost and annual profile, 3) baseline consumption in terms of energy/utility at the facility, 4) the Energy Use Index, or Btu/sq ft, and cost/sq ft. For multiple water meters, the utility data is combined to illustrate annual consumption for each utility type.

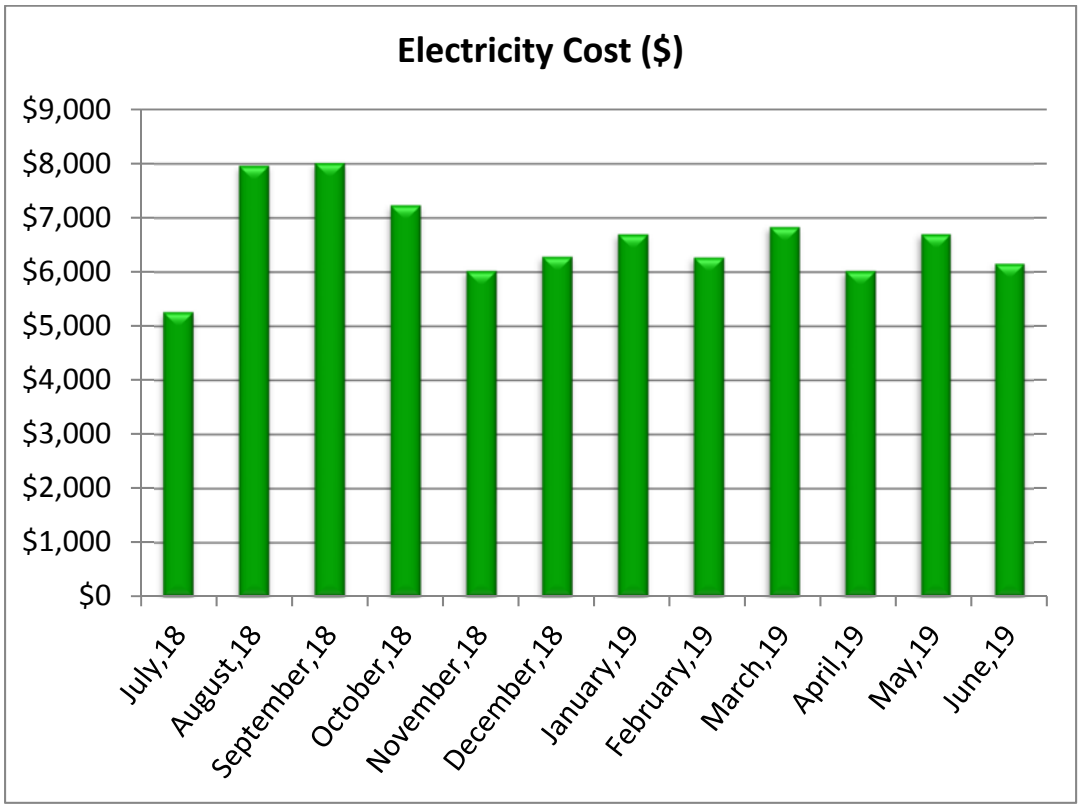
4.1. Electricity

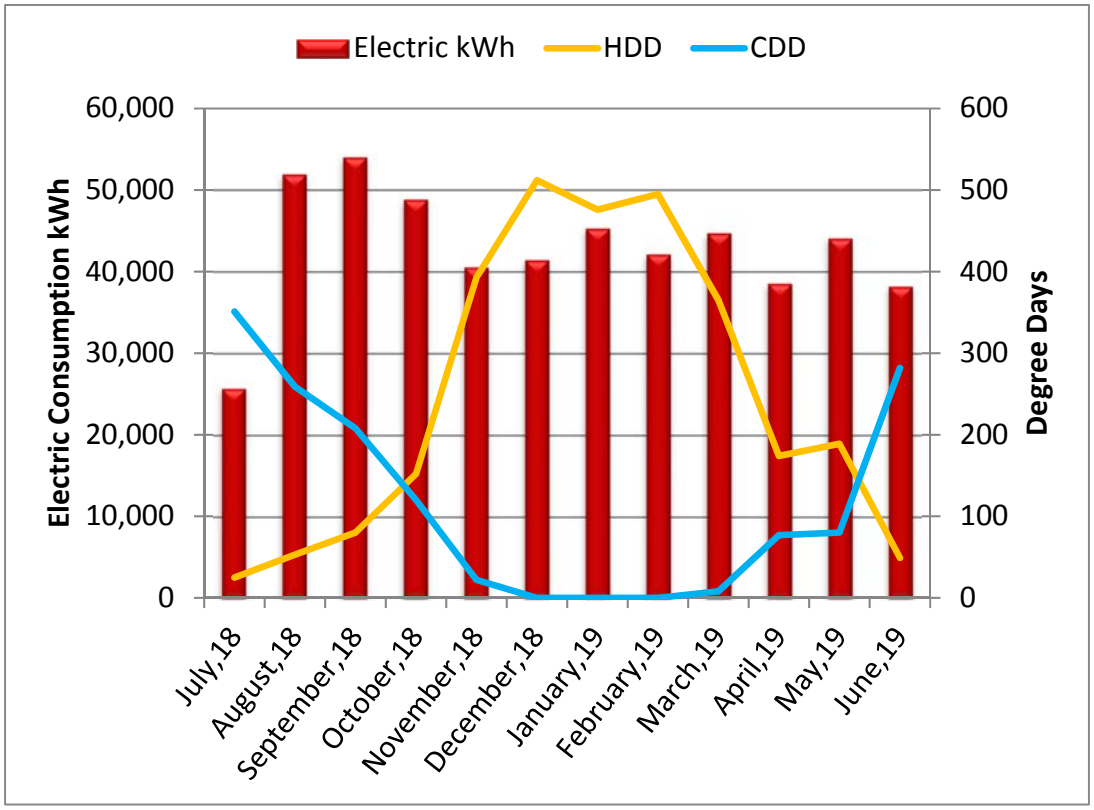
SMUD satisfies the electricity requirements for the facility. The primary end uses for electric utility compromises of lighting, cooling, office/school equipment, and appliances in the break room.

The table below provides the electric use for the period of twelve continuous months.

Electric Consumption and Cost Data

BILLING MONTH	CONSUMPTION (KWH)	UNIT COST/KWH	TOTAL COST
July,18	25,763	$0.20	$5,259
August,18	51,858	$0.15	$7,956
September,18	53,972	$0.15	$8,010
October,18	48,812	$0.15	$7,229
November,18	40,549	$0.15	$6,017
December,18	41,423	$0.15	$6,279
January,19	45,283	$0.15	$6,691
February,19	42,131	$0.15	$6,265
March,19	44,716	$0.15	$6,828
April,19	38,567	$0.16	$6,017
May,19	44,059	$0.15	$6,693
June,19	38,221	$0.16	$6,150
Total/average	**515,354**	**$0.15**	**$79,394**


Electricity Cost ($)
$9,000
$8,000
$7,000
$6,000
$5,000
$4,000
$3,000
$2,000
$1,000
$0
July,18
August,18
September,18
October,18
November,18
December,18
January,19
February,19
March,19
April,19
May,19
June,19


Electric kWh
HDD
CDD
Electric Consumption kWh
Degree Days
60,000
50,000
40,000
30,000
20,000
10,000
0
600
500
400
300
200
100
0
July,18
August,18
September,18
October,18
November,18
December,18
January,19
February,19
March,19
April,19
May,19
June,19

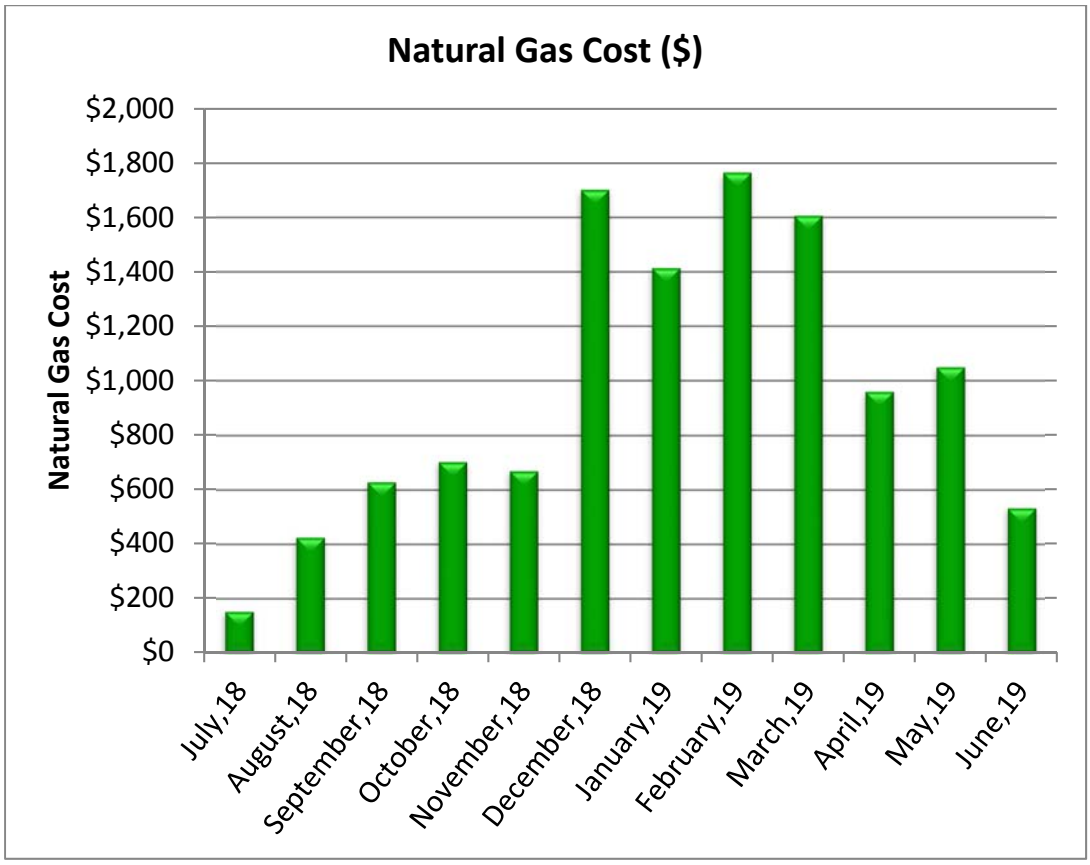
4.2. Natural Gas

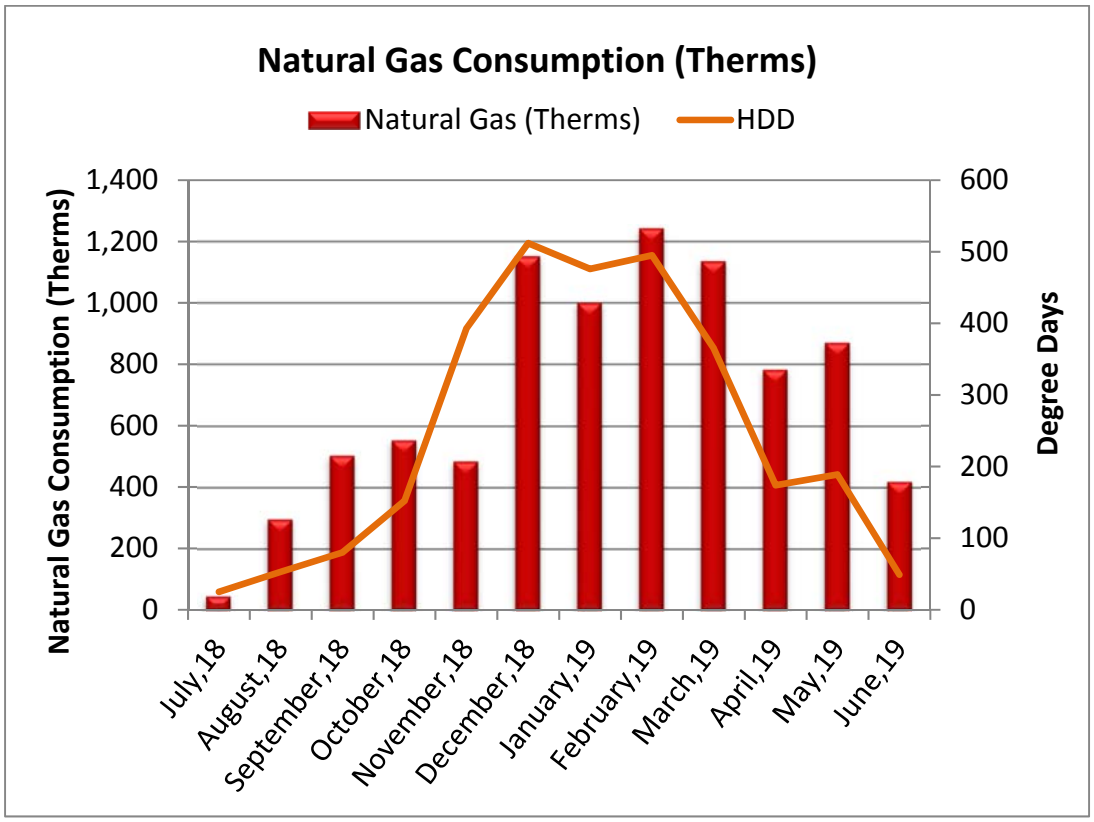
PGE satisfies the natural gas requirements of the facility. The primary end use of natural gas is for building heating, domestic water heating, and cooking in the cafeteria.

The analysis of the 12 months of consumption is provided below.

Natural Gas Consumption and Cost Data

BILLING MONTH	CONSUMPTION (THERMS)	UNIT COST/THERM	TOTAL COST
July,18	46	$3.32	$152
August,18	298	$1.43	$426
September,18	506	$1.25	$630
October,18	556	$1.27	$704
November,18	487	$1.38	$671
December,18	1,151	$1.48	$1,700
January,19	1,000	$1.41	$1,414
February,19	1,242	$1.42	$1,764
March,19	1,135	$1.41	$1,606
April,19	782	$1.23	$959
May,19	870	$1.21	$1,050
June,19	420	$1.27	$534
Total/average	**8,492**	**$1.37**	**$11,610**


Natural Gas Cost ($)
Natural Gas Cost
$2,000
$1,800
$1,600
$1,400
$1,200
$1,000
$800
$600
$400
$200
$0
July,18
August,18
September,18
October,18
November,18
December,18
January,19
February,19
March,19
April,19
May,19
June,19

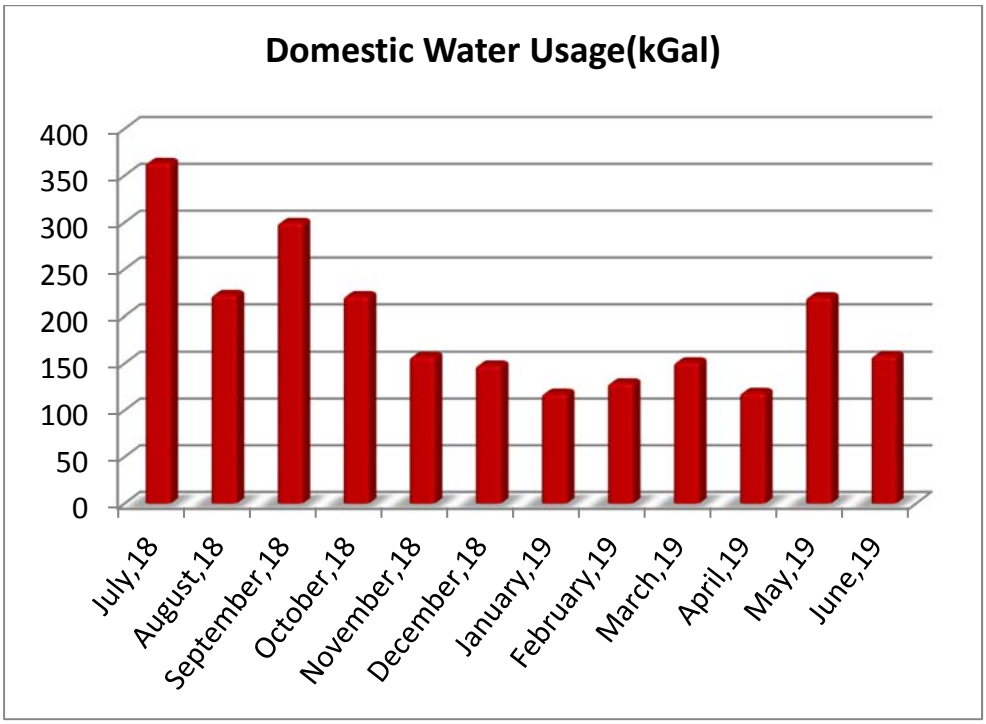

Natural Gas Consumption (Therms)
Natural Gas (Therms)
HDD
Natural Gas Consumption (Therms)
1,400
1,200
1,000
800
600
400
200
0
Degree Days
600
500
400
300
200
100
0
July,18
August,18
September,18
October,18
November,18
December,18
January,19
February,19
March,19
April,19
May,19
June,19

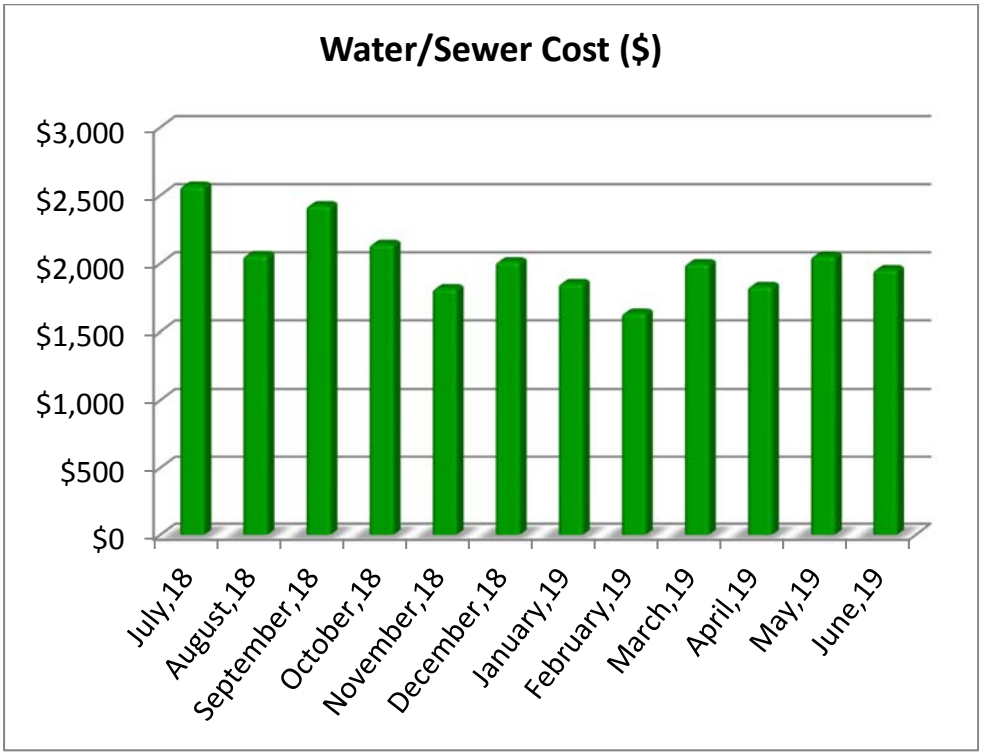
4.3. Water and Sewer

The City of Sacramento satisfies the water requirements for the facility. The primary end use of water is the plumbing fixtures such as staff showers, water closets, and lavatories. The table below provides the twelve continuous months' worth of consumption and cost for water in kGal for the facility.

Water and Sewer Consumption and Cost Data

BILLING MONTH	CONSUMPTION (KGAL)	UNIT COST/KGAL	TOTAL COST
July,18	365	$7.06	$2,573
August,18	223	$9.24	$2,064
September,18	300	$8.09	$2,429
October,18	222	$9.66	$2,145
November,18	158	$11.51	$1,820
December,18	149	$13.56	$2,017
January,19	119	$15.66	$1,858
February,19	130	$12.64	$1,640
March,19	152	$13.17	$2,003
April,19	120	$15.36	$1,836
May,19	221	$9.31	$2,058
June,19	159	$12.34	$1,959
Total/average	**2,317**	**$10.53**	**$24,403**


Domestic Water Usage(kGal)
400
350
300
250
200
150
100
50
0
July,18
August,18
September,18
October,18
November,18
December,18
January,19
February,19
March,19
April,19
May,19
June,19


Water/Sewer Cost ($)
$3,000
$2,500
$2,000
$1,500
$1,000
$500
$0
July,18
August,18
September,18
October,18
November,18
December,18
January,19
February,19
March,19
April,19
May,19
June,19

5. Renewable Energy Discussions

5.1. Rooftop Solar Photovoltaic Feasibility

Solar Energy Feasibility

A photovoltaic array is a linked collection of photovoltaic modules, which are in turn made of multiple interconnected solar cells. The cells convert solar energy into direct current electricity via the photovoltaic effect. The power that one module can produce is seldom enough to meet requirements of a home or a business, so the modules are linked together to form an array. Most PV arrays use an inverter to convert the DC power produced by the modules into alternating current that can plug into the existing infrastructure to power lights, motors, and other loads. The modules in a PV array are usually first connected in series to obtain the desired voltage; the individual strings are then connected in parallel to allow the system to produce more current. Solar arrays are typically measured by the peak electrical power they produce, in watts, kilowatts, or even megawatts.

When determining if a site is suitable for a solar application, two basic considerations must be evaluated:

- At minimum, the sun should shine upon the solar collectors from 9 AM to 3 PM. If less, the application may still be worthwhile, but the benefit will be less.
- The array should face south and be free of any shading from buildings, trees, rooftop equipment, etc. If the array is not facing directly south, there will be a penalty in transfer efficiency, reducing the overall efficiency of the system.

SOLAR PV QUESTIONNAIRE	RESPONSE
Does the property have a south, east, or west facing roof or available land of more than 250 square feet per required Solar Array Panel?	**Yes**
Is the area free from any shading such as trees, buildings, equipment etc throughout the whole day?	**Yes**
Can the panels be mounted at an incline of roughly 25-45 degrees? (equal to latitude of property)	**Yes**
Is the property in an area with acceptable average monthly sunlight levels?	**Yes**
Has the roofing been replaced within the past 3-5 years?	**No**
Is the roof structure sufficient to hold solar panels?	**Additional Study Required**
Is the property located in a state eligible for net metering?	**Yes**

A solar feasibility analysis of the site has resulted in the building containing more than sufficient amount of roof area for solar electricity generation. The analysis through the use of National Renewable Energy Laboratory's solar photovoltaic software assisted in calculating the potential electricity generated from the allocated land and roof area set for solar photovoltaic installment. The allocated roof area was through looking at the roof and surrounding areas at a bird's eye view. Also detailed in the report are incentives and rebates that can potentially bring down the installation cost of the ECMs and result in a higher return on investment and quicker payback period.

The approach taken in the solar photovoltaic (PV) roof analysis begins with surveying the roof and determine areas on the roof where solar PV panels can potentially be installed.

1) Conducting a preliminary sizing of solar PV panels on the roofs and on the ground and its potential electricity production for its first year of installment using the National Renewable Energy Laboratory (NREL) PV WATTS Version 2 Software.

2) Calculate energy and cost savings for the site as a sole proprietor of the system capable of collecting state, local, and federal tax credits and incentives and interconnecting and selling the renewable energy electrical production to the building.

SOLAR ROOFTOP PHOTOVOLTAIC ANALYSIS		
Estimated Number of Panels	442	
Estimated KW Rating	139	KW
Potential Annual kWh Produced	213,530	kWh
% of Current Electricity Uses	41.4%	
FINANCIAL SUMMARY		
Investment Cost	$486,850	
Estimated Energy Cost Savings	$32,896	
Payback without Incentives	14.8	Years
Incentive Payback but without SRECs	8.9	Years
Payback with All Incentives	8.9	Years

A photovoltaic array is a linked collection of photovoltaic modules, which are in turn made of multiple interconnected solar cells. The cells convert solar energy into direct current. Modules of cells are linked together to form an array. Most PV arrays use an inverter to convert the DC power produced by the modules into alternating current that can connect to existing AC infrastructure to power lights, motors, and other loads.

Cost of production has fallen years with increasing demand and through production and technological advances. The cost dropped from $8–10/watt in 1996 to $4–7/watt in 2006. The market is diversifying with new types of panels suited to unique installation methods including stick on sheets and PV spray coating. The solar PV cost used in the analysis was set at $7.0/Watt which includes design, construction, administration, and installation and maintenance cost throughout the life of the solar panels.

One breakthrough for PV is “Net Metering”. When more PV electric power is generated than is consumed on site, the electric service meter reverses to “sell” the excess power directly back onto the power grid. The economics of PV for commercial industrial installations become attractive when coupled with incentives from Federal and state agencies, as well utility companies.

A kilowatt-hour costing $0.15 might be valued at $0.30 when produced by PV and sent to the grid. The economics of PV for commercial industrial installations become attractive when coupled with incentives from Federal and state agencies, as well utility companies.

The low payback period is highly dependent on the marketing potential of selling Solar Renewable Certificates to electricity generated providers who are under state regulations to contain a certain percentage of their electricity generation derived from renewable energy such as wind and solar.

Solar facilities are encouraged to sell their SRECs on the market (either spot market or through long-term contracts). Utilities may use SRECs for compliance under the state RPS for the year in which they are generated. Utilities may purchase up to 10% more SRECs than they require for compliance and "bank" those surplus SRECs for compliance during the following two years. Any SRECs pricing can range from $300 - $450/MWh and can be sold across state borders to other utility providers looking to purchase SRECs. EMG has selected to use the market value of $300/MWh minus 5% administrative fee in the analysis.

A number of states and corresponding electrical utility supplier are required under regulation to have a certain percentage of its electricity be produced by solar energy. To offset that they allow other utility companies to buy Renewable Energy Credits (REC) credit off their customers and facilities that produce their own solar energy. Typically the national market, the utility market is $400 per MWh to Utility Suppliers for not meeting this standard percentage so these REC credits are sold for $350 per MWH. (1 REC credit = 1 MWH).

State charges these utility companies to meet their state compliance of 0.2% of the entire electricity consumption from solar energy by 2022 (from.005% in 2008 aggregated up to 0.2% by 2022). The REC credits correspond to these percentages as they aggregate each year.

6. Operations and Maintenance Plan

The quality of the maintenance and the operation of the facility's energy systems have a direct effect on its overall energy efficiency. Energy-efficiency needs to be a consideration when implementing facility modifications, equipment replacements, and general corrective actions. The following is a list of activities that should be performed as part of the routine maintenance program for the property.

Building Envelope

- ✓ Ensure that the building envelope has proper caulking and weather stripping.
- ✓ Patch holes in the building envelope with foam insulation and fire rated caulk around combustion vents
- ✓ Inspect building vents semiannually for bird infestation
- ✓ Inspect windows monthly for damaged panes and failed thermal seals
- ✓ Repair and adjust automatic door closing mechanisms as needed.

Heating and Cooling

- ✓ Pilots lights on furnaces and boilers be turned off in summer
- ✓ All preventive maintenance should be performed on all furnaces and boilers, which would include cleaning of burners and heat exchanger tubes.
- ✓ Ensure that the combustion vents exhaust outside the conditioned space and the vent dampers are functional
- ✓ Ensure that the control valves are functioning properly before start of every season
- ✗ Ensure steam traps are functional before start of each heating season
- ✗ Ensure use of chemical treatment for boiler make up water
- ✓ Ensure boiler outside temperature re-set is set to 55F
- ✗ Ensure use of chemical treatment for Colling tower water to prevent corrosion
- ✓ Ensure the duct work in unconditioned space is un-compromised and well insulated
- ✓ Duct cleaning is recommended every 10 years. This should include sealing of ducts using products similar to 'aero-seal'
- ✓ Ensure use of economizer mode is functional and used
- ✓ Ensure that the outside air dampers actuators are operating correctly
- ✓ Ensure air coils in the AHU and FCA's are pressure washed annually
- ✓ Return vents should remain un-obstructed and be located centrally
- ✓ Temperature settings reduced in unoccupied areas and set points seasonally adjusted.
- ✓ Evaporator coils and condenser coils should be regularly cleaned to improve heat transfer
- ✓ Refrigerant pipes should be insulated with a minimum of ¾" thick Elastomeric Rubber Pipe Insulation
- ✓ Ensure refrigerant pressure is maintained in the condensers
- ✓ Change air filters on return vents seasonally. Use only filters with 'Minimum Efficiency Rating Value'(MERV) of 8

Central Domestic Hot Water Heater

- ✓ *Never place gas fired water heaters adjacent to return vents so as to prevent flame roll outs*
- ✓ *Ensure the circulation system is on timer to reduce the losses through re-circulation*
- ✓ *Ensure all hot water pipes are insulated with fiberglass insulation at all times*
- ✓ *Replacement water heater should have Energy Factor (EF)>0.9*
- ✓ *Tank-type water heaters flushed monthly*

Lighting Improvements

- ✓ Utilize bi-level lighting controls in stairwells and hallways.
- ✓ Use LED replacement lamps
- ✓ Clean lighting fixture reflective surfaces and translucent covers.
- ✓ Ensure that timers and/or photocells are operating correctly on exterior lighting
- ✓ Use occupancy sensors for offices and other rooms with infrequent occupancy

Existing Equipment and Replacements

- ✓ Ensure that refrigerator and freezer doors close and seal correctly
- ✓ Ensure kitchen and bathroom exhaust outside the building and the internal damper operates properly
- ✓ Ensure that bathroom vents exhaust out
- ✓ Office/ computer equipment either in the “sleep” or “off” mode when not used

7. Appendices

APPENDIX A: Glossary of Terms

APPENDIX B: Mechanical Equipment Inventory

APPENDIX C: Lighting System Schedule

APPENDIX D: ECM Checklist

APPENDIX E: ECM Calculations

APPENDIX F: Solar PV

APPENDIX A:
Glossary of Terms

Glossary of Terms and Acronyms

ECM – Energy Conservation Measures are projects recommended to reduce energy consumption. These can be No/Low cost items implemented as part of routine maintenance or Capital Cost items to be implemented as a capital improvement project.

Initial Investment – The estimated cost of implementing an ECM project. Estimates typically are based on R.S. Means Construction cost data and Industry Standards.

Annual Energy Savings – The reduction in energy consumption attributable to the implementation of a particular ECM. These savings values do not include the interactive effects of other ECMs.

Cost Savings – The expected reduction in utility or energy costs achieved through the corresponding reduction in energy consumption by implementation of an ECM.

Simple Payback Period –The number of years required for the cumulative value of energy or water cost savings less future non-fuel or non-water costs to equal the investment costs of the building energy or water system, without consideration of discount rates.

EUL – Expected Useful Life is the estimated lifespan of a typical piece of equipment based on industry accepted standards.

RUL – Remaining Useful Life is the EUL minus the effective age of the equipment and reflects the estimated number of operating years remaining for the item.

SIR - The savings-to-investment ratio is the ratio of the present value savings to the present value costs of an energy or water conservation measure. The numerator of the ratio is the present value of net savings in energy or water and non-fuel or non-water operation and maintenance costs attributable to the proposed energy or water conservation measure. The denominator of the ratio is the present value of the net increase in investment and replacement costs less salvage value attributable to the proposed energy or water conservation measure. It is recommended that energy-efficiency recommendations be based on a calculated SIR, with larger SIRs receiving a higher priority. A project typically is recommended only if the SIR is greater than or equal to 1.0, unless other factors outweigh the financial benefit.

Life Cycle Cost - The sum of the present values of (a) Investment costs, less salvage values at the end of the study period; (b) Non-fuel operation and maintenance costs: (c) Replacement costs less salvage costs of replaced building systems; and (d) Energy and/or water costs.

Life Cycle Savings – The sum of the estimated annual cost savings over the EUL of the recommended ECM, expressed in present value dollars.

Building Site Energy Use Intensity - The sum of the total site energy use in thousands of Btu per unit of gross building area. Site energy accounts for all energy consumed at the building location only not the energy consumed during generation and transmission of the energy to the site.

Building Source Energy Use Intensity – The sum of the total source energy use in thousands of Btu per unit of gross building area. Source energy is the energy consumed during generation and transmission in supplying the energy to your site.

Building Cost Intensity - This metric is the sum of all energy use costs in dollars per unit of gross building area.

Greenhouse Gas Emissions - Although there are numerous gases that are classified as contributors to the total for Greenhouse Emissions, the scope of this energy audit focuses on carbon dioxide (CO_2). Carbon dioxide enters the atmosphere through the burning of fossil fuels (oil, natural gas, and coal), solid waste, trees and wood products, and also as a result of other chemical reactions (e.g., manufacture of cement).

APPENDIX B:
Mechanical Equipment Inventory

Mechanical Inventory							
System	Make	Model	Serial Number	Input Capacity	Location	Space Served	Quantity
Air Handler (AHU)	McQuay	CAH012FMAC	SCOU000701473	12000 CFM	002-Basement	003 Administration & Classrooms	1
Air Handler (AHU)	Trane	217-1	2786	2000 CFM	Mechanical room-S200	002 Gymnasium & Cafeteria	1
Package Unit	McQuay	ALP012DS27-ER10	STNU000600281	12 TON	Roof-003	003 Administration & Classrooms	1
Central Split Condensing Unit	AAON, Inc.	CB-B-048-3-B-1	201806-CDCE03715	4 TON	Roof-002	004 Art	1
Central Split Condensing Unit	AAON, Inc.	CB-B-048-3-B-1	201806-CDCE03716	4 TON	Roof-002	004 Art	1
Central Split Condensing Unit	AAON, Inc.	CB-B-048-3-B-1	201806-CDCE03713	4 TON	Roof-002	004 Art	1
Central Split Condensing Unit	AAON, Inc.	CB-B-048-3-B-1	201806-CDCE03712	4 TON	Roof-002	004 Art	1
Central Split Condensing Unit	Concord	CCU10A36A-1	8400H25670	3 TON	Roof-003	002 Gymnasium & Cafeteria	1
Central Split Condensing Unit	Concord	CCU10A36A-1	8400H25693	3 TON	Roof-004	002 Gymnasium & Cafeteria	1
Central Split Condensing Unit	Concord	CCU10A36A-1	8400H25565	3 TON	Roof-004	002 Gymnasium & Cafeteria	1
Central Split Condensing Unit	Concord	CCU10A36A-1	8400H25700	3 TON	Roof-004	002 Gymnasium & Cafeteria	1
Central Split Condensing Unit	Carrier	24AAA618A300	1415E10214	2 TON	Roof-004	003 Administration & Classrooms	1
Domestic Circulation Pump	Bell & Gossett	Inaccessible	Inaccessible	.5 HP	2	003 Administration & Classrooms	1
Domestic Circulation Pump	Armstrong	810119MF-003	No tag/plate found	.5 HP	002	004 Art	1
Domestic Circulation Pump	Inaccessible	Inaccessible	Inaccessible	2 HP	002	002 Gymnasium & Cafeteria	1
Domestic Circulation Pump	Bell & Gossett	Inaccessible	Inaccessible	2 HP	Mechanical room-S200	002 Gymnasium & Cafeteria	1
Domestic Circulation Pump	Bell & Gossett	XL 40-200	20170605-01506	.5 HP	Boiler room	002 Gymnasium & Cafeteria	1
Furnace	SystemAir	GHM9_080X_2NAV2.0	1868 1208G	80 MBH	Classrooms-O206	003 Administration & Classrooms	1
Furnace	SystemAir	GHM9_080X_2NAV2.3	1879 1208G	80 MBH	Classrooms-O204	003 Administration & Classrooms	1
Furnace	SystemAir	GHM9_080X_2NAV2.3	1878 1208G	80 MBH	Classrooms-O202	003 Administration & Classrooms	1
Furnace	SystemAir	GHM9_080X_2NAV2.3	1876 1208G	80 MBH	Classrooms-O116	003 Administration & Classrooms	1
Furnace	SystemAir	GHM9_080X_2NAV2.0	1886 1208G	80 MBH	Classrooms-O111	003 Administration & Classrooms	1
Furnace	SystemAir	GHM9_080X_2NAV2.0	1900 1208G	80 MBH	Classrooms-O208	003 Administration & Classrooms	1
Furnace	SystemAir	GHM9_080X_2NAV2.3	1872 1208G	80 MBH	Classrooms-O108	003 Administration & Classrooms	1
Furnace	SystemAir	GHM9_080X_2NAV2.0	1889 1208G	80 MBH	Classrooms-O117	003 Administration & Classrooms	1
Furnace	SystemAir	GHM9_040X_2NAV2.0	1868 1208G	40 MBH	Classrooms-O009	003 Administration & Classrooms	1
Furnace	SystemAir	GHM9_080X_2NAV2.0	1898 1208G	80 MBH	Classrooms-O215	003 Administration & Classrooms	1
Furnace	SystemAir	GHM9_080X_2NAV2.0	1887 1208G	80 MBH	Classrooms-O113	003 Administration & Classrooms	1
Furnace	SystemAir	GHM9_080X_2NAV2.0	1893 1208G	80 MBH	Classrooms-O209	003 Administration & Classrooms	1
Furnace	SystemAir	GHM9_080X_2NAV2.0	1899 1208G	80 MBH	Classrooms-O207	003 Administration & Classrooms	1
Furnace	SystemAir	GHM9_080X_2NAV2.0	1885 1208G	80 MBH	Classrooms-O109	003 Administration & Classrooms	1
Furnace	SystemAir	GHM9_040X_2NAV2.0	1867 1208G	40 MBH	Classrooms-O008	003 Administration & Classrooms	1
Furnace	SystemAir	GHM9_080X_2NAV2.0	1884 1208G	80 MBH	Classrooms-O105	003 Administration & Classrooms	1
Furnace	SystemAir	GHM9_080X_2NAV2.0	1883 1208G	80 MBH	Classrooms-O105	003 Administration & Classrooms	1
Furnace	SystemAir	GHM9_080X_2NAV2.0	1891 1208G	80 MBH	Classrooms-O201	003 Administration & Classrooms	1
Furnace	SystemAir	GHM9_040X_2NAV2.0	1864 1208G	80 MBH	Mechanical room-Z007	003 Administration & Classrooms	1

Mechanical Inventory							
System	Make	Model	Serial Number	Input Capacity	Location	Space Served	Quantity
Furnace	SystemAir	GHM9_080X_2NAV2.0	1901 1208G	80 MBH	Classrooms-O212	003 Administration & Classrooms	1
Furnace	SystemAir	GHM9_080X_2NAV2.3	1870 1208G	80 MBH	Classrooms-O106	003 Administration & Classrooms	1
Furnace	SystemAir	GHM9_040X_2NAV2.0	1875 1208G	80 MBH	Classrooms-O006	003 Administration & Classrooms	1
Furnace	SystemAir	GHM9_080X_2NAV2.0	1894 1208G	80 MBH	Classrooms-O209	003 Administration & Classrooms	1
Furnace	SystemAir	GHM9_080X_2NAV2.0	1873 1208G	80 MBH	Classrooms-O110	003 Administration & Classrooms	1
Furnace	SystemAir	GHM9_080X_2NAV2.3	1903 1208G	80 MBH	Classrooms-O210	003 Administration & Classrooms	1
Furnace	SystemAir	GHM9_080X_2NAV2.3	1875 1208G	80 MBH	Classrooms-O114	003 Administration & Classrooms	1
Furnace	SystemAir	GHM9_080X_2NAV2.0	1897 1208G	80 MBH	Classrooms-O205	003 Administration & Classrooms	1
Furnace	SystemAir	GHM9_080X_2NAV2.0	1892 1208G	80 MBH	Classrooms-O203	003 Administration & Classrooms	1
Furnace	SystemAir	GHM9_080X_2NAV2.3	1871 1208G	80 MBH	Classrooms-O106	003 Administration & Classrooms	1
Furnace	SystemAir	GHM9_040X_2NAV2.0	1866 1208G	80 MBH	Classrooms-O007	003 Administration & Classrooms	1
Furnace	SystemAir	GHM9_080X_2NAV2.3	1874 1208G	80 MBH	Classrooms-O112	003 Administration & Classrooms	1
Furnace	SystemAir	GHM9_080X_2NAV2.0	1895 1208G	80 MBH	Classrooms-O213	003 Administration & Classrooms	1
Furnace	SystemAir	GHM9_080X_2NAV2.0	1888 1208G	80 MBH	Classrooms-O115	003 Administration & Classrooms	1
Furnace	SystemAir	GHM9_080X_2NAV2.0	1890 1208G	80 MBH	Classrooms-O119	003 Administration & Classrooms	1
Furnace	SystemAir	GHM9_080X_2NAV2.3	1877 1208G	80 MBH	Classrooms-O118	003 Administration & Classrooms	1
Ductless Mini-Split	Electric	PUZ-A36NKA7	84U04698C	3 TON	Roof-003	Classrooms	1
Ductless Mini-Split	Mitsubishi Electric	PUZ-A36NKA7	84U04705C	3 TON	Roof-003	003 Administration & Classrooms	1
Exhaust Fan	Inaccessible	Inaccessible	Inaccessible	500 CFM	Roof-001	001 Music	1
Exhaust Fan	JennAir	70CRQT	No tag/plate found	500 CFM	Roof-002	003 Administration & Classrooms	1
Exhaust Fan	Greenheck	G-160-B-X	00H05721	1500 CFM	Roof-002	003 Administration & Classrooms	1
Exhaust Fan	Greenheck	G-100-B-19-X	00H05695	1001 - 2000 CFM	Roof-002	002 Gymnasium & Cafeteria	1
Exhaust Fan	Greenheck	G-140-B	00H05718	1001 - 2000 CFM	Roof-003	002 Gymnasium & Cafeteria	1
Exhaust Fan	Greenheck	G-100-B-19-X	00H05694	1001 - 2000 CFM	Roof-003	002 Gymnasium & Cafeteria	1
Exhaust Fan	Greenheck	CUBE-180HP-20-6	15463031 18E	3000 CFM	Roof-003	002 Gymnasium & Cafeteria	1
Expansion Tank	No tag/plate found	AX40V	356886	31 - 60 GAL	Boiler room	002 Gymnasium & Cafeteria	1
Fan Coil Unit, Hydronic	Inaccessible	Inaccessible	Inaccessible	2000 CFM	Gymnasium	002 Gymnasium & Cafeteria	1
Heat Pump Air Handler	Trane	TWE090A300EL	4323MKDBD	2401 - 4000 CFM	Classrooms-O112	001 Music	1
Split System	AAON, Inc.	CB-B-036-3-B-1	201806-CDCE03707	3 TON	Roof-001	003 Administration & Classrooms	1
Split System	AAON, Inc.	CB-B-060-3-B-1	201806-CDCF03722	4 TON	Roof-001	003 Administration & Classrooms	1
Split System	AAON, Inc.	CB-B-036-3-B-1	201806-CDCC03691	4 TON	Roof-001	003 Administration & Classrooms	1
Split System	AAON, Inc.	CB-B-036-3-B-1	201806-CDCE03718	3 TON	Roof-001	003 Administration & Classrooms	1
Split System	AAON, Inc.	CB-B-060-3-B-1	201806-CDCF03721	4 TON	Roof-003	003 Administration & Classrooms	1
Split System	AAON, Inc.	CB-B-048-3-B-1	201806-CDCE03706	4 TON	Roof-003	003 Administration & Classrooms	1
Split System	AAON, Inc.	CB-B-036-3-B-1	201806-CDCC03689	3 TON	Roof-003	003 Administration & Classrooms	1
Split System	AAON, Inc.	CB-B-048-3-B-1	201806-CDCE03700	4 TON	Roof-003	003 Administration & Classrooms	1
Split System	AAON, Inc.	CB-B-048-3-B-1	201806-CDCE03709	4 TON	Roof-003	003 Administration & Classrooms	1

Mechanical Inventory							
System	Make	Model	Serial Number	Input Capacity	Location	Space Served	Quantity
Split System	AAON, Inc.	CB-B-060-3-B-1	201806-CDCF03724	4 TON	Roof-003	003 Administration & Classrooms	1
Split System	AAON, Inc.	CB-B-048-3-B-1	201806-CDCE03719	4 TON	Roof-003	003 Administration & Classrooms	1
Split System	AAON, Inc.	CB-B-048-3-B-1	201806-CDCE03714	4 TON	Roof-003	003 Administration & Classrooms	1
Split System	AAON, Inc.	CB-B-048-3-B-1	201806-CDCE03699	4 TON	Roof-003	003 Administration & Classrooms	1
Split System	AAON, Inc.	CB-B-048-3-B-1	201806-CDCE03703	4 TON	Roof-003	003 Administration & Classrooms	1
Split System	AAON, Inc.	CB-B-048-3-B-1	201806-CDCE03695	4 TON	Roof-003	003 Administration & Classrooms	1
Split System	AAON, Inc.	CB-B-048-3-B-1	201806-CDCE03696	4 TON	Roof-003	003 Administration & Classrooms	1
Split System	AAON, Inc.	CB-B-036-3-B-1	201806-CDCC03686	3 TON	Roof-003	003 Administration & Classrooms	1
Split System	AAON, Inc.	CB-B-036-3-B-1	201806-CDCC03688	4 TON	Roof-003	003 Administration & Classrooms	1
Split System	AAON, Inc.	CB-B-048-3-B-1	201806-CDCE03711	4 TON	Roof-003	003 Administration & Classrooms	1
Split System	AAON, Inc.	CB-B-048-3-B-1	201806-CDCE03717	4 TON	Roof-003	003 Administration & Classrooms	1
Split System	AAON, Inc.	CB-B-060-3-B-1	201806-CDCF03723	4 TON	Roof-003	003 Administration & Classrooms	1
Split System	AAON, Inc.	CB-B-036-3-B-1	201806-CDCC03690	3 TON	Roof-003	003 Administration & Classrooms	1
Split System	AAON, Inc.	CB-B-048-3-B-1	201806-CDCE03694	4 TON	Roof-003	003 Administration & Classrooms	1
Split System	AAON, Inc.	CB-B-048-3-B-1	201806-CDCE03702	4 TON	Roof-003	003 Administration & Classrooms	1
Split System	AAON, Inc.	CB-B-048-3-B-1	201806-CDCE03692	4 TON	Roof-003	003 Administration & Classrooms	1
Split System	AAON, Inc.	CB-B-048-3-B-1	201806-CDCE03698	4 TON	Roof-003	003 Administration & Classrooms	1
Split System	Trane	TWA090A400FA	41414YKAD	7.5 TON	Roof-003	001 Music	1
Split System	AAON, Inc.	CB-B-048-3-B-1	201806-CDCE03705	4 TON	Roof-003	003 Administration & Classrooms	1
Hydronic Boiler	Laars Heating Systems	NTH285N XX3	G18423792	285 MBH	Boiler room	003 Administration & Classrooms	1
Hydronic Boiler	Laars Heating Systems	MGH2000NXXAX2	N18288620	2000 MBH	Mechanical room-S200	002 Gymnasium & Cafeteria	1
Hydronic Unit Heater	Inaccessible	Inaccessible	Inaccessible	37 - 85 MBH	Stage	002 Gymnasium & Cafeteria	1
Hydronic Unit Heater	Inaccessible	Inaccessible	Inaccessible	100 MBH	Gymnasium	002 Gymnasium & Cafeteria	1
Hydronic Unit Heater	Inaccessible	Inaccessible	Inaccessible	1000	Gymnasium	002 Gymnasium & Cafeteria	1
Packaged Unit (RTU)	AAON, Inc.	RN-009-3-0-EB09-2 F2	201807-ANGQ69376	195 MBH	Roof-004	004 Art	1
Packaged Unit (RTU)	AAON, Inc.	RN-007-3-0-E B09 -	201807-ANGG69382	90 MBH	Roof-004	004 Art	1
Packaged Unit (RTU)	AAON, Inc.	RN-007-3-0-E B09 -	201807-ANGF69381	90 MBH	Roof-004	004 Art	1
Split System Forced-Air Furnace	Carrier	59TP6A040E17-12	5117A46683	40 MBH	Mechanical room-S200	003 Administration & Classrooms	1
Split System Forced-Air Furnace	SystemAir	GHM9_080X_2NAV2.0	1902 1208G	80 MBH	Classrooms-O005	004 Art	1
Split System Forced-Air Furnace	SystemAir	GHM9_080X_2NAV2.3	1881 1208G	80 MBH	Classrooms-O004	004 Art	1
Split System Forced-Air Furnace	SystemAir	GHM9_080X_2NAV2.3	1880 1208G	80 MBH	Classrooms-O004	004 Art	1
Split System Forced-Air Furnace	SystemAir	GHM9_080X_2NAV2.3	1882 1208G	80 MBH	Classrooms-O005	004 Art	1
Wall Mounted Heat Pump	Bard	WH421-A05UX4XXX	126K991376086-01	3.5 TON	Building exterior - 116	P01 Modular Classrooms 114-117	1
Wall Mounted Heat Pump	Bard	WH421-A05UX4XXX	126K991376133-01	3.5 TON	Building exterior - 114	P01 Modular Classrooms 114-117	1
Wall Mounted Heat Pump	Bard	WH421-A05UX4XXX	126K991376122-01	3.5 TON	Building exterior - 117	P01 Modular Classrooms 114-117	1
Wall Mounted Heat Pump	Bard	WH421-A05UX4XXX	126K991376068-01	3.5 TON	Building exterior - 115	P01 Modular Classrooms 114-117	1
Wall Mounted Heat Pump	Bard	WH431-A10CX4XXX	176D9913394-02	3.5 TON	Building exterior - 119	P02 Modular Classrooms 118-119	1
Wall Mounted Heat Pump	Bard	WH431-A10CX4XXX	176D991339799-02	3.5 TON	Building exterior - 118	P02 Modular Classrooms 118-119	1

Mechanical Inventory							
System	Make	Model	Serial Number	Input Capacity	Location	Space Served	Quantity
Wall Mounted Heat Pump	Bard	WH361-A05VP4XXX	125D041900453-02	3 TON	Building exterior	P03 Modular Classroom 120	1
Wall Mounted Heat Pump	Bard	WH482-A05VX4XXX	149B011591020-01	4 TON	Building exterior	P04 Modular Classroom 121	1
Water Heater	A. O. Smith	BTH-199 300	1820110453173	100 GAL, 200 MBH	002	002 Gymnasium & Cafeteria	1
Water Heater	A. O. Smith	BTH-199 300	1826110964634	100 GAL, 200 MBH	002	002 Gymnasium & Cafeteria	1
Water Heater	A. O. Smith	BTR 200 106	MB000988962	100 GAL, 200 MBH	Boiler room	004 Art	1

APPENDIX C:
Lighting System Schedule

									Lamp Details				Fixture Details				Existing Consumption	
Line No.	Building Name	Interior/ Exterior	Floor	Space Type	Room No.	LUX	Control Quantity	Existing Control	Technology	Sub-Technology	Lamp Type	Total Lamps	Fixture Type	Fixture Quantity	24x7 Fixture Count	Fixture Height	Annual Hours	Existing Annual kWh
1	Sutter Middle School	Interior	1	CAFETERIA	U001	256	6	Light Switch	Linear Fluorescent	T5	4' 28W T5	48	Industrial	12	0	20	2,220	2,984
2	Sutter Middle School	Interior	1	STORAGE	S002	39	3	Light Switch	Linear Fluorescent	T8	4' 32W T8	6	Industrial	3	0	8	6,216	1,193
3	Sutter Middle School	Interior	1	STORAGE	M002	58	4	Light Switch	Linear Fluorescent	T8	4' 32W T8	8	Industrial	4	0	8	6,216	1,591
4	Sutter Middle School	Interior	Below ground	STORAGE	M001	103	2	Light Switch	CFL	CFL - Screw-in	CFL23	1	Ceiling Fan Light Combo	1	0	8	6,216	143
5	Sutter Middle School	Interior	Below ground	STORAGE	M001	103	2	Light Switch	Linear Fluorescent	T8	4' 32W T8	10	Industrial	5	0	8	6,216	1,989
6	Sutter Middle School	Interior	1	MECHANICAL	B001	73	1	Light Switch	Linear Fluorescent	T8	4' 32W T8	8	Industrial	4	0	8	1,554	398
7	Sutter Middle School	Interior	1	STORAGE	S002	40	2	Light Switch	Linear Fluorescent	T8	4' 32W T8	10	Industrial	5	0	8	6,216	1,989
8	Sutter Middle School	Interior	1	STORAGE	B001	169	1	Light Switch	Linear Fluorescent	T8	4' 32W T8	12	Industrial	6	0	8	6,216	2,387
9	Sutter Middle School	Interior	1	STORAGE	N01A	-	1	Light Switch	Linear Fluorescent	T8	4' 32W T8	8	Troffer 2'x4'	4	0	8	703	180
10	Sutter Middle School	Interior	3	CLASSROOM	O201	242	18	Ceiling-Mounted Sensor	LED	-	-	216	2x4 Prism Troffer	216	0	9	2,220	-
11	Sutter Middle School	Interior	3	ESTROOM - PRIVAT	T204	168	1	Timer	LED	-	-	2	2x4 Prism Troffer	1	0	8	2,220	-
12	Sutter Middle School	Interior	3	CLASSROOM	O210	486	3	Wall-Mounted Sensor	LED	-	-	45	2x4 Indirect Troffer	45	0	8	2,220	-
13	Sutter Middle School	Interior	3	STORAGE	O21A	305	2	Light Switch	Linear Fluorescent	T8	4' 32W T8	12	2x4 Prism Troffer	4	0	8	703	270
14	Sutter Middle School	Interior	3	STORAGE	O21B	147	1	Ceiling-Mounted Sensor	Linear Fluorescent	T8	4' 32W T8	4	2x4 Prism Troffer	2	0	8	6,216	796
15	Sutter Middle School	Interior	3	CLASSROOM	O212	486	1	Wall-Mounted Sensor	LED	-	-	15	2x4 Indirect Troffer	15	0	8	2,220	-
16	Sutter Middle School	Interior	3	MECHANICAL	S200	70	1	Wall-Mounted Sensor	Linear Fluorescent	T8	4' 32W T8	14	Industrial	7	0	8	1,554	696
17	Sutter Middle School	Interior	1	OFFICE	Z007	252	1	Wall-Mounted Sensor	LED	-	-	6	2x4 Indirect Troffer	6	0	8	2,220	-
18	Sutter Middle School	Interior	1	LOCKER ROOM	Boys locker room	76	2	Light Switch	Linear Fluorescent	T8	4' 32W T8	54	2x4 Prism Troffer	27	0	8	2,220	3,836
19	Sutter Middle School	Interior	1	STORAGE	S2V1	103	2	Light Switch	Linear Fluorescent	T8	4' 32W T8	16	2x4 Prism Troffer	8	0	8	6,216	3,183
20	Sutter Middle School	Interior	1	OFFICE	C02R	-	2	Light Switch	Linear Fluorescent	T8	4' 32W T8	16	2x4 Prism Troffer	4	0	8	2,220	1,137
21	Sutter Middle School	Interior	1	STORAGE	J2R1	159	3	Light Switch	Linear Fluorescent	T8	4' 32W T8	6	Industrial	3	0	8	6,216	1,193
22	Sutter Middle School	Interior	1	GYMNASIUM	Activity room	121	4	Light Switch	Linear Fluorescent	T8	4' 32W T8	108	2x4 Prism Troffer	36	0	18	2,220	7,672
23	Sutter Middle School	Interior	1	GYMNASIUM	Gym	186	4	Light Switch	Linear Fluorescent	T5	4' 28W T5	80	Industrial	20	0	22	2,220	4,973
24	Sutter Middle School	Interior	1	GYMNASIUM	Gym	186	4	Timer	LED	-	-	8	Exit Sign	4	0	8	2,220	-
25	Sutter Middle School	Interior	1	LOCKER ROOM	Boys locker room	76	2	Timer	LED	-	-	8	Exit Sign	4	0	8	2,220	-
26	Sutter Middle School	Interior	1	LOCKER ROOM	Girl locker room	76	2	Light Switch	Linear Fluorescent	T8	4' 32W T8	52	2x4 Prism Troffer	26	0	11	2,220	3,694
27	Sutter Middle School	Interior	1	LOCKER ROOM	Girl locker room	76	2	Timer	LED	-	-	8	Exit Sign	4	0	8	2,220	-
28	Sutter Middle School	Interior	1	RESTROOM	T1VW	-	2	Light Switch	Linear Fluorescent	T8	4' 32W T8	4	2x4 Prism Troffer	2	0	8	2,220	284
29	Sutter Middle School	Interior	1	JANITORIAL	J01V	94	2	Light Switch	Linear Fluorescent	T8	4' 32W T8	4	Industrial	2	0	8	703	90
30	Sutter Middle School	Interior	1	STORAGE	I001	-	1	Light Switch	Linear Fluorescent	T8	4' 32W T8	20	2x4 Prism Troffer	10	0	8	703	450
31	Sutter Middle School	Interior	1	KITCHEN	K002	185	4	Light Switch	Linear Fluorescent	T8	4' 32W T8	129	2x4 Prism Troffer	43	0	8	1,850	7,637
32	Sutter Middle School	Interior	1	KITCHEN	K002	185	4	Light Switch	Linear Fluorescent	T8	4' 32W T8	4	2x4 Prism Troffer	2	0	8	1,850	237
33	Sutter Middle School	Interior	1	KITCHEN	K002	185	4	Timer	LED	-	-	8	Exit Sign	4	0	8	1,850	-
34	Sutter Middle School	Interior	1	RESTROOM	T01K	174	2	Light Switch	Linear Fluorescent	T8	4' 32W T8	2	2x4 Prism Troffer	1	0	8	2,220	142
35	Sutter Middle School	Interior	1	RESTROOM	T01K	174	2	Light Switch	HID	MH	MH100	1	Cobra Head	1	0	8	2,220	222
36	Sutter Middle School	Interior	1	RESTROOM	T01K	174	2	Light Switch	Linear Fluorescent	T8	4' 32W T8	2	Industrial	1	0	8	2,220	142
37	Sutter Middle School	Interior	1	CAFETERIA	U001	256	6	Light Switch	Linear Fluorescent	T8	4' 32W T8	16	Industrial	8	0	8	2,220	1,137
38	Sutter Middle School	Interior	1	CAFETERIA	U001	256	6	Timer	LED	-	-	4	Flood Light Dual Head	2	0	8	2,220	-
39	Sutter Middle School	Interior	1	CAFETERIA	U001	256	6	Light Switch	Incan/H/MR	Incan	I60-Globe	1	Ceiling Fan Light Combo	1	0	8	2,220	133
40	Sutter Middle School	Interior	1	CAFETERIA	U001	256	6	Timer	LED	-	-	2	Exit Sign	1	0	8	2,220	-
41	Sutter Middle School	Interior	1	CAFETERIA	U001	256	6	Timer	LED	-	-	6	Exit Sign	3	0	8	2,220	-
42	Sutter Middle School	Interior	3	HALLWAY	H295	-	2	Timer	Linear Fluorescent	T8	4' 32W T8	128	2x4 Prism Troffer	64	0	8	2,220	9,093
43	Sutter Middle School	Interior	3	STORAGE	J204	82	1	Ceiling-Mounted Sensor	Linear Fluorescent	T8	4' 32W T8	2	Industrial	1	0	8	703	45
44	Sutter Middle School	Interior	3	RESTROOM	T25B	200	2	Light Switch	Linear Fluorescent	T8	4' 32W T8	8	2x4 Prism Troffer	4	0	10	2,220	568
45	Sutter Middle School	Interior	3	JaNITORIAL	J350	94	1	Ceiling-Mounted Sensor	Linear Fluorescent	T8	4' 32W T8	2	Industrial	1	0	8	703	45
46	Sutter Middle School	Interior	3	RESTROOM	T25G	200	2	Light Switch	Linear Fluorescent	T8	4' 32W T8	8	2x4 Prism Troffer	4	0	10	2,220	568
47	Sutter Middle School	Interior	3	CLASSROOM	O209	291	1	Ceiling-Mounted Sensor	LED	-	-	20	2x4 Prism Troffer	20	0	9	1,480	-
48	Sutter Middle School	Interior	3	CLASSROOM	O203	242	1	Ceiling-Mounted Sensor	LED	-	-	12	2x4 Prism Troffer	12	0	9	1,480	-
49	Sutter Middle School	Interior	1	ELEVATOR	Elevator	216	1	Timer	Linear Fluorescent	T8	4' 32W T8	2	2x4 Prism Troffer	1	0	8	6,216	398
50	Sutter Middle School	Interior	2	OPEN OFFICE	C110	275	3	Ceiling-Mounted Sensor	LED	-	-	24	2x4 Indirect Troffer	24	0	9	2,220	-
51	Sutter Middle School	Interior	2	CONFERENCE ROOM	Z101	242	1	Wall-Mounted Sensor	LED	-	-	2	2x4 Indirect Troffer	2	0	9	2,220	-
52	Sutter Middle School	Interior	2	RESTROOM	T12M	190	1	Light Switch	Linear Fluorescent	T8	4' 32W T8	2	2x4 Prism Troffer	1	0	9	2,220	142
53	Sutter Middle School	Interior	2	RESTROOM	T12W	190	1	Light Switch	Linear Fluorescent	T8	4' 32W T8	2	2x4 Prism Troffer	1	0	9	2,220	142
54	Sutter Middle School	Interior	2	OFFICE	Z103	387	2	Wall-Mounted Sensor	LED	-	-	8	2x4 Indirect Troffer	8	0	9	2,220	-
55	Sutter Middle School	Interior	2	OFFICE	C11D	224	4	Wall-Mounted Sensor	LED	-	-	4	2x4 Indirect Troffer	4	0	9	2,220	-
56	Sutter Middle School	Interior	2	CAFETERIA	Z102	685	1	Wall-Mounted Sensor	LED	-	-	4	2x4 Indirect Troffer	4	0	9	2,220	-
57	Sutter Middle School	Interior	2	ESTROOM - PRIVAT	T102	157	1	Light Switch	Linear Fluorescent	T8	4' 32W T8	2	2x4 Prism Troffer	1	0	9	2,220	142
58	Sutter Middle School	Interior	2	STORAGE	O102	227	1	Wall-Mounted Sensor	LED	-	-	1	2x4 Indirect Troffer	1	0	9	6,216	-
59	Sutter Middle School	Interior	2	OFFICE	C104	850	1	Wall-Mounted Sensor	LED	-	-	2	2x4 Indirect Troffer	2	0	9	2,220	-
60	Sutter Middle School	Interior	2	OFFICE	S014	151	1	Wall-Mounted Sensor	LED	-	-	2	2x4 Indirect Troffer	2	0	9	2,220	-

61	Sutter Middle School	Interior	2	STORAGE	S114	88	1	Light Switch	Linear Fluorescent	T8	4' 32W T8	2	2x4 Prism Troffer	1	0	9	703	45
62	Sutter Middle School	Interior	2	STORAGE	S011	88	2	Light Switch	Linear Fluorescent	T8	4' 32W T8	4	2x4 Prism Troffer	2	0	9	703	90
63	Sutter Middle School	Interior	2	STORAGE	S15p	227	1	Ceiling-Mounted Sensor	Linear Fluorescent	T8	4' 32W T8	2	Industrial	1	0	9	703	45
64	Sutter Middle School	Interior	2	STORAGE	S102	442	1	Light Switch	Linear Fluorescent	T8	4' 32W T8	4	2x4 Prism Troffer	2	0	9	703	90
65	Sutter Middle School	Interior	2	STORAGE	J102	145	1	Light Switch	Linear Fluorescent	T8	4' 32W T8	3	2x4 Prism Troffer	1	0	9	703	67
66	Sutter Middle School	Interior	2	CLASSROOM	O105	403	2	Wall-Mounted Sensor	LED	-	-	20	2x4 Indirect Troffer	20	0	10	1,480	-
67	Sutter Middle School	Interior	2	LIBRARY	X106	366	2	Wall-Mounted Sensor	LED	-	-	33	2x4 Indirect Troffer	33	0	10	2,220	-
68	Sutter Middle School	Interior	2	OFFICE	S106	-	2	Light Switch	Linear Fluorescent	T8	4' 32W T8	6	2x4 Prism Troffer	2	0	10	2,220	426
69	Sutter Middle School	Interior	1	CLASSROOM	112	325	1	Wall-Mounted Sensor	LED	-	-	20	2x4 Indirect Troffer	20	0	12	1,480	-
70	Sutter Middle School	Interior	1	CLASSROOM	111	325	1	Wall-Mounted Sensor	LED	-	-	20	2x4 Indirect Troffer	20	0	12	1,480	-
71	Sutter Middle School	Interior	1	CLASSROOM	110	325	1	Wall-Mounted Sensor	LED	-	-	20	2x4 Indirect Troffer	20	0	10	1,480	-
72	Sutter Middle School	Interior	1	RESTROOM	T01B	190	1	Light Switch	Linear Fluorescent	T8	4' 32W T8	4	2x4 Prism Troffer	2	0	10	2,220	284
73	Sutter Middle School	Interior	1	RESTROOM	T01G	190	1	Light Switch	Linear Fluorescent	T8	4' 32W T8	4	2x4 Prism Troffer	2	0	10	2,220	284
74	Sutter Middle School	Interior	1	CLASSROOM	110	325	1	Light Switch	Linear Fluorescent	T8	4' 32W T8	2	1x4 Prism Troffer	1	0	8	1,480	95
75	Sutter Middle School	Interior	1	CLASSROOM	O009	404	4	Wall-Mounted Sensor	LED	-	-	32	2x4 Indirect Troffer	32	0	10	1,480	-
76	Sutter Middle School	Interior	1	HALLWAY	H002	-	1	Timer	Linear Fluorescent	T8	4' 32W T8	12	2x4 Prism Troffer	4	0	10	2,220	852
77	Sutter Middle School	Interior	1	CLASSROOM	O005	350	2	Wall-Mounted Sensor	LED	-	-	40	2x4 Indirect Troffer	40	0	10	1,480	-
78	Sutter Middle School	Interior	1	OFFICE	004	260	1	Light Switch	Linear Fluorescent	T8	4' 32W T8	3	2x4 Prism Troffer	1	0	10	2,220	213
79	Sutter Middle School	Interior	1	STORAGE	S04B	80	5	Timer	Linear Fluorescent	T8	4' 32W T8	10	Industrial	5	0	10	703	225
80	Sutter Middle School	Interior	1	RESTROOM	T001	174	2	Light Switch	Linear Fluorescent	T8	4' 32W T8	8	2x4 Prism Troffer	4	0	10	2,220	568
81	Sutter Middle School	Interior	1	ResTROOM	Men's Staff Restroom	174	1	Timer	Linear Fluorescent	T8	4' 32W T8	4	2x4 Prism Troffer	2	0	10	2,220	284
82	Sutter Middle School	Interior	1	CLASSROOM	O03W	408	2	Wall-Mounted Sensor	LED	-	-	24	2x4 Indirect Troffer	24	0	10	1,480	-
83	Sutter Middle School	Interior	1	STORAGE	S03A	168	1	Light Switch	Linear Fluorescent	T8	4' 32W T8	3	2x4 Prism Troffer	1	0	10	703	67
84	Sutter Middle School	Interior	1	STORAGE	S03B	168	2	Light Switch	Linear Fluorescent	T8	4' 32W T8	4	Industrial	2	0	10	703	90
85	Sutter Middle School	Interior	1	CLASSROOM	O03W	408	2	Timer	Linear Fluorescent	T5	4' 28W T5	24	2x4 Indirect Troffer	12	0	6	1,480	995
86	Sutter Middle School	Interior	1	OPEN OFFICE	O002	270	1	Wall-Mounted Sensor	LED	-	-	21	2x4 Indirect Troffer	21	0	9	2,220	-
87	Sutter Middle School	Interior	1	OFFICE	C002	413	1	Light Switch	Linear Fluorescent	T8	4' 32W T8	3	2x4 Prism Troffer	1	0	10	2,220	213
88	Sutter Middle School	Interior	1	STORAGE	S2WB	107	2	Light Switch	Linear Fluorescent	T8	4' 32W T8	4	Industrial	2	0	10	703	90
89	Sutter Middle School	Interior	1	OFFICE	Vice principal	229	2	Light Switch	Linear Fluorescent	T8	4' 32W T8	12	2x4 Prism Troffer	4	0	10	2,220	852
90	Sutter Middle School	Interior	1	OFFICE	Counselor	196	2	Light Switch	Linear Fluorescent	T8	4' 32W T8	6	2x4 Prism Troffer	2	0	10	2,220	426
91	Sutter Middle School	Interior	1	CLASSROOM	N001	382	1	Wall-Mounted Sensor	LED	-	-	70	2x4 Prism Troffer	35	0	10	1,480	-
92	Sutter Middle School	Interior	1	STORAGE	S01A	-	1	Light Switch	Linear Fluorescent	T8	4' 32W T8	4	Industrial	2	0	10	703	90
93	Sutter Middle School	Interior	1	STORAGE	S01B	93	2	Light Switch	Linear Fluorescent	T8	4' 32W T8	4	Industrial	2	0	10	703	90
94	Sutter Middle School	Interior	1	OFFICE	Cp01	-	1	Light Switch	Linear Fluorescent	T8	4' 32W T8	3	2x4 Prism Troffer	1	0	10	2,220	213
95	Sutter Middle School	Interior	1	CLASSROOM	121	416	4	Wall-Mounted Sensor	LED	-	-	48	2x4 Indirect Troffer	48	0	10	1,480	-
96	Sutter Middle School	Interior	1	CLASSROOM	0017	-	4	Wall-Mounted Sensor	LED	-	-	40	2x4 Indirect Troffer	40	0	9	1,480	-
97	Sutter Middle School	Exterior	1	HALLWAY	Ext	-	1	Timer	Linear Fluorescent	T8	4' 32W T8	1	Strip Fixture	1	0	8	2,220	71
98	Sutter Middle School	Exterior	1	HALLWAY	Ext	-	1	Timer	Linear Fluorescent	T8	4' 32W T8	48	2x4 Prism Troffer	24	0	8	2,220	3,410
99	Sutter Middle School	Exterior	1	HALLWAY	Ext	-	1	Timer	LED	-	-	2	Wallpack-Horizontal	2	0	8	2,220	-
100	Sutter Middle School	Exterior	1	HALLWAY	Ext	-	1	Timer	LED	-	-	9	Wallpack-Horizontal	9	0	8	2,220	-
101	Sutter Middle School	Exterior	1	HALLWAY	Ext	-	1	Timer	HID	HPS	HPS70	2	Wallpack-Horizontal	2	0	8	2,220	311
102	Sutter Middle School	Exterior	1	HALLWAY	Ext	-	1	Timer	LED	-	-	2	Wallpack-Horizontal	2	0	8	2,220	-
103	Sutter Middle School	Exterior	1	HALLWAY	Ext	-	1	Timer	HID	HPS	HPS100	10	Wallpack-Horizontal	10	0	8	2,220	2,220
	Totals											1,816		1,176			234,025	74,630

								Fixture Details						Existing Consumption				Proposed- Post Retrofit				
Line No.	Building Name	Interior/ Exterior	Floor	Space Type	Room No.	Existing Control	Control Quantity	Technology	Sub-Technology	Lamp- Fixture	Fixture Quantity	Total Lamps	Fixture Height	Annual Hours	Existing Annual kWh	ECM	ECM Type	Recommended Sensor	LED Lamp Retrofit	Annual Hours of Operation	Proposed Annual kWh	Annual Savings From LED Retrofit
																						kWh
1	Sutter Middle School	Interior	1	CAFETERIA	U001	Light Switch	6	Linear Fluorescent	T5	4' 28W T5; Industrial	12	48	20	2,220	2,984	ECM	RB - Replace Bulb	Wall Mounted	4' 15W LED T5	2,220	1,598	1,385
2	Sutter Middle School	Interior	1	STORAGE	S002	Light Switch	3	Linear Fluorescent	T8	4' 32W T8; Industrial	3	6	8	6,216	1,193	ECM	RB - Replace Bulb	Wall Mounted	4' 17W LED T8	6,216	634	559
3	Sutter Middle School	Interior	1	STORAGE	M002	Light Switch	4	Linear Fluorescent	T8	4' 32W T8; Industrial	4	8	8	6,216	1,591	ECM	RB - Replace Bulb	Wall Mounted	4' 17W LED T8	6,216	845	746
4	Sutter Middle School	Interior	Below ground	STORAGE	M001	Light Switch	2	CFL	CFL - Screw-in	CFL23; Ceiling Fan Light Combo	1	1	8	6,216	143	ECM	RB - Replace Bulb	Wall Mounted	14W LED A19	6,216	87	56
5	Sutter Middle School	Interior	Below ground	STORAGE	M001	Light Switch	2	Linear Fluorescent	T8	4' 32W T8; Industrial	5	10	8	6,216	1,989	ECM	RB - Replace Bulb	Wall Mounted	4' 17W LED T8	6,216	1,057	932
6	Sutter Middle School	Interior	1	MECHANICAL	B001	Light Switch	1	Linear Fluorescent	T8	4' 32W T8; Industrial	4	8	8	1,554	398	ECM	RB - Replace Bulb	Wall Mounted	4' 17W LED T8	1,554	211	186
7	Sutter Middle School	Interior	1	STORAGE	S002	Light Switch	2	Linear Fluorescent	T8	4' 32W T8; Industrial	5	10	8	6,216	1,989	ECM	RB - Replace Bulb	Wall Mounted	4' 17W LED T8	6,216	1,057	932
8	Sutter Middle School	Interior	1	STORAGE	B001	Light Switch	1	Linear Fluorescent	T8	4' 32W T8; Industrial	6	12	8	6,216	2,387	ECM	RB - Replace Bulb	Wall Mounted	4' 17W LED T8	6,216	1,268	1,119
9	Sutter Middle School	Interior	1	STORAGE	N01A	Light Switch	1	Linear Fluorescent	T8	4' 32W T8; Troffer 2'x4'	4	8	8	703	180	ECM	RB - Replace Bulb	Wall Mounted	4' 17W LED T8	703	96	84
10	Sutter Middle School	Interior	3	CLASSROOM	O201	Ceiling-Mounted Sensor	18	LED	-		216	216	9	2,220				Retain Existing Controls				
11	Sutter Middle School	Interior	3	RESTROOM - PRIVATE	T204	Timer	1	LED	-		1	2	8	2,220				Wall Mounted				
12	Sutter Middle School	Interior	3	CLASSROOM	O210	Wall-Mounted Sensor	3	LED	-		45	45	8	2,220				Retain Existing Controls				
13	Sutter Middle School	Interior	3	STORAGE	O21A	Light Switch	2	Linear Fluorescent	T8	4' 32W T8; 2x4 Prism Troffer	4	12	8	703	270	ECM	RB - Replace Bulb	Wall Mounted	4' 17W LED T8	703	143	127
14	Sutter Middle School	Interior	3	STORAGE	O21B	Ceiling-Mounted Sensor	1	Linear Fluorescent	T8	4' 32W T8; 2x4 Prism Troffer	2	4	8	6,216	796	ECM	RB - Replace Bulb	Retain Existing Controls	4' 17W LED T8	6,216	423	373
15	Sutter Middle School	Interior	3	CLASSROOM	O212	Wall-Mounted Sensor	1	LED	-		15	15	8	2,220				Retain Existing Controls				
16	Sutter Middle School	Interior	3	MECHANICAL	S200	Wall-Mounted Sensor	1	Linear Fluorescent	T8	4' 32W T8; Industrial	7	14	8	1,554	696	ECM	RB - Replace Bulb	Retain Existing Controls	4' 17W LED T8	1,554	370	326
17	Sutter Middle School	Interior	1	OFFICE	Z007	Wall-Mounted Sensor	1	LED	-		6	6	8	2,220				Retain Existing Controls				
18	Sutter Middle School	Interior	1	LOCKER ROOM	Boys locker room	Light Switch	2	Linear Fluorescent	T8	4' 32W T8; 2x4 Prism Troffer	27	54	8	2,220	3,836	ECM	RB - Replace Bulb	Wall Mounted	4' 17W LED T8	2,220	2,038	1,798
19	Sutter Middle School	Interior	1	STORAGE	S2V1	Light Switch	2	Linear Fluorescent	T8	4' 32W T8; 2x4 Prism Troffer	8	16	8	6,216	3,183	ECM	RB - Replace Bulb	Wall Mounted	4' 17W LED T8	6,216	1,691	1,492
20	Sutter Middle School	Interior	1	OFFICE	C02R	Light Switch	2	Linear Fluorescent	T8	4' 32W T8; 2x4 Prism Troffer	4	16	8	2,220	1,137	ECM	RB - Replace Bulb	Wall Mounted	4' 17W LED T8	2,220	604	533
21	Sutter Middle School	Interior	1	STORAGE	J2R1	Light Switch	3	Linear Fluorescent	T8	4' 32W T8; Industrial	3	6	8	6,216	1,193	ECM	RB - Replace Bulb	Wall Mounted	4' 17W LED T8	6,216	634	559
22	Sutter Middle School	Interior	1	GYMNASIUM	Activity room	Light Switch	4	Linear Fluorescent	T8	4' 32W T8; 2x4 Prism Troffer	36	108	18	2,220	7,672	ECM	RB - Replace Bulb	Wall Mounted	4' 17W LED T8	2,220	4,076	3,596
23	Sutter Middle School	Interior	1	GYMNASIUM	Gym	Light Switch	4	Linear Fluorescent	T5	4' 28W T5; Industrial	20	80	22	2,220	4,973	ECM	RB - Replace Bulb	Wall Mounted	4' 15W LED T5	2,220	2,664	2,309
24	Sutter Middle School	Interior	1	GYMNASIUM	Gym	Timer	4	LED	-		4	8	8	2,220				Wall Mounted				
25	Sutter Middle School	Interior	1	LOCKER ROOM	Boys locker room	Timer	2	LED	-		4	8	8	2,220				Wall Mounted				
26	Sutter Middle School	Interior	1	LOCKER ROOM	Girl locker room	Light Switch	2	Linear Fluorescent	T8	4' 32W T8; 2x4 Prism Troffer	26	52	11	2,220	3,694	ECM	RB - Replace Bulb	Wall Mounted	4' 17W LED T8	2,220	1,962	1,732
27	Sutter Middle School	Interior	1	LOCKER ROOM	Girl locker room	Timer	2	LED	-		4	8	8	2,220				Wall Mounted				
28	Sutter Middle School	Interior	1	RESTROOM	T1VW	Light Switch	2	Linear Fluorescent	T8	4' 32W T8; 2x4 Prism Troffer	2	4	8	2,220	284	ECM	RB - Replace Bulb	Wall Mounted	4' 17W LED T8	2,220	151	133
29	Sutter Middle School	Interior	1	JANITORIAL	J01V	Light Switch	2	Linear Fluorescent	T8	4' 32W T8; Industrial	2	4	8	703	90	ECM	RB - Replace Bulb	Wall Mounted	4' 17W LED T8	703	48	42
30	Sutter Middle School	Interior	1	STORAGE	I001	Light Switch	1	Linear Fluorescent	T8	4' 32W T8; 2x4 Prism Troffer	10	20	8	703	450	ECM	RB - Replace Bulb	Wall Mounted	4' 17W LED T8	703	239	211
31	Sutter Middle School	Interior	1	KITCHEN	K002	Light Switch	4	Linear Fluorescent	T8	4' 32W T8; 2x4 Prism Troffer	43	129	8	1,850	7,637	ECM	RB - Replace Bulb	Wall Mounted	4' 17W LED T8	1,850	4,057	3,580
32	Sutter Middle School	Interior	1	KITCHEN	K002	Light Switch	4	Linear Fluorescent	T8	4' 32W T8; 2x4 Prism Troffer	2	4	8	1,850	237	ECM	RB - Replace Bulb	Wall Mounted	4' 17W LED T8	1,850	126	111
33	Sutter Middle School	Interior	1	KITCHEN	K002	Timer	4	LED	-		4	8	8	1,850				Wall Mounted				
34	Sutter Middle School	Interior	1	RESTROOM	T01K	Light Switch	2	Linear Fluorescent	T8	4' 32W T8; 2x4 Prism Troffer	1	2	8	2,220	142	ECM	RB - Replace Bulb	Wall Mounted	4' 17W LED T8	2,220	75	67
35	Sutter Middle School	Interior	1	RESTROOM	T01K	Light Switch	2	HID	MH	MH100; Cobra Head	1	1	8	2,220	222	ECM	RB - Replace Bulb	Wall Mounted	75W LED Cobra	2,220	167	56
36	Sutter Middle School	Interior	1	RESTROOM	T01K	Light Switch	2	Linear Fluorescent	T8	4' 32W T8; Industrial	1	2	8	2,220	142	ECM	RB - Replace Bulb	Wall Mounted	4' 17W LED T8	2,220	75	67
37	Sutter Middle School	Interior	1	CAFETERIA	U001	Light Switch	6	Linear Fluorescent	T8	4' 32W T8; Industrial	8	16	8	2,220	1,137	ECM	RB - Replace Bulb	Wall Mounted	4' 17W LED T8	2,220	604	533
38	Sutter Middle School	Interior	1	CAFETERIA	U001	Timer	6	LED	-		2	4	8	2,220				Wall Mounted				
39	Sutter Middle School	Interior	1	CAFETERIA	U001	Light Switch	6	Incan/H/MR	Incan	I60-Globe; Ceiling Fan Light Combo	1	1	8	2,220	133	ECM	RB - Replace Bulb	Wall Mounted	11W LED A19	2,220	24	109
40	Sutter Middle School	Interior	1	CAFETERIA	U001	Timer	6	LED	-		1	2	8	2,220				Wall Mounted				
41	Sutter Middle School	Interior	1	CAFETERIA	U001	Timer	6	LED	-		3	6	8	2,220				Wall Mounted				
42	Sutter Middle School	Interior	3	HALLWAY	H295	Timer	2	Linear Fluorescent	T8	4' 32W T8; 2x4 Prism Troffer	64	128	8	2,220	9,093	ECM	RB - Replace Bulb	Ceiling Mounted	4' 17W LED T8	2,220	4,831	4,262
43	Sutter Middle School	Interior	3	STORAGE	J204	Ceiling-Mounted Sensor	1	Linear Fluorescent	T8	4' 32W T8; Industrial	1	2	8	703	45	ECM	RB - Replace Bulb	Retain Existing Controls	4' 17W LED T8	703	24	21
44	Sutter Middle School	Interior	3	RESTROOM	T25B	Light Switch	2	Linear Fluorescent	T8	4' 32W T8; 2x4 Prism Troffer	4	8	10	2,220	568	ECM	RB - Replace Bulb	Wall Mounted	4' 17W LED T8	2,220	302	266
45	Sutter Middle School	Interior	3	JaNITORIAL	J350	Ceiling-Mounted Sensor	1	Linear Fluorescent	T8	4' 32W T8; Industrial	1	2	8	703	45	ECM	RB - Replace Bulb	Retain Existing Controls	4' 17W LED T8	703	24	21
46	Sutter Middle School	Interior	3	RESTROOM	T25G	Light Switch	2	Linear Fluorescent	T8	4' 32W T8; 2x4 Prism Troffer	4	8	10	2,220	568	ECM	RB - Replace Bulb	Wall Mounted	4' 17W LED T8	2,220	302	266
47	Sutter Middle School	Interior	3	CLASSROOM	O209	Ceiling-Mounted Sensor	1	LED	-		20	20	9	1,480				Retain Existing Controls				
48	Sutter Middle School	Interior	3	CLASSROOM	O203	Ceiling-Mounted Sensor	1	LED	-		12	12	9	1,480				Retain Existing Controls				
49	Sutter Middle School	Interior	1	ELEVATOR	Elevator	Timer	1	Linear Fluorescent	T8	4' 32W T8; 2x4 Prism Troffer	1	2	8	6,216	398	ECM	RB - Replace Bulb	Wall Mounted	4' 17W LED T8	6,216	211	186
50	Sutter Middle School	Interior	2	OPEN OFFICE	C110	Ceiling-Mounted Sensor	3	LED	-		24	24	9	2,220				Retain Existing Controls				
51	Sutter Middle School	Interior	2	CONFERENCE ROOM	Z101	Wall-Mounted Sensor	1	LED	-		2	2	9	2,220				Retain Existing Controls				
52	Sutter Middle School	Interior	2	RESTROOM	T12M	Light Switch	1	Linear Fluorescent	T8	4' 32W T8; 2x4 Prism Troffer	1	2	9	2,220	142	ECM	RB - Replace Bulb	Wall Mounted	4' 17W LED T8	2,220	75	67
53	Sutter Middle School	Interior	2	RESTROOM	T12W	Light Switch	1	Linear Fluorescent	T8	4' 32W T8; 2x4 Prism Troffer	1	2	9	2,220	142	ECM	RB - Replace Bulb	Wall Mounted	4' 17W LED T8	2,220	75	67
54	Sutter Middle School	Interior	2	OFFICE	Z103	Wall-Mounted Sensor	2	LED	-		8	8	9	2,220				Retain Existing Controls				
55	Sutter Middle School	Interior	2	OFFICE	C11D	Wall-Mounted Sensor	4	LED	-		4	4	9	2,220				Retain Existing Controls				
56	Sutter Middle School	Interior	2	CAFETERIA	Z102	Wall-Mounted Sensor	1	LED	-		4	4	9	2,220				Retain Existing Controls				
57	Sutter Middle School	Interior	2	RESTROOM - PRIVATE	T102	Light Switch	1	Linear Fluorescent	T8	4' 32W T8; 2x4 Prism Troffer	1	2	9	2,220	142	ECM	RB - Replace Bulb	Wall Mounted	4' 17W LED T8	2,220	75	67
58	Sutter Middle School	Interior	2	STORAGE	O102	Wall-Mounted Sensor	1	LED	-		1	1	9	6,216				Retain Existing Controls				
59	Sutter Middle School	Interior	2	OFFICE	C104	Wall-Mounted Sensor	1	LED	-		2	2	9	2,220				Retain Existing Controls				
60	Sutter Middle School	Interior	2	OFFICE	S014	Wall-Mounted Sensor	1	LED	-		2	2	9	2,220				Retain Existing Controls				
61	Sutter Middle School	Interior	2	STORAGE	S114	Light Switch	1	Linear Fluorescent	T8	4' 32W T8; 2x4 Prism Troffer	1	2	9	703	45	ECM	RB - Replace Bulb	Wall Mounted	4' 17W LED T8	703	24	21
62	Sutter Middle School	Interior	2	STORAGE	S011	Light Switch	2	Linear Fluorescent	T8	4' 32W T8; 2x4 Prism Troffer	2	4	9	703	90	ECM	RB - Replace Bulb	Wall Mounted	4' 17W LED T8	703	48	42
63	Sutter Middle School	Interior	2	STORAGE	S15p	Ceiling-Mounted Sensor	1	Linear Fluorescent	T8	4' 32W T8; Industrial	1	2	9	703	45	ECM	RB - Replace Bulb	Retain Existing Controls	4' 17W LED T8	703	24	21
64	Sutter Middle School	Interior	2	STORAGE	S102	Light Switch	1	Linear Fluorescent	T8	4' 32W T8; 2x4 Prism Troffer	2	4	9	703	90	ECM	RB - Replace Bulb	Wall Mounted	4' 17W LED T8	703	48	42
65	Sutter Middle School	Interior	2	STORAGE	J102	Light Switch	1	Linear Fluorescent	T8	4' 32W T8; 2x4 Prism Troffer	1	3	9	703	67	ECM	RB - Replace Bulb	Wall Mounted	4' 17W LED T8	703	36	32
66	Sutter Middle School	Interior	2	CLASSROOM	O105	Wall-Mounted Sensor	2	LED	-		20	20	10	1,480				Retain Existing Controls				
67	Sutter Middle School	Interior	2	LIBRARY	X106	Wall-Mounted Sensor	2	LED	-		33	33	10	2,220				Retain Existing Controls				
68	Sutter Middle School	Interior	2	OFFICE	S106	Light Switch	2	Linear Fluorescent	T8	4' 32W T8; 2x4 Prism Troffer	2	6	10	2,220	426	ECM	RB - Replace Bulb	Wall Mounted	4' 17W LED T8	2,220	226	200
69	Sutter Middle School	Interior	1	CLASSROOM	112	Wall-Mounted Sensor	1	LED	-		20	20	12	1,480				Retain Existing Controls				
70	Sutter Middle School	Interior	1	CLASSROOM	111	Wall-Mounted Sensor	1	LED	-		20	20	12	1,480				Retain Existing Controls				
71	Sutter Middle School	Interior	1	CLASSROOM	110	Wall-Mounted Sensor	1	LED	-		20	20	10	1,480				Retain Existing Controls				
72	Sutter Middle School	Interior	1	RESTROOM	T01B	Light Switch	1	Linear Fluorescent	T8	4' 32W T8; 2x4 Prism Troffer	2	4	10	2,220	284	ECM	RB - Replace Bulb	Wall Mounted	4' 17W LED T8	2,220	151	133
73	Sutter Middle School	Interior	1	RESTROOM	T01G	Light Switch	1	Linear Fluorescent	T8	4' 32W T8; 2x4 Prism Troffer	2	4	10	2,220	284	ECM	RB - Replace Bulb	Wall Mounted	4' 17W LED T8	2,220	151	133
74	Sutter Middle School	Interior	1	CLASSROOM	110	Light Switch	1	Linear Fluorescent	T8	4' 32W T8; 1x4 Prism Troffer	1	2	8	1,480	95	ECM	RB - Replace Bulb	Retain Existing Controls	4' 17W LED T8	1,480	50	44
75	Sutter Middle School	Interior	1	CLASSROOM	O009	Wall-Mounted Sensor	4	LED	-		32	32	10	1,480				Retain Existing Controls				
76	Sutter Middle School	Interior	1	HALLWAY	H002	Timer	1	Linear Fluorescent	T8	4' 32W T8; 2x4 Prism Troffer	4	12	10	2,220	852	ECM	RB - Replace Bulb	Retain Existing Controls	4' 17W LED T8	2,220	453	400
77	Sutter Middle School	Interior	1	CLASSROOM	O005	Wall-Mounted Sensor	2	LED	-		40	40	10	1,480				Retain Existing Controls				
78	Sutter Middle School	Interior	1	OFFICE	004	Light Switch	1	Linear Fluorescent	T8	4' 32W T8; 2x4 Prism Troffer	1	3	10	2,220	213	ECM	RB - Replace Bulb	Wall Mounted	4' 17W LED T8	2,220	113	100
79	Sutter Middle School	Interior	1	STORAGE	S04B	Timer	5	Linear Fluorescent	T8	4' 32W T8; Industrial	5	10	10	703	225	ECM	RB - Replace Bulb	Ceiling Mounted	4' 17W LED T8	703	120	105
80	Sutter Middle School	Interior	1	RESTROOM	T001	Light Switch	2	Linear Fluorescent	T8	4' 32W T8; 2x4 Prism Troffer	4	8	10	2,220	568	ECM	RB - Replace Bulb	Wall Mounted	4' 17W LED T8	2,220	302	266
81	Sutter Middle School	Interior	1	ResTROOM	Men's Staff Restroom	Timer	1	Linear Fluorescent	T8	4' 32W T8; 2x4 Prism Troffer	2	4	10	2,220	284	ECM	RB - Replace Bulb	Wall Mounted	4' 17W LED T8	2,220	151	133
82	Sutter Middle School	Interior	1	CLASSROOM	O03W	Wall-Mounted Sensor	2	LED	-		24	24	10	1,480				Retain Existing Controls				
83	Sutter Middle School	Interior	1	STORAGE	S03A	Light Switch	1	Linear Fluorescent	T8	4' 32W T8; 2x4 Prism Troffer	1	3	10	703	67	ECM	RB - Replace Bulb	Wall Mounted	4' 17W LED T8	703	36	32

84	Sutter Middle School	Interior	1	STORAGE	S03B	Light Switch	2	Linear Fluorescent	T8	4' 32W T8; Industrial	2	4	10	703	90	ECM	RB - Replace Bulb	Wall Mounted	4' 17W LED T8	703	48	42
85	Sutter Middle School	Interior	1	CLASSROOM	O03W	Timer	2	Linear Fluorescent	T5	4' 28W T5; 2x4 Indirect Troffer	12	24	6	1,480	995	ECM	RB - Replace Bulb	Retain Existing Controls	4' 15W LED T5	1,480	533	462
86	Sutter Middle School	Interior	1	OPEN OFFICE	O002	Wall-Mounted Sensor	1	LED	-		21	21	9	2,220				Retain Existing Controls				
87	Sutter Middle School	Interior	1	OFFICE	C002	Light Switch	1	Linear Fluorescent	T8	4' 32W T8; 2x4 Prism Troffer	1	3	10	2,220	213	ECM	RB - Replace Bulb	Wall Mounted	4' 17W LED T8	2,220	113	100
88	Sutter Middle School	Interior	1	STORAGE	S2WB	Light Switch	2	Linear Fluorescent	T8	4' 32W T8; Industrial	2	4	10	703	90	ECM	RB - Replace Bulb	Wall Mounted	4' 17W LED T8	703	48	42
89	Sutter Middle School	Interior	1	OFFICE	Vice principal	Light Switch	2	Linear Fluorescent	T8	4' 32W T8; 2x4 Prism Troffer	4	12	10	2,220	852	ECM	RB - Replace Bulb	Wall Mounted	4' 17W LED T8	2,220	453	400
90	Sutter Middle School	Interior	1	OFFICE	Counselor	Light Switch	2	Linear Fluorescent	T8	4' 32W T8; 2x4 Prism Troffer	2	6	10	2,220	426	ECM	RB - Replace Bulb	Wall Mounted	4' 17W LED T8	2,220	226	200
91	Sutter Middle School	Interior	1	CLASSROOM	N001	Wall-Mounted Sensor	1	LED	-		35	70	10	1,480				Retain Existing Controls				
92	Sutter Middle School	Interior	1	STORAGE	S01A	Light Switch	1	Linear Fluorescent	T8	4' 32W T8; Industrial	2	4	10	703	90	ECM	RB - Replace Bulb	Wall Mounted	4' 17W LED T8	703	48	42
93	Sutter Middle School	Interior	1	STORAGE	S01B	Light Switch	2	Linear Fluorescent	T8	4' 32W T8; Industrial	2	4	10	703	90	ECM	RB - Replace Bulb	Wall Mounted	4' 17W LED T8	703	48	42
94	Sutter Middle School	Interior	1	OFFICE	Cp01	Light Switch	1	Linear Fluorescent	T8	4' 32W T8; 2x4 Prism Troffer	1	3	10	2,220	213	ECM	RB - Replace Bulb	Wall Mounted	4' 17W LED T8	2,220	113	100
95	Sutter Middle School	Interior	1	CLASSROOM	121	Wall-Mounted Sensor	4	LED	-		48	48	10	1,480				Retain Existing Controls				
96	Sutter Middle School	Interior	1	CLASSROOM	0017	Wall-Mounted Sensor	4	LED	-		40	40	9	1,480				Retain Existing Controls				
97	Sutter Middle School	Exterior	1	HALLWAY	Ext	Timer	1	Linear Fluorescent	T8	4' 32W T8; Strip Fixture	1	1	8	2,220	71	ECM	RB - Replace Bulb	Retain Existing Controls	4' 17W LED T8	2,220	38	33
98	Sutter Middle School	Exterior	1	HALLWAY	Ext	Timer	1	Linear Fluorescent	T8	4' 32W T8; 2x4 Prism Troffer	24	48	8	2,220	3,410	ECM	RB - Replace Bulb	Retain Existing Controls	4' 17W LED T8	2,220	1,812	1,598
99	Sutter Middle School	Exterior	1	HALLWAY	Ext	Timer	1	LED	-		2	2	8	2,220				Retain Existing Controls				
100	Sutter Middle School	Exterior	1	HALLWAY	Ext	Timer	1	LED	-		9	9	8	2,220				Retain Existing Controls				
101	Sutter Middle School	Exterior	1	HALLWAY	Ext	Timer	1	HID	HPS	HPS70; Wallpack-Horizontal	2	2	8	2,220	311	ECM	RF - Replace Entire Fixture	Retain Existing Controls	37W LED Wall Pack	2,220	164	147
102	Sutter Middle School	Exterior	1	HALLWAY	Ext	Timer	1	LED	-		2	2	8	2,220				Retain Existing Controls				
103	Sutter Middle School	Exterior	1	HALLWAY	Ext	Timer	1	HID	HPS	HPS100; Wallpack-Horizontal	10	10	8	2,220	2,220	ECM	RF - Replace Entire Fixture	Retain Existing Controls	37W LED Wall Pack	2,220	821	1,399
	Totals											1,816									39,342	35,288

APPENDIX D:
ECM Checklist

UIC	**Upgrade Building Lighting to LED and Install Automatic Lighting Controls**
EAL10	**Location: Building Interior and Exterior**

	No. of ECMs	No. of Fixtures	No. of Lamps	KWh Saved	Energy Cost Saving	O & M Savings
Upgrade Lighting to LED	66	426	1,008	35,288	$5,437.95	$2,031.68

Existing Technology	**Sub-Technology**	**No. of ECMs**	**No. of Fixtures**	**No. of Lamps**	**KWh Saved**	**Energy Cost Saving**	**O & M Savings**
CFL	CFL - 2 Pin	0	0	0	0	$0	$0
CFL	CFL - 4 Pin	0	0	0	0	$0	$0
CFL	CFL - Screw-in	1	1	1	56	$9	$67
Circiline	T9	0	0	0	0	$0	$0
Incan/H/MR	H	0	0	0	0	$0	$0
Incan/H/MR	Incan	1	1	1	109	$17	$279
Incan/H/MR	MR	0	0	0	0	$0	$0
HID	HPS	2	12	12	1,545	$238	$229
HID	MH	1	1	1	56	$9	$19
HID	MV	0	0	0	0	$0	$0
HID	QL	0	0	0	0	$0	$0
Linear Fluorescent	T8	58	367	367	29,367	$4,525	$1,215
Linear Fluorescent	T12	0	0	0	0	$0	$0
Linear Fluorescent	T8 U	0	0	0	0	$0	$0
Linear Fluorescent	T12 U	0	0	0	0	$0	$0
Linear Fluorescent	T5	3	44	44	4,156	$640	$222
Linear Fluorescent	T6	0	0	0	0	$0	$0
Linear Fluorescent	T10	0	0	0	0	$0	$0

Proposed Controls	**No. of Controls**		**No. of Controls**
Photo Sensor	0	Ceiling Mounted	7
Wall Mounted	109		

Initial Investment		**Equipment Rentals**	
Material Cost	$14,609.13	Scissor Lift 26' - Interior Spaces	$445.00
Labor Cost	$19,629.28	Bucket Truck - Exterior Spaces	$0.00
Local Electric Rate:	$0.15 $/kWh	Estimated Annual Energy Savings:	35,288
Hourly Labor Rate For Electrician:	$82.45	Estimated Annual Energy Cost Savings:	$5,438
Budgeted Initial Investment:	$34,683	Estimated Annual O&M Cost Savings:	$2,032
Estimated Return on Investment: *(Including O&M Savings)*	4.64 Years	Estimated Annual Cost Savings:	$7,470

UIC	Install Variable Frequency Drives (VFD)
EAC4	Location: 003 Admin and Classrooms - AHU

Cost/kWh: **$0.15**

Existing Motor

No. of Motors:	1		Are Motors To be Replaced?	Yes
Individual Motor HP:	10	HP	No. of Motors To be Replaced?	1
Existing Motor Effi:	85.00%		Cost of New Motor (Includes Installation)	$1,507
Proposed Motor Effi:	92.40%		Cost For All New Motors:	$1,507
Load Factor:	85%		No. of VFD To Be Installed:	1
Existing Motor Power:	7.46	kW	Cost Per VFD (Excluding Installation):	$1,775
Proposed Motor Power:	6.86	kW	Estimated Labor cost/VFD:	$1,123
Hrs of Operation/Yr:	2220.00	Hrs		

% Load	% hours	Hours	VFD Factor	Full Load kW	Fraction of full load power (kW) with VFD	kW Reduction with VFD	kWh Savings with VFD
0%	0%	-	-	7.46	0.00	7.46	-
10%	1%	22	0.03	7.46	0.21	7.25	161
20%	2%	44	0.07	7.46	0.48	6.98	310
30%	2%	44	0.13	7.46	0.89	6.57	292
40%	5%	111	0.21	7.46	1.44	6.02	668
50%	15%	333	0.30	7.46	2.06	5.40	1,799
60%	20%	444	0.41	7.46	2.81	4.65	2,063
70%	25%	555	0.54	7.46	3.71	3.75	2,084
80%	15%	333	0.68	7.46	4.67	2.79	930
90%	10%	222	0.83	7.46	5.70	1.76	392
100%	5%	111	1.00	7.46	6.86	0.60	66
Total		**2,220**					**8,764**

Total Installation Cost:	$7,395	
Average kW Reduction:	5.80	
Annual kWh Savings Per Motor:	8,764	kWh
Total Savings From All Motors:	8,764	kWh
Estimated annual cost savings:	$1,350	$$
Simple Payback:	5.48	years
Type of Recommendation	Capital Cost ECM Recommendation	

Number of Valves To Be Converted From 3 Way to 2: 1 *($550/Valve)*

Select Type Of Motor Configuration: Stand Alone Motor

ECM DESCRIPTION

Variable frequency drives (VFD) have the ability to control the frequency and voltage to a motor. The speed of an AC motor depends on frequency and number of poles built into the motor. The number of poles cannot be changed once the motor is manufactured, so the only other way to change the speed is to vary the frequency. The frequency of AC power from a utility cannot be changed. Therefore, the only way to change the frequency of an AC circuit is to 'manufacture' your own AC power.

A VFD does of this by first changing the incoming AC power to DC. This is why changing two of the phases on the line side of a VFD does not change the rotation of the motor. Next, the VFD changes the DC power back into AC, but now the frequency can be easily controlled, as can voltage. This is one way a single phase power source can supply a 3 phase motor. The rate of change in frequency can also be controlled, so a VFD certainly can act as a soft-start.

SUMMARY:

Initial Investment: $7,395 Simple Payback: 5.48

Energy Cost Savings: $1,350

UIC	Re-Commission The Building & Its Control Systems
EAC10	Location: Throughout

Enter the Total Area of The Facility	99,935	SqFt
Select the Type of Heating Fuel:	Natural Gas	*(Select)*
Estimated Annual Heating Fuel Consumption:	6,600	Therms
Is the Property Cooled?	Yes	*(Select)*
Estimated Annual Electrical Energy Consumed For Cooling:	103,000	kWh
Estimated Energy Savings From Re-Commissioning on Building Systems:	15%	*(Select)*
Estimated Heating Energy Saving Post Re-Commissioning:	990	Therms
Estimated Cooling Energy Saving Post Re-Commissioning:	15,450	kWh
Average Heating Fuel Rate Paid By The Property:	$1.37	$/Therm
Average Electrical Rate Paid By The Property:	$0.15	$/kWh
Annual Energy Cost Savings:	$3,734	$
Estimated Cost For Re-Commissioning The Facility: *(LBNL 2009 Report on Building Commissioning)*	$44,748	$
Simple Payback Period:	11.98	Yrs

Type of Recommendation Capital Cost ECM Recommendation

ECM DESCRIPTION

The goal of commissioning of a facility is to ensure that the equipments in the facility are performing as per the desired standards or as per design standards. The role of commissioning in existing buildings is to identify the almost inevitable "drift" from where things should be and puts the things back on track. Based on the LBNL 2009 Report on Building Commissioning the average re-commissioning of existing buildings yielded atleast 16% of energy savings across the facility. This average has been developed based on over 643 buildings that were commissioned across United States in different climatic zones.

Thus EMG strongly recommends re-commissioning of all existing buildings in order to ensure that all the sensors, equipments and control systems are working as per the design conditions.

SUMMARY:

Initial Investment:	$44,748	Simple Payback:	11.98	Years
Energy Cost Savings:	$3,734			

UIC	**Install Low Flow Shower Heads**
EAP1	**Location: Restrooms and Locker Rooms**

Total Number of Shower Heads To Be Replaced		66	
No. of Shower Days/Year		37	
No. of Residents		262	
Estimated Time Per Shower		8.10	Mins
GPM of Existing Shower Head		2.0	GPM
GPM of Proposed Shower Head *	*(Select)*	1.50	GPM

**(Federal Law Requires all new shower heads to have a max flow rate of 2.5 GPM)*

Water & Energy Savings Calculations

Property Location in United States		North Central Localities	
Select Type of Water Heater Fuel	*(Select)*	Natural Gas	
Average Hot Water Discharge Temperature		110.00	°F
Annual Water Savings		39	kGal
Energy Factor of Domesitc Hot Water Heater:		0.90	EF
Equivalent Heating Fuel Energy savings:		21,803	kBtu

Cost Savings Calculations

Equivalent Heating Fuel Savings	Natural Gas	218	Therms
Water Tariff ($/1000 Gal)	$10.53	$/kGal	
Annual Cost Savings In Form of Water		$413	$$
Annual Energy Savings From Water Heater		$298	$$
Estimated Total Annual Cost Savings		$712	$$

Estimated Installation Costs

Estimated Total Installation Cost	$2,092	$$
Simple Payback Period	2.94	Years
Type of Recommendation	Capital Cost ECM Recommendation	

ECM EXPLANATION:

By reducing the flow of water coming off the shower heads, savings can be generated in the form of reduced water and sewer costs. Additional savings can be realized via reduction in the demand for hot water. Currently Federal law requires all new shower heads to have a maximum flow rate of 2.5 GPM.

EMG recommends replacing the existing shower heads with new low flow shower heads as mentioned above. The proposed ECM shall also result in an annual energy saving in form of reduction in water heating bills.

Summary:

Initial Investment:	$2,092	Simple Payback:	2.94
Annual Cost Savings:	$712		

UIC	Install Low Flow Tankless Restroom Fixtures
EAP4	Location: Restrooms

ECM FOR DETERMINING WATER SAVINGS IN COMMERCIAL PROPERTIES

Number of Males	655	
Number of Females	655	
Number of Occupied Days Per Week (Max 7)	5.5	
Number of Occupied Weeks/Year (Max 52)	42	
Number of Urinals To Be Retrofitted	15	
Number of Water Closets To Be Retrofitted	34	
No. of Water Closets With Separate Flush Tank *(Typical Residential Type)*	0	
Estimated Restroom Usage/Individual/Day *Default is 4 Uses/Day For Residential/Office*	2	(Select)

Urinal Water Savings

Do you Want To Make Any Changes To The Urinals?	Yes	
Estimated Existing Use of Urinal/Day/Man	80%	
Existing Gallons Per Flush Ratings For Urinal Flushes	1.00	GPF
Proposed Urinal	0.125 GPF -Wall Mount	
GPF of Proposed Urinal Flush Valve** ***(1992 EpACT Energy Act Mandates 1.0GPF Max on Urinals)*	0.125	GPF
Estimated Annual Water Savings From Urinal	211.83	kGal

Water Closet Water Savings

Tankless Water Closets

Do The Water Closet Need To Be Retrofitted?	*(Select)*	Yes	
Existing Gallons Per Flush Ratings For Water Closet Flushes		1.60	GPF
Are The Existing Water Closet Being Replaced? *(If No; Then Only The Flush Valve Would Be Replaced With Dual Flush Retrofit Kit)*	*(Select)*	No	
No. of Tankless Water Closets		34	
GPF of Proposed Dual Flush- Water Closet Valve* **(Federal Law Requires All Flushes Not To Exceed 1.6 GPF)*	*Solid Waste (20%)*	1.60	GPF
	Liquid Waste (80%)	0.48	GPF
Estimated Annual Water Savings From Male Users		54.23	kGal
Estimated Annual Water Savings From Female Users		271.14	kGal
Total Water Savings From Water Closets		325.37	kGal

Water & Cost Saving Calculations

Water Savings Calculation

Water Savings By The Use of Low Flow Water Closet Flush Valves/Yr	325.37	kgal
Water Savings By The Use of Low Flow Urinal Flush Valves/ Yr	211.83	kgal
Total Annual Water Savings in kgal	537.19	kgal

Cost Savings Calculations

Enter Water Tariff Rate ($/1000Gal)	$10.53	$$
Estimated Cost Savings From Water	$5,657	$$

Estimated Cost of Retrofit

Cost For Replacing Existing Urinal Fixture With A Low Flow Fixture	$19,505 *(Includes Labor)*	$$
Cost For Replacing Existing Flush Valves With Low Flow - Dual Flush Valves ($80 Per Unit) *(Up For Liquid Waste And Down For Solid Waste)*	$21,047 *(Includes Labor)*	$$
Estimated Total Cost For Retrofit	$40,553	$$
Simple Pay Back Period	7.17	Yrs
Type of Recommendation	Capital Cost ECM Recommendation	

ECM EXPLANATION:

The highest water utilization at any home/office occurs in the restrooms. It is estimated that on an average a normal human being uses the restroom at least four times a day. Keeping with the global water conservation objectives, federal law prohibits use of any new water closet flushes over 1.6 GPF. At the same time the '1992 EpACT' mandates all new Urinals to have a maximum 1.0 GPF flush valves on urinals.

EMG recommends replacing all urinals above 1.0 GPF with a new 0.5 GPF or lesser urinals. At the same time EMG also recommends replacing all the water closets having a GPF rating of 1.6 and over with low flow water closet fixtures equipped with dual flush valves.

In case the property doesn't wish to replace the entire water closet fixtures, EMG recommends retrofitting all the tankless water closet flush fixtures with new dual flush fixtures that would result in a 30% water savings per flush for liquid wastes, while retaining the same flush rate for solid wastes.

SUMMARY:

Initial Investment:	$40,553	Simple Payback Period:	7.17 Yrs
Annual Cost Savings:	$5,657		

UIC	Install Low Flow Faucet Aerators
EAP2-b	**Location**: Restrooms and Classrooms

Property Type:	Commercial	Estimated No. of Operational Weeks	35
		Number of Occupied Days/Week (Max 7)	5

KITCHEN FAUCETS			BATHROOM FAUCETS		
Number of Occupants Affected By Retrofit	1,310		Number of Occupants Affected by Retrofit	1,310	
Do You Want To Replace Kitchen Faucets Aerators	Yes	*(Select)*	Do You Want To Replace Bathroom Faucets Aerators	Yes	*(Select)*
Total Number of Faucet Aerators To Be Replaced	18		Total Number of Faucet Aerators To Be Replaced	18	
Total Number of Faucets To Be Replaced:	0		Total Number of Faucets To Be Replaced:	0	
GPM of Existing Faucet Aerators	2.2	GPM	GPM of Existing Faucet Aerators	2.2	GPM
GPM of Proposed Faucet Aerator	0.5	GPM	GPM of Proposed Faucet Aerator	0.5	GPM
Estimated Number of Uses Per Day	1		Estimated Number of Uses Per Day	1	
Annual Water Savings From Installing Low Flow Aerators:			74.83	kGal	

WATER & ENERGY SAVING CALCULATION			COST SAVING CALCULATION		
Select Type of Water Heater Fuel:	Natural Gas	(Select)	Property Location in United States	North Central Localities	
Energy Factor of Domestic Hot Water Heater:	0.90	EF	Heating Fuel Tariff	$1.37	$/Therm
Hot Water Discharge Temperature at Faucet	110.00	°F	Water Tariff ($/1000 Gal)	$10.53	$/kGal
Equivalent Heating Fuel Savings: *Savings Discounted by 15% to Account For Cold Water Use*	354	Therms	Annual Cost Savings In Form of Water	$788	$
Annual Water Savings	74.83	kGal	Annual Energy Savings From Water Heater	$483	$

COST BENEFIT ANALYSIS					
Estimated Total Annual Cost Savings	$1,272	$$	Estimated Total Installation Cost	$548	$$
Simple Payback Period	0.43	Years	*Type of Recommendation*	No/Low Cost ECM Recommendation	

ECM EXPLANATION:

By reducing the flow of water coming from the restroom faucets, aerators can generate energy savings at low cost and with easy installation. The savings generated would be in the form of reduced water and sewer costs and at the same time aerators would save energy by reducing the demand for hot water. The average faucet has a flow rate of about 2 to 4 GPM. Adding a screw-in faucet aerator reduces the flow to 0.5 to 1.5 GPM in the bathroom and 2.2 GPM in the kitchen. In addition to saving energy and water, the "foamier" water that comes from faucet aerators wets objects better than water from a faucet with no aerator, which tends to bounce off the object rather than thoroughly wetting it.

EMG recommends replacing the proposed faucet aerators with new low flow aerators as mentioned above. The proposed ECM shall also result in an annual energy saving in form of reduction in water heating bills.

Summary:

Initial Investment: $548 Estimated Annual Cost Savings: $1,272 Simple Payback Period (Yrs): 0.43

UIC	Install On-Demand Ventilation on Air Handlers
EAC1	Location: Rooftop Air Handlers in Building 002, 003

ENTER EXISTING CONDITION

Estimated Facility Sq.Ft Under Consideration:	74672	Sq.ft	No. of Sensors To Be Installed (One/AHU)	2	Qty
Outside Air Intake CFM (Cubic Feet/Min):	13440.96	CFM	Estimated Savings From On-Demand Ventilation	15%	CFM

WINTER			SUMMER		
Select Type of Heating Fuel	Natural Gas	(Select)	Is The Building Cooled?	Yes	(Select)
Estimated Annual Heating Plant Efficiency *(COP in Case of Heat Pumps Only Max 4.5)*	90.00	%	Estimated Annual Cooling Plant Efficiency (EER)	9.00	EER
Annual Heating Degree Days(HDD):	2,963		Annual Cooling Degree Days(CDD):	1,407	
Estimated Annual Energy Consumed For Heating Outside Air During Winter	1,032,279	kbtu/Yr	Estimated Annual Energy Consumed For Cooling Outside Air During Summer	490,184	kbtu/Yr
Estimated Annual Input Heating Energy Savings By Use of On-Demand Ventilation System	172,046	kbtu/Yr	Estimated Annual Input Cooling Energy Savings By Use of On-Demand Ventilation System	8,170	kbtu/Yr
Estimated Intake Annual Heating Fuel Savings:	1,720	Therms	Estimated Annual Intake Cooling Fuel Savings:	908	kWh
Cost/Unit of Heating Fuel:	$1.37	$/Therm	Cost/Unit For Electricity	$0.15	$$
Estimated Annual Heating Cost Savings	$2,352	$$	Estimated Annual Cooling Cost Savings	$140	$$

COST ANALYSIS

Estimated Annual O&M Savings	$124.60	$$	Estimated Installation Cost (Including Labor)	$1,816	$$
Total Estimated Annual Cost Savings	$2,617	$$	Total Estimated Installation Cost	$3,632	$$
Simple Pay Back Period	1.39	Yrs	*Type of Recommendation*	Capital Cost ECM Recommendation	

ECM DESCRIPTION:

Some buildings are ventilated at a rate in excess of the recommended values. To reduce the energy consumed by the ventilation system, the ventilation rates should be lowered, unless typically high levels of pollutants are being generated. (If human carcinogens or other harmful contaminants are suspected to be present in the occupied space, other relevant standards or guidelines, such as OSHA or NIH, must supersede the listed values.) For spaces with transient or variable occupancy, the quantity of outdoor air should be adjusted by use of dampers, multi-speed ventilation fans, or by duty cycling the system. When contaminants independent of the occupants are generated in the space, the supply of outdoor air should lead occupancy so that acceptable conditions are attained before occupants return. On the other hand, if contaminants are generated solely by the occupants, the supply of outdoor air may lag occupancy. Such control over the ventilation rate can be achieved by installing on demand ventilation system on air-handling units that senses the amount of carbon di-oxide in the return air and modulates the external air flow based on it. In case the CO_2 levels are low, which means the occupancy level in the facility is below normal, hence there doesn't exist, a need to bring in fresh air. This indirectly reduces the load on the air handling unit as it decreases the amount of energy required to condition the outside air. Conversely on detecting a high level of pollutants and carbon di-oxide residue in the return air, the sensor shall modulate to increase the intake of outside air, for compensating the impure air.

SUMMARY:

Initial Investment:	$3,632	Simple Payback (Yrs)	1.39
Energy Cost Savings:	$2,617		

UIC	Install Energy Recovery Wheel on Air Handling Unit
EAH13	Location: 003 Admin and Classrooms

ENTER AHU DETAILS

Supply CFM of the Air Handling Unit:	6,000	CFM	Outside Air Intake Percentage:	18%	
Return CFM of the Air Handling Unit:	5,500	CFM	Base Efficiency Ratio For Enthalpy Wheel:	1.1	
Effectiveness Factor	0.92		Base Efficiency of Energy Recovery Wheel	80%	
Outside Air Intake CFM (Cubic Feet/Min):	1,080	CFM	Net Efficiency of Energy Recovery Wheel	73%	

WINTER			SUMMER		
Select Type of Heating Fuel	Natural Gas	(Select)	Select Type of Cooling Fuel	ELECTRICITY	(Default)
Estimated Annual Heating Plant Efficiency: *(COP in Case of Heat Pumps Only Max 4.5)*	90.00	%	Estimated Annual Cooling Plant Efficiency *(EER)*:	9.00	EER
Annual Runtime Hours During Heating Season:	1464.00		Annual Runtime Hours During Cooling Season:	976.00	
Default Winter Indoor Air Relative Humidity: *(Typically between 25 - 45%)*	40.0	%	Default Summer Indoor Air Relative Humidity: *(Typically between 30 - 60%)*	50.0	%
Average Winter Indoor Temperature *(Return Air)*	69.0	°F	Average Summer Indoor Temperature *(Return Air)*	73.0	°F
Average Outside Air Temperature in Winter:	45.0	°F	Average Outside Air Temperature in Summer:	80.0	°F
Average Winter Outside Air Relative Humidity:	67.0	%	Average Summer Outside Air Relative Humidity:	67.0	%
Pre-heated Supply Air Temperature:	62.6	°F	Pre-cooled Supply Air Temperature:	74.9	°F
Existing Energy Lost Through Exhaust Air:	40,983	kBtu/Yr	Existing Energy Lost Through Exhaust Air:	40,965	kBtu/Yr
Sensible Energy Recovered Via Enthalpy Wheel:	30,193	kbtu/Yr	Energy Recovered Via Enthalpy Wheel:	27,160	kbtu/Yr
Estimated Intake Annual Heating Fuel Savings:	335	Therms	Estimated Annual Cooling Savings:	3,018	kWh

COST ANALYSIS

Cost/Unit of Heating Fuel:	$1.37	$/Therm	Cost/Unit For Electricity	$0.15	$/kWh
Estimated Annual Heating Cost Savings	$459	$	Estimated Annual Cooling Cost Savings	$465	$
			Estimated Installation Cost (Including Labor)	$10,100	
Total Estimated Annual Cost Savings	$924	$			
Type of Recommendation	Capital Cost ECM Recommendation		Simple Pay Back Period	10.94	Yrs

ECM DESCRIPTION:

Air-to-air heat exchangers are devices used to preheat the incoming cold air by transferring heat from the warm exhaust air to the supply air. Similarly, the hot outside air in the summer can be pre-cooled. This reduces the impact of air exchange on the space conditioning loads while maintaining a desirable amount of ventilation. One type of air-to-air heat exchangers devices designed to precondition the supply air is the energy recovery wheel.

A number of air-to-air heat exchanger systems are available. Depending on the specific building application, stand-alone units or central units can be used. Stand-alone units can be installed in windows or walls, but these serve only the immediate areas. Adaptation to internal zones may be difficult. Central units are integrated with the dis-tribution systems. Exhaust and ventilation air for the building are both ducted through the device. The typical heat transfer efficiencies of the heat exchangers range from 60% to 90%. Separate blowers are required to move the air in the intake and exhaust streams. On very cold winter days, frost may form along the path of the exhaust air stream and heaters are often required to either preheat the outdoor air or to defrost heat exchange coils. Some air-to-air heat exchangers have water-permeable surfaces that allow both heat and moisture transfer, recovering both the sensible and the latent heat. However, the disadvantage of such a device is that water-soluble pollutants may transfer back into the fresh air, which defeats the purpose of bringing in ventilated air. Always determine whether cross leakage of air occurs in the system(s) being considered

Summary:

Initial Investment:	$10,100	Simple Payback:	10.94 Yrs
Energy Cost Savings:	$924		

UIC	Control External Air Leakage In Commercial Buildings
EAE4A	Location: Buildings 001, 002 and 004

ENTER EXISTING CONDITION

Insert Existing Estimated Air Change Rate/Hr (ACH 1): *(Existing Air Changes Per Hour, 3 is very leaky and 0.35 ideal)*	0.80	Cubic Feet/Min (CFM 1):	1,259
Insert Proposed Estimated Air Change Rate/Hr (ACH 2):	0.35	Cubic Feet/Min (CFM 2):	551
Estimated Space Volume Under Consideration	94,460.00 Cu.Ft		

WINTER			SUMMER		
Select Type of Heating Fuel	Natural Gas (Select)		Is The Building Cooled?	Yes	
Estimated Annual Heating Plant Efficiency	90.00	%	Estimated Annual Cooling Plant Efficiency	9.00	EER
Annual Heating Degree Days(HDD):	2,963		Annual Cooling Degree Days(CDD):	1,407	
Estimated Total Annual Input Heating Energy Savings	605	Therms	Estimated Total Annual Input Cooling Energy Savings	2,871	kWh
Cost/Unit of Heating Fuel:	$1.37	$/Therm	Cost/Unit For Electricity	$0.15	$$
Estimated Annual Heating Cost Savings	$827	$$	Estimated Annual Cooling Cost Savings	$442	$$

Cost Analysis

Install Flush Mounted, Vinyl Door Sweeps ?	No	Total Length of Door Sweeps to Be Installed: *(3.5' Standard Width Door)*	0	LF
Install Window Air Conditioner Covers For Winter:	No	Number of Air Conditioner Covers To Be Installed: *(Covers would meet HUD Chapter-12 Energ Conservation Compliance Section 329C)*	0	
Estimated Annual O&M Savings	$63	Estimated Length of Joints To Be Re-Caulked: *(Includes Demolition and Re-Caulking)*	2800	LF
Total Estimated Annual Cost Savings	$1,332	Total Cost For Controlling Air Leakage	$11,535	
Simple Pay Back Period	8.66 Yrs	*Type of Recommendation*	Capital Cost ECM Recommendation	

ECM DESCRIPTION:

One of the most commonly used methods for reducing air leakage through building structures is caulking and weather stripping.

Particularly effective measures include caulking cracks around windows and door frames and weather stripping around windows and doors. Weather-stripping and caulking of doors and windows, helps in thermally isolating of the building with the outside atmosphere. This prevents the infiltration of external un-conditioned air along with moisture and humidity into the conditioned space at the same time, prevents the conditioned air from escaping out. A precisely thermally isolated building directly affects the cooling and heating load on the facilities HVAC system as it has to put in less effort in maintaining the desired temperature inside the facility. As per ASHRAE a well insulated and ventilated building should have an air change rate not more than 0.35 per hour.

In order to ensure proper thermal isolation of the property, EMG recommends ensuring that the weather-stripping and caulking of all external doors and windows remains intact. Its also recommended that door sweeps be installed under all the doors opening into conditioned space. Any visible cracks between the window frame and wall should be plugged by caulking.

In case of building with window airconditioners, EMG recommends use of interior/exterior window airconditioner covers so as to prevent cold air drafts into the conditioned space during the winter so as to save on heating costs.

SUMMARY:

Initial Investment:	$11,535	Simple Pay Back Perio	8.66 Yrs
Annual Energy Cost Savings	$1,332		

UIC	Replace External Windows
EAE2	Location: Buildings 001, 002, 004 - Storefront

ENTER EXISTING CONDITIONS

Existing and Proposed Window Properties

Total Sq.Ft window area:	2,800	sq.ft
Approximate number of windows:	230	
Total existing window area:	2,800	Sq.Ft
Select The Existing Window Type	Metal Frame & Single Glazing	*(Select)*
Existing U-value of window: (1/R)	1.31	Btu/ ft²·°F·h
ASHRAE Climatic Zone	Zone-3	
New U-value with Double pane Low E window: (1/R)	0.35	Btu/ ft²·°F·h

AHRAE 90.1 Recommended Value

Existing & Proposed Air Leakage Through Windows

Insert Existing Estimated Air Change Rate/Hr (ACH 1):	1.25	
(Existing Air Changes Per Hour, 1.5 is very leaky and 0.35 ideal)		
Insert Proposed Estimated Air Change Rate/Hr (ACH 2):	0.35	
Estimated Space Volume Under Consideration	188,920.00	Cu. Ft
Is the Property Cooled ?	Yes	*(Select)*

WINTER

Select Type of Heating Fuel	Natural Gas	*(Select)*
Net heating plant & distribution system efficiency:	90.00	%
Annual Heating Hours:	2,963	HDD
Estimated Total Annual Input Heating Energy Savings By Replacing Windows	21.24	Therms
Estimated Total Annual Input Heating Energy Savings Achieved By Controlling Air Leakage Through Windows	2,418	Therms
Estimated Total Input Heating Fuel Savings From Replacing Windows	2,439	Therms

SUMMER

Select Type of Cooling Fuel:	Electric	*(Default)*
Cooling Plant Efficiency **(EER)**:	9.00	EER
Annual Cooling Hours:	1,407	CDD
Annual Total Input Cooling Fuel Savings During Summer Season By Replacing Windows	10,085	kWh
Estimated Total Annual Input Cooling Energy Savings Achieved By Controlling Air Leakage Through Windows	11,483	kWh
Estimated Total Input Cooling Fuel Savings From Replacing Windows	21,568	kWh

ENERGY & COST ANALYSIS

Insert Cost of Heating Fuel:	$1.37	$/Therm
Insert Cost of Cooling Fuel:	$0.15	$/kWh
Total Annual Cost Savings	$6,725	
Cost of window upgrade:	$188,810	
Simple payback:	28.08	Yrs

Annual Heating Cost Savings:	$3,335.25	$$
Annual Cooling Cost Savings:	$3,322.77	$$
Total Annual Cost Savings From Heating & Cooling:	$6,658	$$
Estimated Annual O&M Savings	$67	$
Type of Recommendation	Capital Cost ECM Recommendation	

ECM DESCRIPTION:

Windows play a major role in the energy use and comfort of an interior space. In the winter, heat in a room is lost when cold outside air infiltrates around the edges of windows. Heat also can be lost by conduction directly through the pane, even if the window fits tightly. Windows with insulated panes, such as those filled with Argon address this issue, while proper caulking and sealant address the infiltration issue. The cold drafts and the chilly windowpane make the room uncomfortable. Windows also can help to heat a room by letting the sun's rays enter. While this solar radiation is beneficial in the winter, it can be a major source of discomfort in hot, summer climates. Energy Star rated windows with Low-E glazing are designed to keep the solar heat gain minimized during the summer months. Choosing a replacement window that fits properly has the desired U-value, and proper glazing characteristics is critical to energy conservation through window upgrades.

Summary:

Initial Investment:	$188,810	Simple Payback	28.08 Yrs
Annual Energy Cost Savings:	$6,725		

APPENDIX E:
ECM Calculations

UIC	**Upgrade Building Lighting to LED and Install Automatic Lighting Controls**
EAL10	**Location: Building Interior and Exterior**

	No. of ECMs	No. of Fixtures	No. of Lamps	KWh Saved	Energy Cost Saving	O & M Savings
Upgrade Lighting to LED	66	426	1,008	35,288	$5,437.95	$2,031.68

Existing Technology	**Sub-Technology**	**No. of ECMs**	**No. of Fixtures**	**No. of Lamps**	**KWh Saved**	**Energy Cost Saving**	**O & M Savings**
CFL	CFL - 2 Pin	0	0	0	0	$0	$0
CFL	CFL - 4 Pin	0	0	0	0	$0	$0
CFL	CFL - Screw-in	1	1	1	56	$9	$67
Circiline	T9	0	0	0	0	$0	$0
Incan/H/MR	H	0	0	0	0	$0	$0
Incan/H/MR	Incan	1	1	1	109	$17	$279
Incan/H/MR	MR	0	0	0	0	$0	$0
HID	HPS	2	12	12	1,545	$238	$229
HID	MH	1	1	1	56	$9	$19
HID	MV	0	0	0	0	$0	$0
HID	QL	0	0	0	0	$0	$0
Linear Fluorescent	T8	58	367	367	29,367	$4,525	$1,215
Linear Fluorescent	T12	0	0	0	0	$0	$0
Linear Fluorescent	T8 U	0	0	0	0	$0	$0
Linear Fluorescent	T12 U	0	0	0	0	$0	$0
Linear Fluorescent	T5	3	44	44	4,156	$640	$222
Linear Fluorescent	T6	0	0	0	0	$0	$0
Linear Fluorescent	T10	0	0	0	0	$0	$0

Proposed Controls	**No. of Controls**		**No. of Controls**
Photo Sensor	0	Ceiling Mounted	7
Wall Mounted	109		

Initial Investment		**Equipment Rentals**	
Material Cost	$14,609.13	Scissor Lift 26' - Interior Spaces	$445.00
Labor Cost	$19,629.28	Bucket Truck - Exterior Spaces	$0.00
Local Electric Rate:	$0.15 $/kWh	Estimated Annual Energy Savings:	35,288
Hourly Labor Rate For Electrician:	$82.45	Estimated Annual Energy Cost Savings:	$5,438
Budgeted Initial Investment:	$34,683	Estimated Annual O&M Cost Savings:	$2,032
Estimated Return on Investment: *(Including O&M Savings)*	4.64 Years	Estimated Annual Cost Savings:	$7,470

UIC	Install Variable Frequency Drives (VFD)
EAC4	Location: 003 Admin and Classrooms - AHU

Cost/kWh: **$0.15**

Existing Motor

No. of Motors:	1		Are Motors To be Replaced?	Yes
Individual Motor HP:	10	HP	No. of Motors To be Replaced?	1
Existing Motor Effi:	85.00%		Cost of New Motor (Includes Installation)	$1,507
Proposed Motor Effi:	92.40%		Cost For All New Motors:	$1,507
Load Factor:	85%		No. of VFD To Be Installed:	1
Existing Motor Power:	7.46	kW	Cost Per VFD (Excluding Installation):	$1,775
Proposed Motor Power:	6.86	kW	Estimated Labor cost/VFD:	$1,123
Hrs of Operation/Yr:	2220.00	Hrs		

% Load	% hours	Hours	VFD Factor	Full Load kW	Fraction of full load power (kW) with VFD	kW Reduction with VFD	kWh Savings with VFD
0%	0%	-	-	7.46	0.00	7.46	-
10%	1%	22	0.03	7.46	0.21	7.25	161
20%	2%	44	0.07	7.46	0.48	6.98	310
30%	2%	44	0.13	7.46	0.89	6.57	292
40%	5%	111	0.21	7.46	1.44	6.02	668
50%	15%	333	0.30	7.46	2.06	5.40	1,799
60%	20%	444	0.41	7.46	2.81	4.65	2,063
70%	25%	555	0.54	7.46	3.71	3.75	2,084
80%	15%	333	0.68	7.46	4.67	2.79	930
90%	10%	222	0.83	7.46	5.70	1.76	392
100%	5%	111	1.00	7.46	6.86	0.60	66
Total		**2,220**					**8,764**

Total Installation Cost:	$7,395	
Average kW Reduction:	5.80	
Annual kWh Savings Per Motor:	8,764	kWh
Total Savings From All Motors:	8,764	kWh
Estimated annual cost savings:	$1,350	$$
Simple Payback:	5.48	years
Type of Recommendation	Capital Cost ECM Recommendation	

Number of Valves To Be Converted From 3 Way to 2: 1 *($550/Valve)*

Select Type Of Motor Configuration: Stand Alone Motor

ECM DESCRIPTION

Variable frequency drives (VFD) have the ability to control the frequency and voltage to a motor. The speed of an AC motor depends on frequency and number of poles built into the motor. The number of poles cannot be changed once the motor is manufactured, so the only other way to change the speed is to vary the frequency. The frequency of AC power from a utility cannot be changed. Therefore, the only way to change the frequency of an AC circuit is to 'manufacture' your own AC power.

A VFD does of this by first changing the incoming AC power to DC. This is why changing two of the phases on the line side of a VFD does not change the rotation of the motor. Next, the VFD changes the DC power back into AC, but now the frequency can be easily controlled, as can voltage. This is one way a single phase power source can supply a 3 phase motor. The rate of change in frequency can also be controlled, so a VFD certainly can act as a soft-start.

SUMMARY:

Initial Investment: $7,395 Simple Payback: 5.48

Energy Cost Savings: $1,350

UIC	Re-Commission The Building & Its Control Systems
EAC10	Location: Throughout

Enter the Total Area of The Facility	99,935	SqFt
Select the Type of Heating Fuel:	Natural Gas	*(Select)*
Estimated Annual Heating Fuel Consumption:	6,600	Therms
Is the Property Cooled?	Yes	*(Select)*
Estimated Annual Electrical Energy Consumed For Cooling:	103,000	kWh
Estimated Energy Savings From Re-Commissioning on Building Systems:	15%	*(Select)*
Estimated Heating Energy Saving Post Re-Commissioning:	990	Therms
Estimated Cooling Energy Saving Post Re-Commissioning:	15,450	kWh
Average Heating Fuel Rate Paid By The Property:	$1.37	$/Therm
Average Electrical Rate Paid By The Property:	$0.15	$/kWh
Annual Energy Cost Savings:	$3,734	$
Estimated Cost For Re-Commissioning The Facility: *(LBNL 2009 Report on Building Commissioning)*	$44,748	$
Simple Payback Period:	11.98	Yrs

Type of Recommendation Capital Cost ECM Recommendation

ECM DESCRIPTION

The goal of commissioning of a facility is to ensure that the equipments in the facility are performing as per the desired standards or as per design standards. The role of commissioning in existing buildings is to identify the almost inevitable "drift" from where things should be and puts the things back on track. Based on the LBNL 2009 Report on Building Commissioning the average re-commissioning of existing buildings yielded atleast 16% of energy savings across the facility. This average has been developed based on over 643 buildings that were commissioned across United States in different climatic zones.

Thus EMG strongly recommends re-commissioning of all existing buildings in order to ensure that all the sensors, equipments and control systems are working as per the design conditions.

SUMMARY:

Initial Investment:	$44,748	Simple Payback:	11.98	Years
Energy Cost Savings:	$3,734			

UIC	**Install Low Flow Shower Heads**
EAP1	**Location: Restrooms and Locker Rooms**

Total Number of Shower Heads To Be Replaced		66	
No. of Shower Days/Year		37	
No. of Residents		262	
Estimated Time Per Shower		8.10	Mins
GPM of Existing Shower Head		2.0	GPM
GPM of Proposed Shower Head *	*(Select)*	1.50	GPM

**(Federal Law Requires all new shower heads to have a max flow rate of 2.5 GPM)*

Water & Energy Savings Calculations

Property Location in United States		North Central Localities	
Select Type of Water Heater Fuel	*(Select)*	Natural Gas	
Average Hot Water Discharge Temperature		110.00	°F
Annual Water Savings		39	kGal
Energy Factor of Domesitc Hot Water Heater:		0.90	EF
Equivalent Heating Fuel Energy savings:		21,803	kBtu

Cost Savings Calculations

Equivalent Heating Fuel Savings	Natural Gas	218	Therms
Water Tariff ($/1000 Gal)	$10.53	$/kGal	
Annual Cost Savings In Form of Water		$413	$$
Annual Energy Savings From Water Heater		$298	$$
Estimated Total Annual Cost Savings		$712	$$

Estimated Installation Costs

Estimated Total Installation Cost	$2,092	$$
Simple Payback Period	2.94	Years
Type of Recommendation	Capital Cost ECM Recommendation	

ECM EXPLANATION:

By reducing the flow of water coming off the shower heads, savings can be generated in the form of reduced water and sewer costs. Additional savings can be realized via reduction in the demand for hot water. Currently Federal law requires all new shower heads to have a maximum flow rate of 2.5 GPM.

EMG recommends replacing the existing shower heads with new low flow shower heads as mentioned above. The proposed ECM shall also result in an annual energy saving in form of reduction in water heating bills.

Summary:

Initial Investment:	$2,092	Simple Payback:	2.94
Annual Cost Savings:	$712		

UIC	Install Low Flow Tankless Restroom Fixtures
EAP4	Location: Restrooms

ECM FOR DETERMINING WATER SAVINGS IN COMMERCIAL PROPERTIES

Number of Males	655	
Number of Females	655	
Number of Occupied Days Per Week (Max 7)	5.5	
Number of Occupied Weeks/Year (Max 52)	42	
Number of Urinals To Be Retrofitted	15	
Number of Water Closets To Be Retrofitted	34	
No. of Water Closets With Separate Flush Tank *(Typical Residential Type)*	0	
Estimated Restroom Usage/Individual/Day *Default is 4 Uses/Day For Residential/Office*	2	(Select)

Urinal Water Savings

Do you Want To Make Any Changes To The Urinals?	Yes	
Estimated Existing Use of Urinal/Day/Man	80%	
Existing Gallons Per Flush Ratings For Urinal Flushes	1.00	GPF
Proposed Urinal	0.125 GPF -Wall Mount	
GPF of Proposed Urinal Flush Valve** ***(1992 EpACT Energy Act Mandates 1.0GPF Max on Urinals)*	0.125	GPF
Estimated Annual Water Savings From Urinal	211.83	kGal

Water Closet Water Savings

Tankless Water Closets

Do The Water Closet Need To Be Retrofitted?	*(Select)*	Yes	
Existing Gallons Per Flush Ratings For Water Closet Flushes		1.60	GPF
Are The Existing Water Closet Being Replaced? *(If No; Then Only The Flush Valve Would Be Replaced With Dual Flush Retrofit Kit)*	*(Select)*	No	
No. of Tankless Water Closets		34	
GPF of Proposed Dual Flush- Water Closet Valve* **(Federal Law Requires All Flushes Not To Exceed 1.6 GPF)*	*Solid Waste (20%)*	1.60	GPF
	Liquid Waste (80%)	0.48	GPF
Estimated Annual Water Savings From Male Users		54.23	kGal
Estimated Annual Water Savings From Female Users		271.14	kGal
Total Water Savings From Water Closets		325.37	kGal

Water & Cost Saving Calculations

Water Savings Calculation

Water Savings By The Use of Low Flow Water Closet Flush Valves/Yr	325.37	kgal
Water Savings By The Use of Low Flow Urinal Flush Valves/ Yr	211.83	kgal
Total Annual Water Savings in kgal	537.19	kgal

Cost Savings Calculations

Enter Water Tariff Rate ($/1000Gal)	$10.53	$$
Estimated Cost Savings From Water	$5,657	$$

Estimated Cost of Retrofit

Cost For Replacing Existing Urinal Fixture With A Low Flow Fixture	$19,505 *(Includes Labor)*	$$
Cost For Replacing Existing Flush Valves With Low Flow - Dual Flush Valves ($80 Per Unit) *(Up For Liquid Waste And Down For Solid Waste)*	$21,047 *(Includes Labor)*	$$
Estimated Total Cost For Retrofit	$40,553	$$
Simple Pay Back Period	7.17	Yrs
Type of Recommendation	Capital Cost ECM Recommendation	

ECM EXPLANATION:

The highest water utilization at any home/office occurs in the restrooms. It is estimated that on an average a normal human being uses the restroom at least four times a day. Keeping with the global water conservation objectives, federal law prohibits use of any new water closet flushes over 1.6 GPF. At the same time the '1992 EpACT' mandates all new Urinals to have a maximum 1.0 GPF flush valves on urinals.

EMG recommends replacing all urinals above 1.0 GPF with a new 0.5 GPF or lesser urinals. At the same time EMG also recommends replacing all the water closets having a GPF rating of 1.6 and over with low flow water closet fixtures equipped with dual flush valves.

In case the property doesn't wish to replace the entire water closet fixtures, EMG recommends retrofitting all the tankless water closet flush fixtures with new dual flush fixtures that would result in a 30% water savings per flush for liquid wastes, while retaining the same flush rate for solid wastes.

SUMMARY:

Initial Investment:	$40,553	Simple Payback Period:	7.17 Yrs
Annual Cost Savings:	$5,657		

UIC	Install Low Flow Faucet Aerators
EAP2-b	**Location**: Restrooms and Classrooms

Property Type:	Commercial	Estimated No. of Operational Weeks	35
		Number of Occupied Days/Week (Max 7)	5

KITCHEN FAUCETS			BATHROOM FAUCETS		
Number of Occupants Affected By Retrofit	1,310		Number of Occupants Affected by Retrofit	1,310	
Do You Want To Replace Kitchen Faucets Aerators	Yes	*(Select)*	Do You Want To Replace Bathroom Faucets Aerators	Yes	*(Select)*
Total Number of Faucet Aerators To Be Replaced	18		Total Number of Faucet Aerators To Be Replaced	18	
Total Number of Faucets To Be Replaced:	0		Total Number of Faucets To Be Replaced:	0	
GPM of Existing Faucet Aerators	2.2	GPM	GPM of Existing Faucet Aerators	2.2	GPM
GPM of Proposed Faucet Aerator	0.5	GPM	GPM of Proposed Faucet Aerator	0.5	GPM
Estimated Number of Uses Per Day	1		Estimated Number of Uses Per Day	1	
Annual Water Savings From Installing Low Flow Aerators:			74.83	kGal	

WATER & ENERGY SAVING CALCULATION			COST SAVING CALCULATION		
Select Type of Water Heater Fuel:	Natural Gas	(Select)	Property Location in United States	North Central Localities	
Energy Factor of Domestic Hot Water Heater:	0.90	EF	Heating Fuel Tariff	$1.37	$/Therm
Hot Water Discharge Temperature at Faucet	110.00	°F	Water Tariff ($/1000 Gal)	$10.53	$/kGal
Equivalent Heating Fuel Savings: *Savings Discounted by 15% to Account For Cold Water Use*	354	Therms	Annual Cost Savings In Form of Water	$788	$
Annual Water Savings	74.83	kGal	Annual Energy Savings From Water Heater	$483	$

COST BENEFIT ANALYSIS					
Estimated Total Annual Cost Savings	$1,272	$$	Estimated Total Installation Cost	$548	$$
Simple Payback Period	0.43	Years	*Type of Recommendation*	No/Low Cost ECM Recommendation	

ECM EXPLANATION:

By reducing the flow of water coming from the restroom faucets, aerators can generate energy savings at low cost and with easy installation. The savings generated would be in the form of reduced water and sewer costs and at the same time aerators would save energy by reducing the demand for hot water. The average faucet has a flow rate of about 2 to 4 GPM. Adding a screw-in faucet aerator reduces the flow to 0.5 to 1.5 GPM in the bathroom and 2.2 GPM in the kitchen. In addition to saving energy and water, the "foamier" water that comes from faucet aerators wets objects better than water from a faucet with no aerator, which tends to bounce off the object rather than thoroughly wetting it.

EMG recommends replacing the proposed faucet aerators with new low flow aerators as mentioned above. The proposed ECM shall also result in an annual energy saving in form of reduction in water heating bills.

Summary:

Initial Investment: $548 Estimated Annual Cost Savings: $1,272 Simple Payback Period (Yrs): 0.43

UIC	Install On-Demand Ventilation on Air Handlers
EAC1	Location: Rooftop Air Handlers in Building 002, 003

ENTER EXISTING CONDITION

Estimated Facility Sq.Ft Under Consideration:	74672	Sq.ft	No. of Sensors To Be Installed (One/AHU)	2	Qty
Outside Air Intake CFM (Cubic Feet/Min):	13440.96	CFM	Estimated Savings From On-Demand Ventilation	15%	CFM

WINTER			SUMMER		
Select Type of Heating Fuel	Natural Gas	(Select)	Is The Building Cooled?	Yes	(Select)
Estimated Annual Heating Plant Efficiency *(COP in Case of Heat Pumps Only Max 4.5)*	90.00	%	Estimated Annual Cooling Plant Efficiency (EER)	9.00	EER
Annual Heating Degree Days(HDD):	2,963		Annual Cooling Degree Days(CDD):	1,407	
Estimated Annual Energy Consumed For Heating Outside Air During Winter	1,032,279	kbtu/Yr	Estimated Annual Energy Consumed For Cooling Outside Air During Summer	490,184	kbtu/Yr
Estimated Annual Input Heating Energy Savings By Use of On-Demand Ventilation System	172,046	kbtu/Yr	Estimated Annual Input Cooling Energy Savings By Use of On-Demand Ventilation System	8,170	kbtu/Yr
Estimated Intake Annual Heating Fuel Savings:	1,720	Therms	Estimated Annual Intake Cooling Fuel Savings:	908	kWh
Cost/Unit of Heating Fuel:	$1.37	$/Therm	Cost/Unit For Electricity	$0.15	$$
Estimated Annual Heating Cost Savings	$2,352	$$	Estimated Annual Cooling Cost Savings	$140	$$

COST ANALYSIS

Estimated Annual O&M Savings	$124.60	$$	Estimated Installation Cost (Including Labor)	$1,816	$$
Total Estimated Annual Cost Savings	$2,617	$$	Total Estimated Installation Cost	$3,632	$$
Simple Pay Back Period	1.39	Yrs	*Type of Recommendation*	Capital Cost ECM Recommendation	

ECM DESCRIPTION:

Some buildings are ventilated at a rate in excess of the recommended values. To reduce the energy consumed by the ventilation system, the ventilation rates should be lowered, unless typically high levels of pollutants are being generated. (If human carcinogens or other harmful contaminants are suspected to be present in the occupied space, other relevant standards or guidelines, such as OSHA or NIH, must supersede the listed values.) For spaces with transient or variable occupancy, the quantity of outdoor air should be adjusted by use of dampers, multi-speed ventilation fans, or by duty cycling the system. When contaminants independent of the occupants are generated in the space, the supply of outdoor air should lead occupancy so that acceptable conditions are attained before occupants return. On the other hand, if contaminants are generated solely by the occupants, the supply of outdoor air may lag occupancy. Such control over the ventilation rate can be achieved by installing on demand ventilation system on air-handling units that senses the amount of carbon di-oxide in the return air and modulates the external air flow based on it. In case the CO_2 levels are low, which means the occupancy level in the facility is below normal, hence there doesn't exist, a need to bring in fresh air. This indirectly reduces the load on the air handling unit as it decreases the amount of energy required to condition the outside air. Conversely on detecting a high level of pollutants and carbon di-oxide residue in the return air, the sensor shall modulate to increase the intake of outside air, for compensating the impure air.

SUMMARY:

Initial Investment:	$3,632	Simple Payback (Yrs)	1.39
Energy Cost Savings:	$2,617		

UIC	Install Energy Recovery Wheel on Air Handling Unit
EAH13	Location: 003 Admin and Classrooms

ENTER AHU DETAILS

Supply CFM of the Air Handling Unit:	6,000	CFM	Outside Air Intake Percentage:	18%	
Return CFM of the Air Handling Unit:	5,500	CFM	Base Efficiency Ratio For Enthalpy Wheel:	1.1	
Effectiveness Factor	0.92		Base Efficiency of Energy Recovery Wheel	80%	
Outside Air Intake CFM (Cubic Feet/Min):	1,080	CFM	Net Efficiency of Energy Recovery Wheel	73%	

WINTER			SUMMER		
Select Type of Heating Fuel	Natural Gas	(Select)	Select Type of Cooling Fuel	ELECTRICITY	(Default)
Estimated Annual Heating Plant Efficiency: *(COP in Case of Heat Pumps Only Max 4.5)*	90.00	%	Estimated Annual Cooling Plant Efficiency *(EER)*:	9.00	EER
Annual Runtime Hours During Heating Season:	1464.00		Annual Runtime Hours During Cooling Season:	976.00	
Default Winter Indoor Air Relative Humidity: *(Typically between 25 - 45%)*	40.0	%	Default Summer Indoor Air Relative Humidity: *(Typically between 30 - 60%)*	50.0	%
Average Winter Indoor Temperature *(Return Air)*	69.0	°F	Average Summer Indoor Temperature *(Return Air)*	73.0	°F
Average Outside Air Temperature in Winter:	45.0	°F	Average Outside Air Temperature in Summer:	80.0	°F
Average Winter Outside Air Relative Humidity:	67.0	%	Average Summer Outside Air Relative Humidity:	67.0	%
Pre-heated Supply Air Temperature:	62.6	°F	Pre-cooled Supply Air Temperature:	74.9	°F
Existing Energy Lost Through Exhaust Air:	40,983	kBtu/Yr	Existing Energy Lost Through Exhaust Air:	40,965	kBtu/Yr
Sensible Energy Recovered Via Enthalpy Wheel:	30,193	kbtu/Yr	Energy Recovered Via Enthalpy Wheel:	27,160	kbtu/Yr
Estimated Intake Annual Heating Fuel Savings:	335	Therms	Estimated Annual Cooling Savings:	3,018	kWh

COST ANALYSIS

Cost/Unit of Heating Fuel:	$1.37	$/Therm	Cost/Unit For Electricity	$0.15	$/kWh
Estimated Annual Heating Cost Savings	$459	$	Estimated Annual Cooling Cost Savings	$465	$
			Estimated Installation Cost (Including Labor)	$10,100	
Total Estimated Annual Cost Savings	$924	$			
Type of Recommendation	Capital Cost ECM Recommendation		Simple Pay Back Period	10.94	Yrs

ECM DESCRIPTION:

Air-to-air heat exchangers are devices used to preheat the incoming cold air by transferring heat from the warm exhaust air to the supply air. Similarly, the hot outside air in the summer can be pre-cooled. This reduces the impact of air exchange on the space conditioning loads while maintaining a desirable amount of ventilation. One type of air-to-air heat exchangers devices designed to precondition the supply air is the energy recovery wheel.

A number of air-to-air heat exchanger systems are available. Depending on the specific building application, stand-alone units or central units can be used. Stand-alone units can be installed in windows or walls, but these serve only the immediate areas. Adaptation to internal zones may be difficult. Central units are integrated with the dis-tribution systems. Exhaust and ventilation air for the building are both ducted through the device. The typical heat transfer efficiencies of the heat exchangers range from 60% to 90%. Separate blowers are required to move the air in the intake and exhaust streams. On very cold winter days, frost may form along the path of the exhaust air stream and heaters are often required to either preheat the outdoor air or to defrost heat exchange coils. Some air-to-air heat exchangers have water-permeable surfaces that allow both heat and moisture transfer, recovering both the sensible and the latent heat. However, the disadvantage of such a device is that water-soluble pollutants may transfer back into the fresh air, which defeats the purpose of bringing in ventilated air. Always determine whether cross leakage of air occurs in the system(s) being considered

Summary:

Initial Investment:	$10,100	Simple Payback:	10.94 Yrs
Energy Cost Savings:	$924		

UIC	Control External Air Leakage In Commercial Buildings
EAE4A	Location: Buildings 001, 002 and 004

ENTER EXISTING CONDITION

Insert Existing Estimated Air Change Rate/Hr (ACH 1): *(Existing Air Changes Per Hour, 3 is very leaky and 0.35 ideal)*	0.80	Cubic Feet/Min (CFM 1):	1,259
Insert Proposed Estimated Air Change Rate/Hr (ACH 2):	0.35	Cubic Feet/Min (CFM 2):	551
Estimated Space Volume Under Consideration	94,460.00 Cu.Ft		

WINTER			SUMMER		
Select Type of Heating Fuel	Natural Gas (Select)		Is The Building Cooled?	Yes	
Estimated Annual Heating Plant Efficiency	90.00	%	Estimated Annual Cooling Plant Efficiency	9.00	EER
Annual Heating Degree Days(HDD):	2,963		Annual Cooling Degree Days(CDD):	1,407	
Estimated Total Annual Input Heating Energy Savings	605	Therms	Estimated Total Annual Input Cooling Energy Savings	2,871	kWh
Cost/Unit of Heating Fuel:	$1.37	$/Therm	Cost/Unit For Electricity	$0.15	$$
Estimated Annual Heating Cost Savings	$827	$$	Estimated Annual Cooling Cost Savings	$442	$$

Cost Analysis

Install Flush Mounted, Vinyl Door Sweeps ?	No	Total Length of Door Sweeps to Be Installed: *(3.5' Standard Width Door)*	0	LF
Install Window Air Conditioner Covers For Winter:	No	Number of Air Conditioner Covers To Be Installed: *(Covers would meet HUD Chapter-12 Energ Conservation Compliance Section 329C)*	0	
Estimated Annual O&M Savings	$63	Estimated Length of Joints To Be Re-Caulked: *(Includes Demolition and Re-Caulking)*	2800	LF
Total Estimated Annual Cost Savings	$1,332	Total Cost For Controlling Air Leakage	$11,535	
Simple Pay Back Period	8.66 Yrs	*Type of Recommendation*	Capital Cost ECM Recommendation	

ECM DESCRIPTION:

One of the most commonly used methods for reducing air leakage through building structures is caulking and weather stripping.

Particularly effective measures include caulking cracks around windows and door frames and weather stripping around windows and doors. Weather-stripping and caulking of doors and windows, helps in thermally isolating of the building with the outside atmosphere. This prevents the infiltration of external un-conditioned air along with moisture and humidity into the conditioned space at the same time, prevents the conditioned air from escaping out. A precisely thermally isolated building directly affects the cooling and heating load on the facilities HVAC system as it has to put in less effort in maintaining the desired temperature inside the facility. As per ASHRAE a well insulated and ventilated building should have an air change rate not more than 0.35 per hour.

In order to ensure proper thermal isolation of the property, EMG recommends ensuring that the weather-stripping and caulking of all external doors and windows remains intact. Its also recommended that door sweeps be installed under all the doors opening into conditioned space. Any visible cracks between the window frame and wall should be plugged by caulking.

In case of building with window airconditioners, EMG recommends use of interior/exterior window airconditioner covers so as to prevent cold air drafts into the conditioned space during the winter so as to save on heating costs.

SUMMARY:

Initial Investment:	$11,535	Simple Pay Back Perio	8.66 Yrs
Annual Energy Cost Savings	$1,332		

UIC	Replace External Windows
EAE2	Location: Buildings 001, 002, 004 - Storefront

ENTER EXISTING CONDITIONS

Existing and Proposed Window Properties

Total Sq.Ft window area:	2,800	sq.ft
Approximate number of windows:	230	
Total existing window area:	2,800	Sq.Ft
Select The Existing Window Type	Metal Frame & Single Glazing	*(Select)*
Existing U-value of window: (1/R)	1.31	Btu/ ft²·°F·h
ASHRAE Climatic Zone	Zone-3	
New U-value with Double pane Low E window: (1/R)	0.35	Btu/ ft²·°F·h

AHRAE 90.1 Recommended Value

Existing & Proposed Air Leakage Through Windows

Insert Existing Estimated Air Change Rate/Hr (ACH 1):	1.25	
(Existing Air Changes Per Hour, 1.5 is very leaky and 0.35 ideal)		
Insert Proposed Estimated Air Change Rate/Hr (ACH 2):	0.35	
Estimated Space Volume Under Consideration	188,920.00	Cu. Ft
Is the Property Cooled ?	Yes	*(Select)*

WINTER

Select Type of Heating Fuel	Natural Gas	*(Select)*
Net heating plant & distribution system efficiency:	90.00	%
Annual Heating Hours:	2,963	HDD
Estimated Total Annual Input Heating Energy Savings By Replacing Windows	21.24	Therms
Estimated Total Annual Input Heating Energy Savings Achieved By Controlling Air Leakage Through Windows	2,418	Therms
Estimated Total Input Heating Fuel Savings From Replacing Windows	2,439	Therms

SUMMER

Select Type of Cooling Fuel:	Electric	*(Default)*
Cooling Plant Efficiency **(EER)**:	9.00	EER
Annual Cooling Hours:	1,407	CDD
Annual Total Input Cooling Fuel Savings During Summer Season By Replacing Windows	10,085	kWh
Estimated Total Annual Input Cooling Energy Savings Achieved By Controlling Air Leakage Through Windows	11,483	kWh
Estimated Total Input Cooling Fuel Savings From Replacing Windows	21,568	kWh

ENERGY & COST ANALYSIS

Insert Cost of Heating Fuel:	$1.37	$/Therm
Insert Cost of Cooling Fuel:	$0.15	$/kWh
Total Annual Cost Savings	$6,725	
Cost of window upgrade:	$188,810	
Simple payback:	28.08	Yrs

Annual Heating Cost Savings:	$3,335.25	$$
Annual Cooling Cost Savings:	$3,322.77	$$
Total Annual Cost Savings From Heating & Cooling:	$6,658	$$
Estimated Annual O&M Savings	$67	$
Type of Recommendation	Capital Cost ECM Recommendation	

ECM DESCRIPTION:

Windows play a major role in the energy use and comfort of an interior space. In the winter, heat in a room is lost when cold outside air infiltrates around the edges of windows. Heat also can be lost by conduction directly through the pane, even if the window fits tightly. Windows with insulated panes, such as those filled with Argon address this issue, while proper caulking and sealant address the infiltration issue. The cold drafts and the chilly windowpane make the room uncomfortable. Windows also can help to heat a room by letting the sun's rays enter. While this solar radiation is beneficial in the winter, it can be a major source of discomfort in hot, summer climates. Energy Star rated windows with Low-E glazing are designed to keep the solar heat gain minimized during the summer months. Choosing a replacement window that fits properly has the desired U-value, and proper glazing characteristics is critical to energy conservation through window upgrades.

Summary:

Initial Investment:	$188,810	Simple Payback	28.08 Yrs
Annual Energy Cost Savings:	$6,725		

APPENDIX F:
Solar PV

UIC	Install Fixed Tilt Solar Photovoltaic System
EAR-2	Details: Sutter Middle School

Select State: Northern California **Electric Rate:** **$0.15** $/KWH Annual Electric Consumption: 515,354 KWh

Roof No.	Description	Number of Roofs	DC System Size Per Roof	PV System Sizing For All Roofs	Estimated Number of 315 Watt PV Panels:	Total Estimated Annual Electricity Generated/ Roof	Total Estimated Electricity Generated (All Roofs)	Total Cost Savings	Installation Cost: ($3.5/Watt)	Simple Pay Back Period without Incentives	One Time Potential Utility or State Incentives	One Time Potential Federal Incentives	Annual Potential Incentives and Rebates		Simple Pay Back Period with All Incentives
			kW	kW		kWh	kWh			Yrs		Dept. of Treasury Renewable Grant (30%)	Federal REPI Incentive	Solar Renewable Certificates (SRECS)- (~$0/MWH)	Years
												30%	$0.02	$0	
1	Building 1	1	52.70	53	167	80,899	80,899	$12,463	$184,450	14.8	$0	$55,335	$1,780	$0	8.9
2	Building 2	1	21	21	68	32,697	32,697	$5,037	$74,550	14.8	$0	$22,365	$719	$0	8.9
3	Building 3	1	15	15	46	22,412	22,412	$3,453	$51,100	14.8	$0	$15,330	$493	$0	8.9
4	Building 4	1	28	28	90	43,443	43,443	$6,693	$99,050	14.8	$0	$29,715	$956	$0	8.9
5	Building 5	1	22	22	70	34,079	34,079	$5,250	$77,700	14.8	$0	$23,310	$750	$0	8.9
		5		**139**	**442**	**213,530.0**	**213,530**	**$32,896**	**$486,850**	**14.80**	**$0**	**$146,055**	**$4,698**	**$0**	**8.93**

Solar Rooftop Photovoltaic Analysis		
Total Number of Roofs	5	
Estimated Number of Panels	442	
Estimated KW Rating	139	KW
Potential Annual KWh Produced	213,530	KWh
% of Current Electricity Load	41.4%	

Financial Analysis		
Investment Cost	$486,850	
Estimated Energy Cost Savings	$32,896	
Potential Rebates	$146,055	
Potential Annual Incentives	$4,698	
Payback without Incentives	14.8	years
Incentive Payback but without SRECS	8.9	years
Payback with All Incentives	8.9	years