LEVEL II ENERGY AUDIT

SACRAMENTO CITY UNIFIED SCHOOL DISTRICT
5735 47th Avenue
Sacramento, California 95824

DLR GROUP
1050 20th Street, Suite 250
Sacramento, California 95972

ZERO NET ENERGY ASHRAE LEVEL II AUDIT

FATHER KEITH B. KENNY SCHOOL

3525 Martin L. King Jr. Boulevard

Sacramento, California 95817

PREPARED BY:
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EMG PROJECT #:

136988.19R000-072.268

DATE OF REPORT:

October 7, 2019

ONSITE DATE:

September 23-24, 2019

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Certification

EMG has completed an Energy Audit of Father Keith B. Kenny School located at Prop A in Sacramento, California 95817. EMG visited the site on September 23-24, 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 95817. Since actual installed costs may vary widely for particular installation based on labor and 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 Father Keith B. Kenny 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 and 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.

Building #	Structures Assessed	Building Type	EMG Calculated Area (SF)	Estimated Occupancy
1	Building 001	School Building	6,680	50
2	Building 002	School Building	6,678	50
3	Building 003	School Building	12,364	100
4	Building 004	School Building	6,679	50
5	Building 005	School Building	9,783	91
6	Building 006	Restrooms	560	10
7	Building 007	Restrooms	560	10
8	P01	Portable School Building	960	15
9	P02	Portable School Building	960	15
10	P03	Portable School Building	1,440	20

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 seven 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)*	$104,526 *(In Current Dollars)*
Estimated Annual Cost Savings *(Current Dollars Only)*	$13,784 *(In Current Dollars)*
ECM Effective Payback	7.58 years

Item	Estimate
Estimated Annual Energy Savings	15.2%
Estimated Annual Energy Utility Cost Savings *(Excluding Water)*	11.52%
Estimated Annual Water Cost Saving	47.05%

Solar Photovoltaic (PV) Screening for FATHER KEITH B. KENNY SCHOOL

Solar Rooftop Photovoltaic Analysis		
Estimated Number of Panels	267	
Estimated KW Rating	84	KW
Potential Annual kWh Produced	140,194	kWh
% of Current Electricity Uses	35.5%	
Financial Summary		
Investment Cost	$294,350	
Estimated Energy Cost Savings	$21,338	
Payback without Incentives	13.8	Years
Incentive Payback but without SRECs	8.2	Years
Payback with All Incentives	8.2	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)	46 kBtu/ft^2
Post ECM Site Energy Use Intensity (EUI)	39 kBtu/ft^2
Source Energy Use Intensity (Eui)	**Rating**
Current Source Energy Use Intensity (EUI)	115 kBtu/ft^2
Post ECM Source Energy Use Intensity (EUI)	101 kBtu/ft^2
Building Cost Intensity (Bci)	**Rating**
Current Building Cost Intensity	$1.53/ft^2
Post ECM Building Cost Intensity	$1.35/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	329 MMbtu
Total CO_2 Emissions Reduced	22.64 MtCO_2/Yr
Total Cars Off the Road (Equivalent)*	4
Total Acres of Pine Trees Planted (Equivalent)*	5

**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	2,161,887 kBtu
Total Annual Energy Savings for Non-Renewable Energy Measures	328,631 kBtu
Total Annual Energy Savings from Renewable Energy Measures	478,432 kBtu
Total Annual Energy Savings	807,063 kBtu
Net Energy Consumption from Grid Post Implementation	1,354,914 kBtu
% Energy Reduction (Annual Energy-Net Energy) / (Annual Energy)	37%

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 Father Keith B. Kenny 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	Propane	No.2 Oil	Steam	Electricity								
		$	Therms	Gallons	Gallons	Mlbs	kWh	kgal	$	$	$	Years		$	Years
No/Low Cost Recommendations															
1	Install Low Flow Faucet Aerators Location: Restrooms And Classrooms	$716	444	0	0	0	0	67	$1,182	$0	$1,182	0.61	14.09	$9,371	10.00
Totals for No/Low Cost Items		**$716**	**444**	**0**	**0**	**0**	**0**	**67**	**$1,182**	**$0**	**$1,182**	**0.61**			
Capital Cost Recommendations															
1	Install Timers On Exhaust Fans Location: Throughout	$1,769	459	0	0	0	5,315	0	$1,433	$0	$1,433	1.23	9.67	$15,343	15.00
2	Install Low Flow Restroom Flush Tank Toilets Location: Restrooms And Locker Rooms	$3,795	0	0	0	0	0	237	$2,055	$0	$2,055	1.85	8.06	$26,779	20.00
3	Upgrade Building Lighting to LED and Install Automatic Lighting Controls Location: Building Interior And Exterior	$32,183	0	0	0	0	23,942	0	$3,645	$1,300	$4,945	6.51	1.83	$26,848	15.00
4	Control External Air Leakage In Commercial Buildings Location: Extrior Doors	$7,080	436	0	0	0	2,532	0	$978	$49	$1,027	6.89	1.73	$5,182	15.00
5	Re-Commission The Building & Its Control Systems Location: Throughout	$20,895	974	0	0	0	7,435	0	$2,456	$0	$2,456	8.51	1.40	$8,419	15.00
6	Install Low Flow Tankless Restroom Fixtures Location: Restrooms	$24,454	0	0	0	0	0	255	$2,217	$0	$2,217	11.03	1.08	$2,010	15.00
Total For Capital Cost		**$90,176**	**1,869**	**0**	**0**	**0**	**39,224**	**492**	**$12,784**	**$1,349**	**$14,133**	**6.38**			
	Interactive Savings Discount @ 10%		-231	0	0	0	-3,922	-56	-$1,397	-$135	-$1,532				
	Total Contingency Expenses @ 15%	$13,634													
Total for Improvements		**$104,526**	**2,082**	**0**	**0**	**0**	**35,302**	**503**	**$12,570**	**$1,214**	**$13,784**	**7.58**			

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 Father Keith B. Kenny 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	Propane	No.2 Oil	Steam	Electricity	kgal	$	$	$	Years		$	Years
1	Replace Existing Water Heater With New Energy Efficient Units Location: Utility Closets	$17,503	590	0	0	0	0	0	$802	$0	$802	21.81	0.63	-$6,467	18.00
2	Replace External Windows Location: Throughout	$305,379	2,049	0	0	0	39,225	0	$8,757	$88	$8,844	34.53	0.50	-$151,376	25.00
Total for Improvements		**$17,503**	**590**	**0**	**0**	**0**	**0**	**0**	**$802**	**$0**	**$802**	**21.81**			

2. Introduction

The purpose of this Energy Audit is to provide Father Keith B. Kenny 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	35
Operational Weeks / Year	36
Estimated Facility Occupancy	411
Approximate Male Occupants at the Facility	205

Point of Contact	
Point of Contact Name	Peter Yarmola
Point of Contact Title	Plant manager 1
Point of Contact – Contact Number	916-273-2124

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

Description:

Heating and cooling to permanent buildings is provided primarily by rooftop package units utilizing natural gas for heating. Portable classrooms are served by wall mounted heat pumps. Building 005 is additionally served by an evaporative cooler and natural gas furnace. A split system heat pump provides supplementary heating and cooling to building 001.

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

Building Central Heating System	
Primary Heating System	Rooftop Packaged Units
Secondary Heating System	Wall Mounted Heat Pumps
Hydronic Distribution System	Not Applicable
Primary Heating Fuel	Natural Gas
Heating Mode Set-point	69 °F
Heating Mode- Set-back Temperature	53 °F

Building Cooling System	
Primary Cooling System	Packaged Units

Building Cooling System	
Secondary Cooling System	Wall Mounted Heat Pumps
Hydronic Distribution System	Not Applicable
Cooling Mode Set-point	73 °F
Cooling Mode- Set-back Temperature	93 °F

Air Distribution System	
Building Ventilation	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 primarily High Intensity Discharge (HID) 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	$1.36 /therm	$8.68 /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.

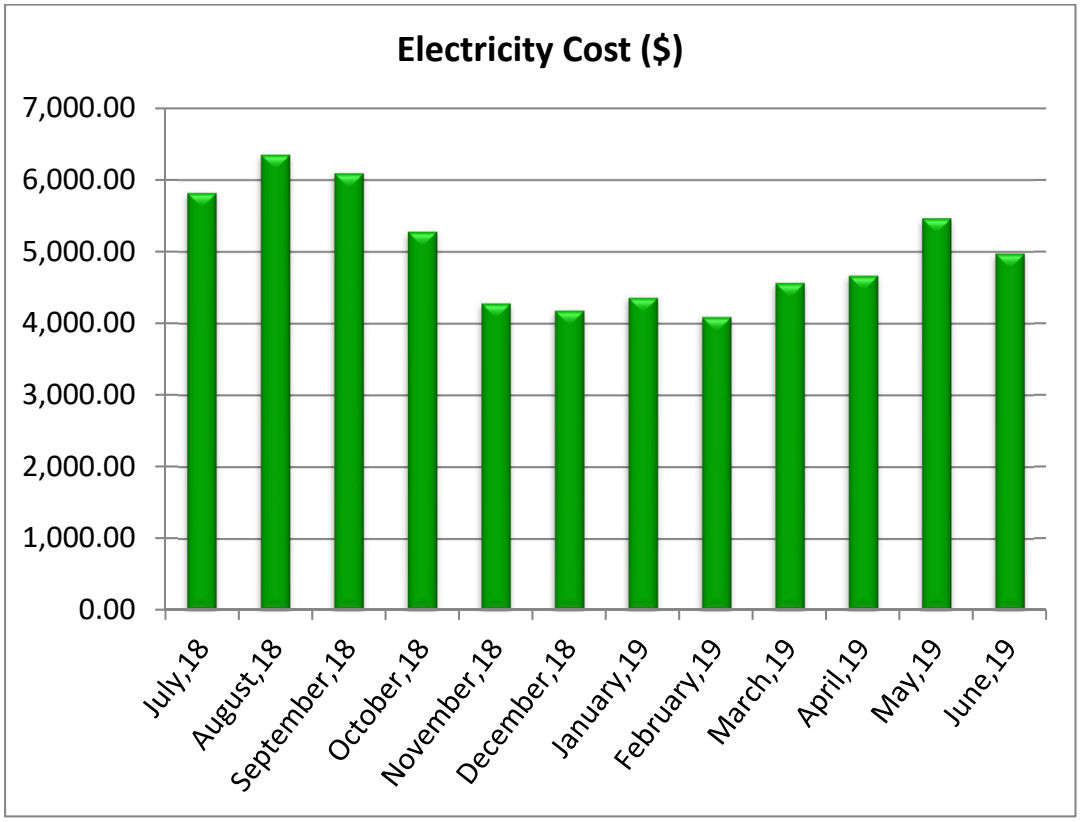
4.1. Electricity

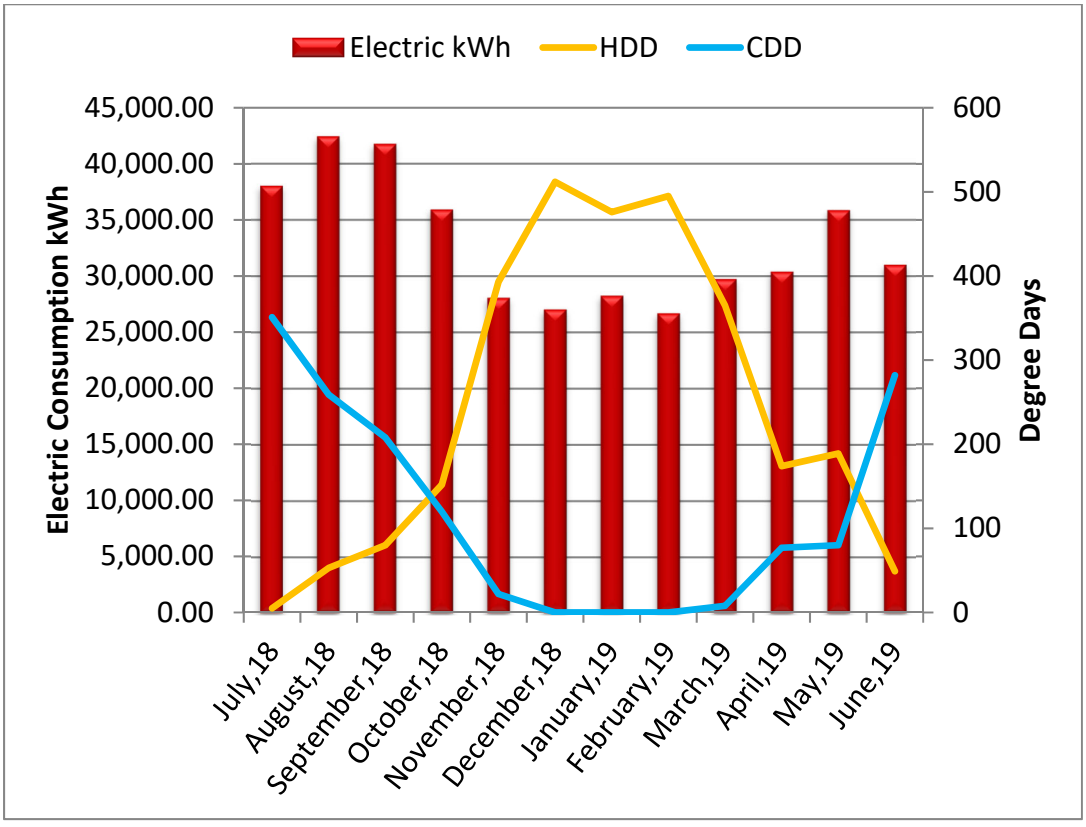
PGE satisfies the electricity requirements for the facility. The primary end uses for electric utility compromises of lighting, cooling, office/school equipment, and appliances in the break room.

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	38,002.00	0.15	5,817.00
August,18	42,385.00	0.15	6,351.00
September,18	41,724.00	0.15	6,090.00
October,18	35,885.00	0.15	5,278.00
November,18	28,047.00	0.15	4,281.00
December,18	27,013.00	0.15	4,180.00
January,19	28,227.00	0.15	4,358.00
February,19	26,675.00	0.15	4,092.00
March,19	29,705.00	0.15	4,564.00
April,19	30,371.00	0.15	4,664.00
May,19	35,825.00	0.15	5,464.00
June,19	30,979.00	0.16	4,973.00
Total/average	**394,838.00**	**0.15**	**60,112.00**


Electricity Cost ($)
7,000.00
6,000.00
5,000.00
4,000.00
3,000.00
2,000.00
1,000.00
0.00
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
45,000.00
40,000.00
35,000.00
30,000.00
25,000.00
20,000.00
15,000.00
10,000.00
5,000.00
0.00
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

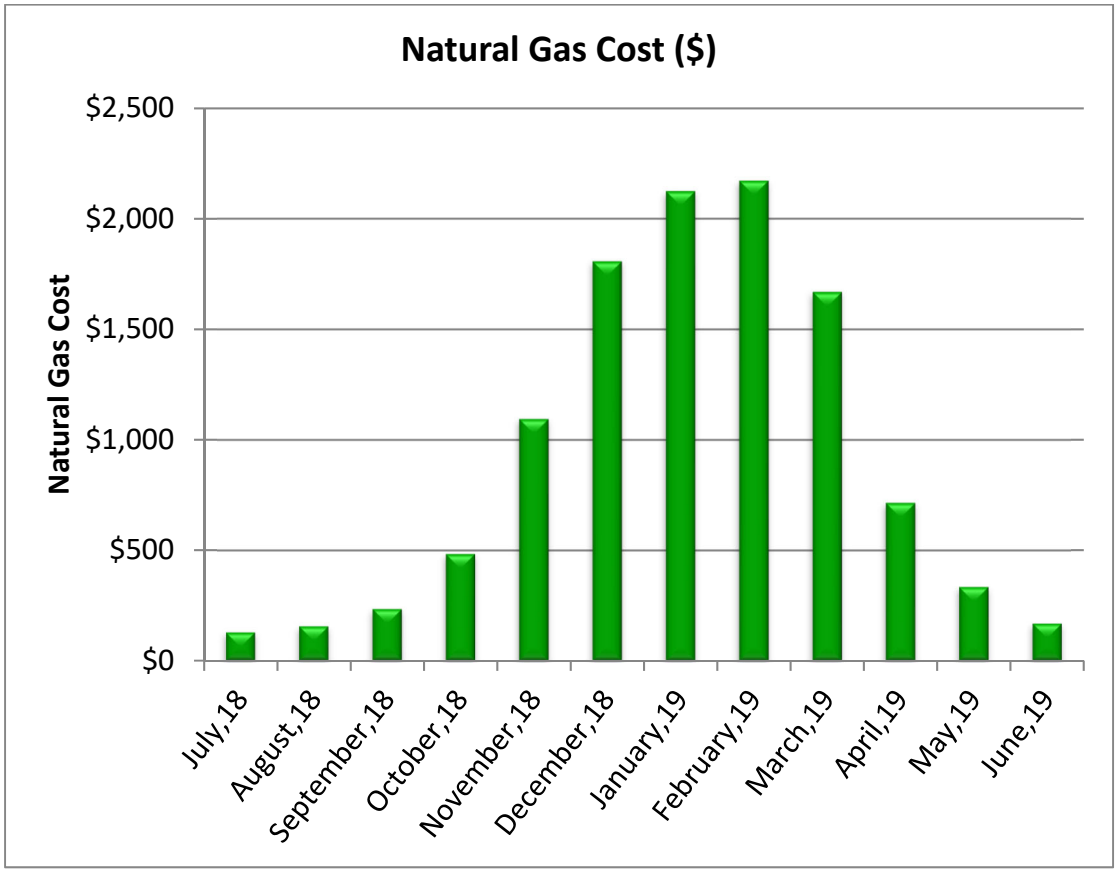
4.2. Natural Gas

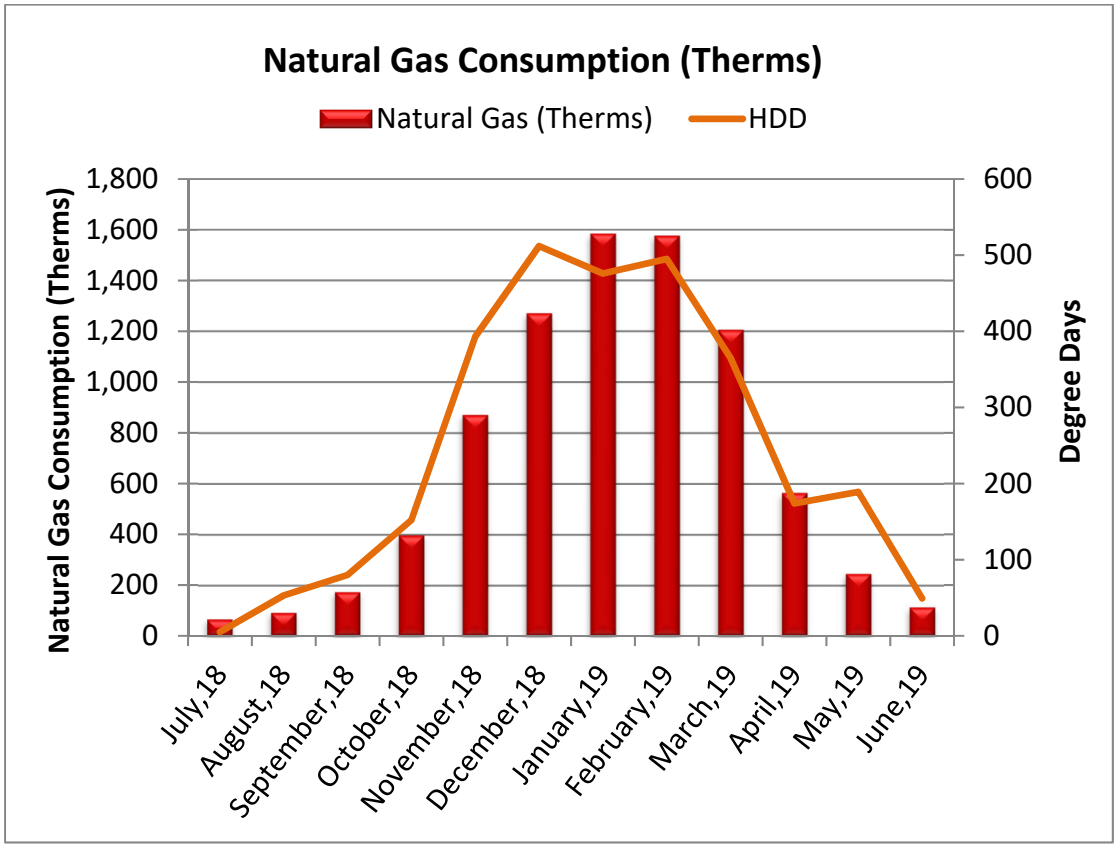
SPURR Gas satisfies the natural gas requirements of the facility. The primary end use of natural gas is for building heating, domestic water heating, and cooking in the cafeteria.

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	66	$1.92	$127
August,18	92	$1.68	$155
September,18	173	$1.35	$233
October,18	396	$1.22	$482
November,18	869	$1.26	$1,093
December,18	1,269	$1.42	$1,806
January,19	1,583	$1.34	$2,123
February,19	1,574	$1.38	$2,171
March,19	1,204	$1.39	$1,668
April,19	563	$1.27	$714
May,19	245	$1.36	$333
June,19	113	$1.48	$167
Total/average	**8,147**	**$1.36**	**$11,072**


Natural Gas Cost ($)
Natural Gas Cost
$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

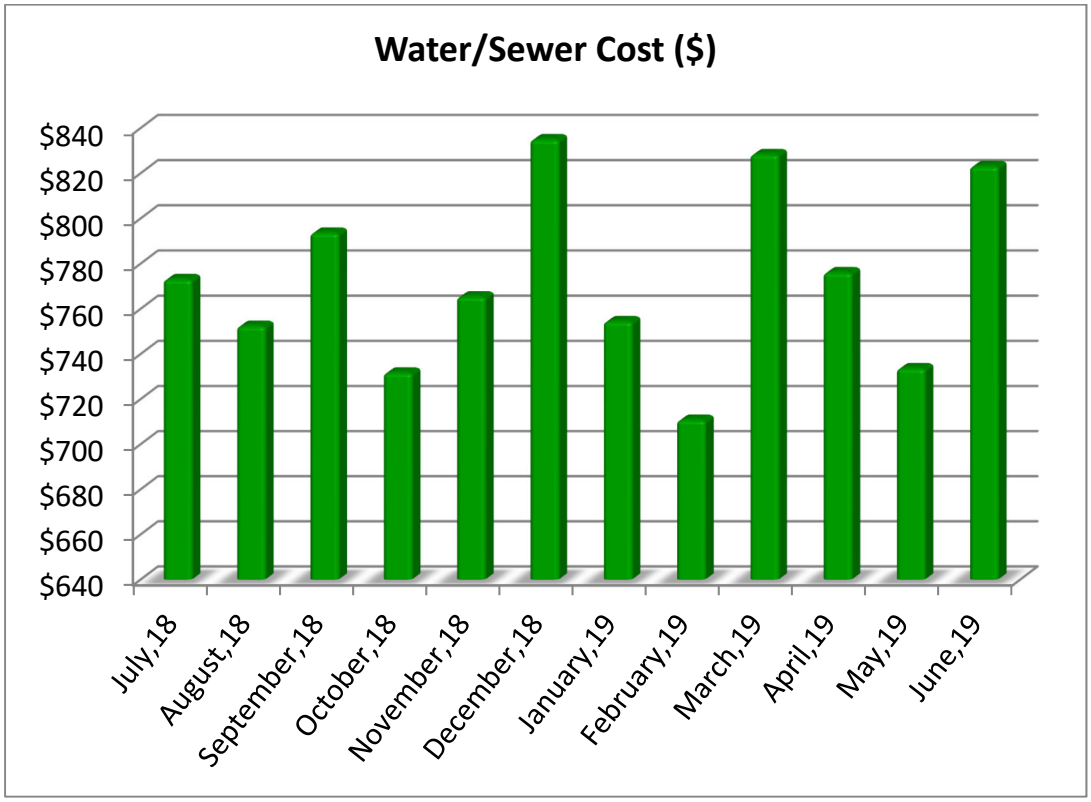

Natural Gas Consumption (Therms)
Natural Gas (Therms)
HDD
Natural Gas Consumption (Therms)
Degree Days
1,800
1,600
1,400
1,200
1,000
800
600
400
200
0
600
500
400
300
200
100
0
July,18
August,18
September,18
October,18
November,18
December,18
January,19
February,19
March,19
April,19
May,19
June,19

4.3. 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	145	$5.33	$773
August,18	162	$4.65	$753
September,18	198	$4.01	$794
October,18	202	$3.62	$732
November,18	48	$15.95	$766
December,18	43	$19.42	$835
January,19	31	$24.34	$755
February,19	49	$14.51	$711
March,19	51	$16.25	$829
April,19	44	$17.64	$776
May,19	66	$11.12	$734
June,19	30	$27.44	$823
Total/average	**1,069**	**$8.68**	**$9,280**


Water/Sewer Cost ($)
$840
$820
$800
$780
$760
$740
$720
$700
$680
$660
$640
July,18
August,18
September,18
October,18
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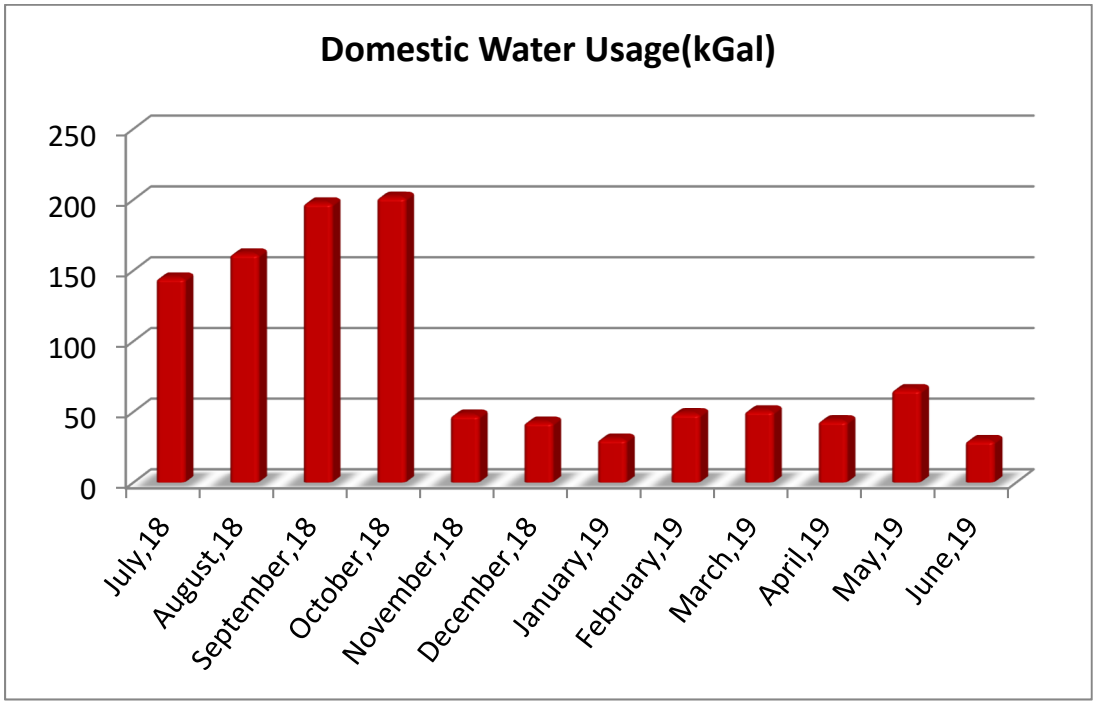
December,18
January,19
February,19
March,19
April,19
May,19
June,19


Domestic Water Usage(kGal)
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

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	267	
Estimated KW Rating	84	KW
Potential Annual kWh Produced	140,194	kWh
% of Current Electricity Uses	35.5%	
Financial Summary		
Investment Cost	$294,350	
Estimated Energy Cost Savings	$21,338	
Payback without Incentives	13.8	Years
Incentive Payback but without SRECs	8.2	Years
Payback with All Incentives	8.2	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	Output Capacity	Room Number	Space Served	Quantity
Water Heater	State Industries, Inc.	PRV 30 NORT8 2F	J92849179	30 GAL, 33.5 MBH	-	Clothes closet	Building 002 - L1, L2, PRE-S	1
Water Heater	State Industries, Inc.	SBF100 400 NE8 F	M92162570	100 GAL, 400 MBH	-	Plant Manager's Office	Building 005 - Multi-purpose Room and Kitchen	1
Packaged Unit (RTU)	Johnson Controls	48TCLA05A2A6A0A0A0	4614C50425	60 MBH	50 MBH	Roof	Building 004 - I1-I6	1
Packaged Unit (RTU)	Carrier	48TCLA06A2A6A0A0A0	0515C56470	60 MBH	50 MBH	Roof	Building 003 - C1-C6 and D1-D6	1
Packaged Unit (RTU)	Carrier	48TCLA06A2A6A0A0A0	0815C58291	60 MBH	50 MBH	Roof	Building 003 - C1-C6 and D1-D6	1
Packaged Unit (RTU)	Carrier	48TCLA06A2A6A0A0A0	5114C53518	60 MBH	50 MBH	Roof	Building 002 - L1, L2, PRE-S	1
Packaged Unit (RTU)	Johnson Controls	ZQG05D4B1AC1A324A2	N1F9015625	70 MBH	56 MBH	Roof	Father Keith B. Kenny School / Building 004 - I1-I6	1
Packaged Unit (RTU)	Johnson Controls	ZQG06D4B1AC1A324A2	N1F9015651	70 MBH	56 MBH	Roof	Building 003 - C1-C6 and D1-D6	1
Packaged Unit (RTU)	Johnson Controls	ZQG05D4B1AC1A324A2	N1F9031952	70 MBH	56 MBH	Roof	Building 003 - C1-C6 and D1-D6	1
Packaged Unit (RTU)	Johnson Controls	ZQG06D4B1AC1A324A2	N1F9015650	70 MBH	56 MBH	Roof	Building 003 - C1-C6 and D1-D6	1
Packaged Unit (RTU)	Johnson Controls	ZQG05D4B1AC1A324A2	N1F9031947	70 MBH	56 MBH	Roof	Father Keith B. Kenny School / Building 003 - C1-C6 and D1-D6	1
Packaged Unit (RTU)	Johnson Controls	ZQG06D4B1AC1A324A2	N1F9015652	70 MBH	56 MBH	Roof	Building 003 - C1-C6 and D1-D6	1
Packaged Unit (RTU)	Johnson Controls	ZQG05D4B1AC1A324A2	N1F9038954	70 MBH	56 MBH	Roof	Building 003 - C1-C6 and D1-D6	1
Packaged Unit (RTU)	Bryant	580FEV048074ABGA	4605G40242	74 MBH	59 MBH	Roof	Building 004 - I1-I6	1
Packaged Unit (RTU)	Johnson Controls	ZQG05D4B1AC1A324A2	N1F9038959	70 MBH	56 MBH	Roof	Building 003 - C1-C6 and D1-D6	1
Packaged Unit (RTU)	Johnson Controls	ZQG05D4B1AC1A324A2	N1F9038957	70 MBH	56 MBH	Roof	Building 003 - C1-C6 and D1-D6	1
Packaged Unit (RTU)	Johnson Controls	ZXG14D4C3AC1B324A2	N1F9015648	180 MBH	144 MBH	Roof	Building 001 - Library and Office	1
Packaged Unit (RTU)	Bryant	580FEV060074ABGA	3505G20230	74 MBH	59 MBH	Roof	Building 004 - I1-I6	1
Packaged Unit (RTU)	Johnson Controls	PCG4A240502X2	W1E9893801	50 MBH	40 MBH	Roof	Building 005 - Multi-purpose Room and Kitchen	1
Packaged Unit (RTU)	Johnson Controls	ZXGA7D4C3AC1B324A2	N1F9015632	70 MBH	56 MBH	Roof	Building 003 - C1-C6 and D1-D6	1
Packaged Unit (RTU)	Controls	ZXGA7D4C3AC1B324A2	N1F9015630	70 MBH	56 MBH	Roof	and D1-D6	1

Packaged Unit (RTU)	Johnson Controls	ZXGA7D4C3AC1B324A2	N1F9015631	70 MBH	56 MBH	Roof	Building 001 - Library and Office	1
Packaged Unit (RTU)	Johnson Controls	ZXGA7D4C3AC1B324A2	N1F9015633	70 MBH	56 MBH	Roof	Building 004 - I1-I6	1
Packaged Unit (RTU)	Johnson Controls	ZYG08D4B3AB1B124A2	N1A9571413	125 MBH	100 MBh	Roof	Father Keith B. Kenny School / Building 002 - L1, L2, PRE-S	1
Packaged Unit (RTU)	Johnson Controls	ZYG08D4B3AC1B324A2	N1F9031970	125 MBH	100 MBh	Roof	Building 002 - L1, L2, PRE-S	1
Packaged Unit (RTU)	Johnson Controls	ZYG09D4B3AC1B324A2	N1F9015638	125 MBH	100 MBh	Roof	Building 001 - Library and Office	1
Packaged Unit (RTU)	Carrier	48TCLA05A2A6A0A0A0	2909G20290	60 MBH	50 MBH	Roof	Building 003 - C1-C6 and D1-D6	1
Packaged Unit (RTU)	Bryant	580FEV060074ABGA	3505G20231	74 MBH	59 MBH	Roof	Building 004 - I1-I6	1
Packaged Unit (RTU)	Johnson Controls	48TCLA06A2A6A0A0A0	5214C53731	60 MBH	50 MBH	Roof	Building 004 - I1-I6	1
Packaged Unit (RTU)	Bryant	580FEV060074ABGA	2106G20210	74 MBH	59 MBH	Roof	Building 002 - L1, L2, PRE-S	1
Packaged Unit (RTU)	Carrier	48HJD006---641--	4506G30410	72 MBH	59 MBH	Roof	Building 003 - C1-C6 and D1-D6	1
Wall Mounted Heat Pump	Bard Manufacturing Company	WH361-A05XX4XXX	125L981282562-02	3 TON	-	Building exterior	P03 - Healthy Start	1
Wall Mounted Heat Pump	Bard Manufacturing Company	WH361-A05XX4XXX	125L981282312-02	3 TON	-	Building exterior	P03 - Healthy Start	1
Wall Mounted Heat Pump	Bard Manufacturing Company	WH431-A10CX4XXX	176D991339426-02	3.5 TON	-	Building exterior	P01 - Portable A	1
Furnace	Reznor	Inaccessible	Inaccessible	89 MBH	73 MBh	Roof	Building 005 - Multi-purpose Room and Kitchen	1
Wall Mounted Heat Pump	Bard Manufacturing Company	WH431-A10CX4XXX	176D991339420-02	3.5 TON	-	Building exterior	P02 - Portable B	1
Exhaust Fan	No tag/plate found	No tag/plate found	No tag/plate found	CFM	-	Roof	Building 005 - Multi-purpose Room and Kitchen	1
Exhaust Fan	Greenheck	SWB-10-5X	92L01763	CFM	-	Roof	Building 005 - Multi-purpose Room and Kitchen	1
Water Heater	State Industries, Inc.	PRV 30 NORT8 2CF	O93659081	30 GAL, 33.5 MBH	-	Utility closet	Building 006 - Restrooms	1
Air Handler (AHU)	Advanced Distributor Products	AM600CT	7119C30558	5 Ton	-	Z001, server room	Building 001 - Library and Office	1

Exhaust Fan	Greenheck	CUBE-120-4X	92G06666	CFM	-	Roof	Building 005 - Multi-purpose Room and Kitchen	1
Split System Heat Pump/ Condensing Unit	Johnson Controls	TCD60B41SA	W1F9974468	5 TON	-	Roof	Building 001 - Library and Office	1
Evaporative Cooler	Adobe Air	Illegible	Illegible	2600 CFM	-	Roof	Building 005 - Multi-purpose Room and Kitchen	1
Water Heater	State Industries, Inc.	PV 30 20RT9 2BF	893688335	30 GAL	-	M001, custodial	Building 001 - Library and Office	1
Water Heater	State Industries, Inc.	PRV 30 NORT8 2F	J92849176	30 GAL, 33.5 MBH	-	Utility closet	Building 007 - Restrooms	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	005*	Interior	1	MECHANICAL	Maintenance shop	-	1	Light Switch	Linear Fluorescent	T8	4' 28W T8	9	2x4 Indirect Troffer	3	0	10	1,512	381
2	002	Interior	1	CLASSROOM	Y004	322	4	Ceiling-Mounted Sensor	Linear Fluorescent	T8	4' 28W T8	112	2x4 Indirect Troffer	56	0	10	1,440	4,516
3	002	Interior	1	RESTROOM	T006	300	6	Light Switch	Linear Fluorescent	T8	4' 28W T8	12	2x4 Indirect Troffer	6	0	10	900	302
4	003*	Interior	1	CLASSROOM	004W	-	12	Light Switch	Linear Fluorescent	T8	4' 28W T8	288	2x2 Prism Troffer	144	0	10	1,440	11,612
5	003*	Interior	1	HALLWAY	F001	450	4	Light Switch	Linear Fluorescent	T8	4' 28W T8	48	2x4 Indirect Troffer	24	0	10	1,800	2,419
6	004	Interior	1	HALLWAY	F001	-	2	Light Switch	Linear Fluorescent	T8	4' 28W T8	24	2x4 Indirect Troffer	12	0	10	1,800	1,210
7	004	Interior	1	CLASSROOM	O002	-	18	Light Switch	Linear Fluorescent	T8	4' 28W T8	144	2x4 Indirect Troffer	72	0	10	1,260	5,080
8	002	Interior	1	STORAGE	0	-	3	Light Switch	Linear Fluorescent	T8	4' 28W T8	12	2x4 Indirect Troffer	6	0	10	684	230
9	002	Interior	1	HALLWAY	0	-	2	Light Switch	Linear Fluorescent	T8	4' 28W T8	16	2x4 Indirect Troffer	8	0	10	1,440	645
10	005*	Interior	1	RESTROOM	T005	-	2	Light Switch	Linear Fluorescent	T8	4' 28W T8	4	1x4 Indirect Troffer	2	0	10	1,440	161
11	005*	Interior	1	KITCHEN	K001	-	2	Light Switch	Linear Fluorescent	T8	4' 28W T8	24	1x4 Indirect Troffer	12	0	10	1,800	1,210
12	005*	Interior	1	GYMNASIUM	Mp	-	3	Light Switch	Linear Fluorescent	T8	2U 31W T8	40	2x2 Indirect Troffer	20	0	30	1,800	2,232
13	005*	Interior	1	RESTROOM	T003	-	4	Light Switch	Linear Fluorescent	T8	4' 28W T8	24	1x4 Indirect Troffer	12	0	10	1,440	968
14	005*	Interior	1	OPEN OFFICE	I001	-	1	Light Switch	Linear Fluorescent	T8	4' 28W T8	14	1x4 Indirect Troffer	7	0	10	2,160	847
15	005*	Interior	1	STORAGE	S003	-	2	Light Switch	Linear Fluorescent	T8	4' 28W T8	24	2x4 Indirect Troffer	12	0	10	684	460
16	005*	Interior	1	AUDITORIUM	0	-	1	Light Switch	Linear Fluorescent	T8	4' 28W T8	16	2x4 Indirect Troffer	8	0	10	1,800	806
17	005*	Interior	1	OFFICE	0	-	1	Light Switch	Linear Fluorescent	T8	4' 28W T8	4	2x4 Indirect Troffer	2	0	10	1,800	202
18	001	Interior	1	OFFICE	C005	-	16	Light Switch	Linear Fluorescent	T8	4' 28W T8	48	2x4 Indirect Troffer	24	0	10	1,800	2,419
19	001	Interior	1	LIBRARY	X001	-	4	Light Switch	Linear Fluorescent	T8	4' 28W T8	64	2x4 Indirect Troffer	32	0	10	1,440	2,580
20	001	Interior	1	CLASSROOM	O001	-	3	Light Switch	Linear Fluorescent	T8	4' 28W T8	28	2x4 Indirect Troffer	14	0	10	1,440	1,129
21	001	Interior	1	RESTROOM	T003	-	4	Light Switch	Linear Fluorescent	T8	4' 28W T8	4	1x4 Indirect Troffer	4	0	10	900	101
22	001	Interior	1	STORAGE	O003	-	1	Light Switch	Linear Fluorescent	T8	4' 28W T8	4	2x4 Indirect Troffer	2	0	10	684	77
23	001	Interior		CONFERENCE ROOM	Z002	-	2	Light Switch	Linear Fluorescent	T8	4' 28W T8	12	2x4 Indirect Troffer	6	0	10	1,800	605
24	006	Interior	1	RESTROOM	0	-	2	Ceiling-Mounted Sensor	Linear Fluorescent	T8	4' 28W T8	4	1x4 Indirect Troffer	4	0	10	900	101
25	P01	Interior	1	CLASSROOM	0001	-	2	Light Switch	Linear Fluorescent	T8	4' 28W T8	36	2x4 Indirect Troffer	12	0	10	1,440	1,452
26	P02	Interior	1	CLASSROOM	0002	-	2	Light Switch	Linear Fluorescent	T8	4' 28W T8	36	2x4 Indirect Troffer	12	0	10	1,440	1,452
27	007	Interior		RESTROOM	0	-	2	Timer	Linear Fluorescent	T8	4' 28W T8	4	1x4 Indirect Troffer	4	0	10	900	101
28	P03	Interior		CLASSROOM	003	-	2	Light Switch	Linear Fluorescent	T8	4' 28W T8	36	2x4 Indirect Troffer	18	0	10	1,440	1,452
29	P03	Interior	1	RESTROOM	0	-	1	Light Switch	Linear Fluorescent	T8	4' 28W T8	2	2x4 Indirect Troffer	1	0	10	900	50
30	P03	Exterior	1	CLASSROOM	0	-	1	Timer	HID	MH	MH150	2	Wallpack-Horizontal	2	0	15	1,440	432
31	P03	Exterior	1	CLASSROOM	0	-	1	Timer	CFL	CFL - 2 Pin	CFL13	1	Wallpack-Horizontal	1	0	10	1,440	19
32	007	Exterior	1	RESTROOM	0	-	1	Timer	CFL	CFL - 2 Pin	CFL13	2	Wallpack-Horizontal	1	0	10	900	23
33	P02	Exterior	1	CLASSROOM	0	-	1	Timer	LED	-	-	1	Wallpack-Vertical	1	0	10	1,440	-
34	P01	Exterior	1	CLASSROOM	0	-	1	Timer	LED	-	-	1	Wallpack-Vertical	1	0	10	1,440	-
35	006	Exterior	1	RESTROOM	0	-	1	Timer	CFL	CFL - 2 Pin	CFL13	2	Wallpack-Horizontal	1	0	10	900	23
36	003*	Exterior	1	CLASSROOM	0	-	1	Timer	CFL	CFL - 2 Pin	CFL26	116	Wallpack-Horizontal	58	0	15	1,440	4,343
37	002	Exterior		CLASSROOM	0	-	1	Timer	CFL	CFL - 2 Pin	CFL26	68	Wallpack-Horizontal	34	0	15	1,440	2,546
38	001	Exterior	1	OFFICE	0	-	1	Timer	CFL	CFL - 2 Pin	CFL26	62	Wallpack-Horizontal	31	0	15	1,800	2,902
39	004	Exterior	1	CLASSROOM	0	-	1	Timer	CFL	CFL - 2 Pin	CFL26	62	Wallpack-Horizontal	31	0	15	1,440	2,321
40	005*	Exterior	1	GYMNASIUM	0	-	1	Timer	CFL	CFL - 2 Pin	CFL26	44	Wallpack-Horizontal	22	0	15	1,800	2,059
41	Site	Exterior	1	STORAGE	0	-	1	Timer	HID	HPS	HPS150	17	Pole Pendant	17	0	10	2,160	5,508
42	Site	Exterior	1	STORAGE	0	-	1	Timer	HID	HPS	HPS250	4	Pole Pendant	2	0	20	2,160	2,160
43	Site	Exterior	1	STORAGE	0	-	1	Timer	HID	HPS	HPS250	1	Pole Pendant	1	0	20	2,160	540
44	Site	Exterior	1	STORAGE	0	-	1	Timer	LED	-	-	4	Pole Pendant	4	0	20	2,160	-
45	006	Interior		STORAGE	0	-	1	Light Switch	Linear Fluorescent	T12	3' 34W T12	2	Industrial	2	0	10	2,160	147
46	007	Interior	1	STORAGE	0	-	1	Light Switch	Linear Fluorescent	T12	3' 34W T12	2	Industrial	2	0	10	2,160	147
	Totals											1,484		747			68,724	67,968

									Fixture Details						Existing Consumption				Proposed- Post Retrofit				
Line No.	Building Name	Interior/ Exterior	Floor	Space Type	Room No.	Additional Area Description	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	005*	Interior	1	MECHANICAL	Maintenance shop		Light Switch	1	Linear Fluorescent	T8	4' 28W T8; 2x4 Indirect Troffer	3	9	10	1,512	381	ECM	RB - Replace Bulb	Ceiling Mounted	4' 17W LED T8	1,512	231	150
2	002	Interior	1	CLASSROOM	Y004	Kindergarden	Ceiling-Mounted Sensor	4	Linear Fluorescent	T8	4' 28W T8; 2x4 Indirect Troffer	56	112	10	1,440	4,516	ECM	RB - Replace Bulb	Retain Existing Controls	4' 17W LED T8	1,440	2,742	1,774
3	002	Interior	1	RESTROOM	T006		Light Switch	6	Linear Fluorescent	T8	4' 28W T8; 2x4 Indirect Troffer	6	12	10	900	302	ECM	RB - Replace Bulb	Ceiling Mounted	4' 17W LED T8	900	184	119
4	003*	Interior	1	CLASSROOM	004W		Light Switch	12	Linear Fluorescent	T8	4' 28W T8; 2x2 Prism Troffer	144	288	10	1,440	11,612	ECM	RB - Replace Bulb	Retain Existing Controls	4' 17W LED T8	1,440	7,050	4,562
5	003*	Interior	1	HALLWAY	F001	Lobby	Light Switch	4	Linear Fluorescent	T8	4' 28W T8; 2x4 Indirect Troffer	24	48	10	1,800	2,419	ECM	RB - Replace Bulb	Retain Existing Controls	4' 17W LED T8	1,800	1,469	950
6	004	Interior	1	HALLWAY	F001		Light Switch	2	Linear Fluorescent	T8	4' 28W T8; 2x4 Indirect Troffer	12	24	10	1,800	1,210	ECM	RB - Replace Bulb	Retain Existing Controls	4' 17W LED T8	1,800	734	475
7	004	Interior	1	CLASSROOM	O002		Light Switch	18	Linear Fluorescent	T8	4' 28W T8; 2x4 Indirect Troffer	72	144	10	1,260	5,080	ECM	RB - Replace Bulb	Retain Existing Controls	4' 17W LED T8	1,260	3,084	1,996
8	002	Interior	1	STORAGE	0		Light Switch	3	Linear Fluorescent	T8	4' 28W T8; 2x4 Indirect Troffer	6	12	10	684	230	ECM	RB - Replace Bulb	Wall Mounted	4' 17W LED T8	684	140	90
9	002	Interior	1	HALLWAY	0		Light Switch	2	Linear Fluorescent	T8	4' 28W T8; 2x4 Indirect Troffer	8	16	10	1,440	645	ECM	RB - Replace Bulb	Retain Existing Controls	4' 17W LED T8	1,440	392	253
10	005*	Interior	1	RESTROOM	T005		Light Switch	2	Linear Fluorescent	T8	4' 28W T8; 1x4 Indirect Troffer	2	4	10	1,440	161	ECM	RB - Replace Bulb	Wall Mounted	4' 17W LED T8	1,440	98	63
11	005*	Interior	1	KITCHEN	K001		Light Switch	2	Linear Fluorescent	T8	4' 28W T8; 1x4 Indirect Troffer	12	24	10	1,800	1,210	ECM	RB - Replace Bulb	Wall Mounted	4' 17W LED T8	1,800	734	475
13	005*	Interior	1	RESTROOM	T003		Light Switch	4	Linear Fluorescent	T8	4' 28W T8; 1x4 Indirect Troffer	12	24	10	1,440	968	ECM	RB - Replace Bulb	Wall Mounted	4' 17W LED T8	1,440	588	380
15	005*	Interior	1	STORAGE	S003		Light Switch	2	Linear Fluorescent	T8	4' 28W T8; 2x4 Indirect Troffer	12	24	10	684	460	ECM	RB - Replace Bulb	Ceiling Mounted	4' 17W LED T8	684	279	181
17	005*	Interior	1	OFFICE	0	Small office	Light Switch	1	Linear Fluorescent	T8	4' 28W T8; 2x4 Indirect Troffer	2	4	10	1,800	202	ECM	RB - Replace Bulb	Retain Existing Controls	4' 17W LED T8	1,800	122	79
19	001	Interior	1	LIBRARY	X001		Light Switch	4	Linear Fluorescent	T8	4' 28W T8; 2x4 Indirect Troffer	32	64	10	1,440	2,580	ECM	RB - Replace Bulb	Ceiling Mounted	4' 17W LED T8	1,440	1,567	1,014
21	001	Interior	1	RESTROOM	T003		Light Switch	4	Linear Fluorescent	T8	4' 28W T8; 1x4 Indirect Troffer	4	4	10	900	101	ECM	RB - Replace Bulb	Wall Mounted	4' 17W LED T8	900	61	40
22	001	Interior	1	STORAGE	O003		Light Switch	1	Linear Fluorescent	T8	4' 28W T8; 2x4 Indirect Troffer	2	4	10	684	77	ECM	RB - Replace Bulb	Ceiling Mounted	4' 17W LED T8	684	47	30
24	006	Interior	1	RESTROOM	0		Ceiling-Mounted Sensor	2	Linear Fluorescent	T8	4' 28W T8; 1x4 Indirect Troffer	4	4	10	900	101	ECM	RB - Replace Bulb	Ceiling Mounted	4' 17W LED T8	900	61	40
25	P01	Interior	1	CLASSROOM	0001		Light Switch	2	Linear Fluorescent	T8	4' 28W T8; 2x4 Indirect Troffer	12	36	10	1,440	1,452	ECM	RB - Replace Bulb	Retain Existing Controls	4' 17W LED T8	1,440	881	570
26	P02	Interior	1	CLASSROOM	0002		Light Switch	2	Linear Fluorescent	T8	4' 28W T8; 2x4 Indirect Troffer	12	36	10	1,440	1,452	ECM	RB - Replace Bulb	Retain Existing Controls	4' 17W LED T8	1,440	881	570
27	007	Interior		RESTROOM	0		Timer	2	Linear Fluorescent	T8	4' 28W T8; 1x4 Indirect Troffer	4	4	10	900	101	ECM	RB - Replace Bulb	Ceiling Mounted	4' 17W LED T8	900	61	40
28	P03	Interior		CLASSROOM	003		Light Switch	2	Linear Fluorescent	T8	4' 28W T8; 2x4 Indirect Troffer	18	36	10	1,440	1,452	ECM	RB - Replace Bulb	Retain Existing Controls	4' 17W LED T8	1,440	881	570
32	007	Exterior	1	RESTROOM	0		Timer	1	CFL	CFL - 2 Pin	CFL13; Wallpack-Horizontal	1	2	10	900	23			Photo Sensor				
33	P02	Exterior	1	CLASSROOM	0		Timer	1	LED	-		1	1	10	1,440				Retain Existing Controls				
34	P01	Exterior	1	CLASSROOM	0		Timer	1	LED	-		1	1	10	1,440				Retain Existing Controls				
35	006	Exterior	1	RESTROOM	0		Timer	1	CFL	CFL - 2 Pin	CFL13; Wallpack-Horizontal	1	2	10	900	23			Photo Sensor				
36	003*	Exterior	1	CLASSROOM	0		Timer	1	CFL	CFL - 2 Pin	CFL26; Wallpack-Horizontal	58	116	15	1,440	4,343			Retain Existing Controls				
37	002	Exterior		CLASSROOM	0		Timer	1	CFL	CFL - 2 Pin	CFL26; Wallpack-Horizontal	34	68	15	1,440	2,546			Retain Existing Controls				
38	001	Exterior	1	OFFICE	0		Timer	1	CFL	CFL - 2 Pin	CFL26; Wallpack-Horizontal	31	62	15	1,800	2,902			Retain Existing Controls				
39	004	Exterior	1	CLASSROOM	0		Timer	1	CFL	CFL - 2 Pin	CFL26; Wallpack-Horizontal	31	62	15	1,440	2,321			Retain Existing Controls				
40	005*	Exterior	1	GYMNASIUM	0		Timer	1	CFL	CFL - 2 Pin	CFL26; Wallpack-Horizontal	22	44	15	1,800	2,059			Retain Existing Controls				
41	Site	Exterior	1	STORAGE	0	Parking lot and outside	Timer	1	HID	HPS	HPS150; Pole Pendant	17	17	10	2,160	5,508	ECM	RF - Replace Entire Fixture	Photo Sensor	54W LED Post	2,160	1,983	3,525
42	Site	Exterior	1	STORAGE	0	Parking lot and outside	Timer	1	HID	HPS	HPS250; Pole Pendant	2	4	20	2,160	2,160	ECM	RF - Replace Entire Fixture	Photo Sensor	54W LED Post	2,160	467	1,693
45	006	Interior		STORAGE	0		Light Switch	1	Linear Fluorescent	T12	3' 34W T12; Industrial	2	2	10	2,160	147	ECM	RF - Replace Entire Fixture	Ceiling Mounted	3' 13W LED T8	2,160	56	91
	Totals												1,484									29,789	23,942

APPENDIX D:
ECM Checklist

NA	In Place	Evaluate	ECM Description
✓			Add Reflective Coating To Exterior Windows
		✓	Replace External Windows
	✓		Upgrade Insulation
		✓	Control External Air Leakage In Commercial Buildings
✓			Install Reflective Insulation Between Radiators And External Wall
✓			Replace Existing Motors With High Efficiency Motors
✓			Install On-Demand Ventilation on Air Handlers
✓			Reduce HVAC Hours of Operation
✓			Install Variable Frequency Drives (VFD)
✓			Install Outside Air Temperature Reset Controls For Hot Water Boilers
✓			Install Chilled Water Reset Control
		✓	Install Timers On Exhaust Fans
✓			Install Energy Savers on Vending, Snack Machines
✓			Install Building Energy Management System and Replace Terminal Units
		✓	Re-Commission The Building & Its Control Systems
✓			Replace Inefficient Heating Plant
✓			Replace Inefficient Cooling Plant
		✓	Replace Existing Air Conditioners with Energy Star Air Conditioners
✓			Replace Unit Electric Heaters with Natural Gas Fired Unit Heaters
✓			Convert From Gas Pilot to Electronic Ignition for Boilers
	✓		Insulate Hot Water Pipes
	✓		Insulate Refrigerant Lines
	✓		Insulate Hot Surfaces And Tanks
	✓		Insulate Air Ducts
✓			Replace Defective Steam Traps
		✓	Upgrade Electric Heating System To Heat Pumps
✓			Replace Inefficient Furnace System
✓			Replace Rooftop Package Unit
✓			Install Energy Recovery Wheel on Air Handling Unit
		✓	Replace Existing Water Heater With New Energy Efficient Units
		✓	Replace Incandescent/Halogen Lamps With Energy Efficient Lamps
		✓	Upgrade Inefficient Linear Fluorescent Lamps And Fixtures
	✓		Upgrade EXIT SIGNS With LED EXIT Signs
✓			Bilevel and Tandem Linear Fluorescent Lighting ECM
		✓	Replace High Intensity Discharge (HID) Lamps With Energy Efficienct Lamps
✓			Replace Existing Refrigerator(s) With Energy Star Certified Refrigerator(s)
✓			Replace Existing Freezers With High Efficiency Freezers
✓			Install Low Flow Shower Heads
		✓	Install Low Flow Faucet Aerators
		✓	Install Low Flow Restroom Flush Tank Toilets
		✓	Install Low Flow Tankless Restroom Fixtures

APPENDIX E:
ECM Calculations

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

Property Type:	Commercial	Estimated No. of Operational Weeks	36
		Number of Occupied Days/Week (Max 7)	5

KITCHEN FAUCETS			BATHROOM FAUCETS		
Number of Occupants Affected By Retrofit	411		Number of Occupants Affected by Retrofit	411	
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	24		Total Number of Faucet Aerators To Be Replaced	23	
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	GPM
GPM of Proposed Faucet Aerator	0.5	GPM	GPM of Proposed Faucet Aerator	0.5	GPM
Estimated Number of Uses Per Day	2		Estimated Number of Uses Per Day	4	

Annual Water Savings From Installing Low Flow Aerators: 66.76 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:	0.64	EF	Heating Fuel Tariff	$1.36	$/Therm
Hot Water Discharge Temperature at Faucet	110.00	°F	Water Tariff ($/1000 Gal)	$8.68	$/kGal
Equivalent Heating Fuel Savings: *Savings Discounted by 15% to Account For Cold Water Use*	444	Therms	Annual Cost Savings In Form of Water	$580	$
Annual Water Savings	66.76	kGal	Annual Energy Savings From Water Heater	$603	$

COST BENEFIT ANALYSIS				
Estimated Total Annual Cost Savings	$1,182	$$	Estimated Total Installation Cost	$716 $$
Simple Payback Period	0.61	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: $716 Estimated Annual Cost Savings: $1,182 Simple Payback Period (Yrs): 0.61

UIC	Install Low Flow Tankless Restroom Fixtures
EAP4	Location: Restrooms

ECM FOR DETERMINING WATER SAVINGS IN COMMERCIAL PROPERTIES

Number of Males	205	
Number of Females	206	
Number of Occupied Days Per Week (Max 7)	5	
Number of Occupied Weeks/Year (Max 52)	35	
Number of Urinals To Be Retrofitted	5	
Number of Water Closets To Be Retrofitted	29	
No. of Water Closets With Separate Flush Tank *(Typical Residential Type)*	4	
Estimated Restroom Usage/Individual/Day *Default is 4 Uses/Day For Residential/Office*	4	(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	100.45	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		25	
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		25.72	kGal
Estimated Annual Water Savings From Female Users		129.20	kGal
Total Water Savings From Water Closets		154.92	kGal

Water & Cost Saving Calculations

Water Savings Calculation

Water Savings By The Use of Low Flow Water Closet Flush Valves/Yr	154.92	kgal
Water Savings By The Use of Low Flow Urinal Flush Valves/ Yr	100.45	kgal
Total Annual Water Savings in kgal	255.37	kgal

Cost Savings Calculations

Enter Water Tariff Rate ($/1000Gal)	$8.68	$$
Estimated Cost Savings From Water	$2,217	$$

Estimated Cost of Retrofit

Cost For Replacing Existing Urinal Fixture With A Low Flow Fixture	$6,502 *(Includes Labor)*	$$
Cost For Replacing Existing Flush Valves With Low Flow - Dual Flush Valves ($80 Per Unit) *(Up For Liquid Waste And Down For Solid Waste)*	$17,952 *(Includes Labor)*	$$
Estimated Total Cost For Retrofit	$24,454	$$
Simple Pay Back Period	11.03	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:	$24,454	Simple Payback Period:	11.03 Yrs
Annual Cost Savings:	$2,217		

UIC	Install Low Flow Restroom Flush Tank Toilets
EAP3	Location: Restrooms and Locker Rooms

EXISTING CONDITION

Total Occupants:	411	
Number of Water Closets To Be Replaced	4	
Number of Occupied Days Per Week (Max 7)	5	
Number of Occupied Weeks/Year (Max 52)	36	
Estimated Restroom Usage/Individual/Day *5.05 flushes/person/day@American Water Works Association (AWWA)*	4	(Select)

PROPOSED RETROFIT/REPLACEMENT

Existing Gallons Per Flush Ratings For Water Closet Flushes	1.60	GPF
Replace or Retrofit Toilets With Dual Flush Toilets	Replace	
Replace		
Proposed Toilet	0.8GPF -Floor Mount, 10" Rough-In	
GPF of Proposed New Low Flow Water Closet Fixture*	0.80	GPF
Retrofit		
Dual Flush - Retrofit Setup Valve for Flush Tank Toilet *(Federal Law Requires All Flushes Not To Exceed 1.6 GPF)*	*Solid Waste (20%)* 0.80	GPF
	Liquid Waste (80%) 0.80	GPF

Water & Cost Saving Calculations

Water Savings By The Use of Low Flow Water Closet Flush Valves/Day	1,315.20	gal
Total Annual Water Savings in gallons	236.74	kgal
Cost Savings Calculations		
Enter Water Tariff Rate ($/1000Gal)	$8.68	$$
Estimated Cost Savings From Water	$2,055	$$
Estimated Cost of Retrofit		
Estimated Total Cost For Retrofit	$3,795	$$
Simple Pay Back Period	1.85	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.

Existing toilets can be retrofitted with pressure-assisted flush technology to reduce the flush rate to 1.0 GPF or less. Though water efficient these toilets make considerable amount of noise as this involves release of pressurized air during the course of flushing. Thus making them unpopular among residential properties.

Thus EMG recommends replacing the existing high flow toilets with new low flow 1.28GPF rated flush tank toilets, which are comparatively more water efficient at the same time considerably quiter as compared to the pressure assisted technology retrofitted toilets.

Summary:

Initial Investment:	$3,795			
		Simple Payback:	1.85	Years
Annual Cost Saving:	$2,055			

UIC	Install Timers On Exhaust Fans
EAC7A	Location: Throughout

Type of Exhaust Fan: Rooftop Exhaust Fans

EXISTING CONDITION

No. of Timers to Be Installed:	5	Qty	HP of Individual Fan Motor:	0.25	HP
No. of Exhaust Fans:	5		Total kW:	0.93	kW
Existing Daily Hours of Operation/Exhaust Fan:	20.00	Hrs/Day	Annual kWh For All Fans:	6,807	kWh

PROPOSED CONDITION

New Daily Hours With Timers/Exhaust Fan:	12.00	Hrs/Day	New Annual kWh For All Fans:	4,084	kWh
Type of Heating Fuel:	Natural Gas		Is The Property Cooled?	Yes	

Only For Apt. Bathroom Exhaust Fans			Only For Roof Top Exhaust Fans- Commerical Spaces		
CFM for Individual Bathroom Exhaust Fans *(For bathrooms<100Sqft)*	90	CFM	No. of Water Closets In Building	19	
			No. of Urinals In Building	2	
Total Exhuast CFM From All Fans	450	CFM	Total CFM for All Restroom Exhaust	1,050	CFM
Annual Heating Energy Savings	0	kbtu	Annual Heating Energy Savings	36,288	kbtu
Annual Cooling Energy Savings	0	kbtu	Annual Cooling Energy Savings	18,144	kbtu

Energy & Cost Savings

Estimated Annual Heating Plant Efficiency	79.00	%	Estimated Annual Cooling Plant Efficiency	7.00	EER
Annual Heating Energy Savings	459	Therms	Annual Cooling Energy Savings	2,592	kWh
Annual Electric Fan Motor Savings	2,723	kWh			

COST ANALYSIS

Electric Rate:	$0.15	$/kWh	Total Annual Electric Savings	5,315	kWh
Material Cost For Timers:	$847	$	Total Annual Non Electric Savings	459	Therms
Total Cost for Installing Timers	$1,769	$	Annual Cost savings:	$1,433	$
Simple Payback:	1.23	Yrs			

Type of Recommendation Capital Cost ECM Recommendation

ECM DESCRIPTION:

Exhaust fans are generally used in areas with high concentrations of pollutants generated from occupants' activities. These exhaust requirements are rarely continuous, and the fans should operate only as needed. Continuous operations of bathroom exhaust fans results in exhausting conditioned air out. This causes low pressures in the conditioned space, which is filled up by infiltrated air from unconditioned spaces. Air infiltration leads to increase loads on heating and cooling system increasing the energy consumed to condition the space. In addition to this the fan motor is also consumes energy to operate, though insignificant as compared to the HVAC losses.

In case of the residential properties with individual exhaust fans in the bathrooms, EMG recommends installing timer switches on each bathroom fan to control the fan operations. Bathroom fans are essential to exhaust out the excess humidity and odor control. The timer switch will limit the operation time to 20 mins.

In case of central exhaust systems that have roof top or side wall mounted exhaust fans, EMG recommends a single electronic timer control to restrict the exhaust fan operations to typical building occupancy hours +/- 2 hrs. A single electronic timer would be able to control all the exhaust fans.

Summary:

Initial Investment:	$847	Simple Payback:	1.23	Years
Energy Cost Savings	$1,433			

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

Enter the Total Area of The Facility	46,664	SqFt
Select the Type of Heating Fuel:	Natural Gas	*(Select)*
Estimated Annual Heating Fuel Consumption:	6,493	Therms
Is the Property Cooled?	Yes	*(Select)*
Estimated Annual Electrical Energy Consumed For Cooling:	49,564	kWh
Estimated Energy Savings From Re-Commissioning on Building Systems:	15%	*(Select)*
Estimated Heating Energy Saving Post Re-Commissioning:	974	Therms
Estimated Cooling Energy Saving Post Re-Commissioning:	7,435	kWh
Average Heating Fuel Rate Paid By The Property:	$1.36	$/Therm
Average Electrical Rate Paid By The Property:	$0.15	$/kWh
Annual Energy Cost Savings:	$2,456	$
Estimated Cost For Re-Commissioning The Facility: *(LBNL 2009 Report on Building Commissioning)*	$20,895	$
Simple Payback Period:	8.51	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

SUMMARY:

Initial Investment: $20,895 Simple Payback: 8.51 Years
Energy Cost Savings: $2,456

UIC	Replace Existing Water Heater With New Energy Efficient Units
EAD3	**Location: Utility Closets**

		Utility Closet		*Throughout*		*Specify Location Here*		*Specify Location Here*	
Step 1	**Existing Water Heater Details**								
	Number of Water Heaters Being Replaced:	1		3					
	Select Existing Hot Water Heater Fuel	Natural Gas		Natural Gas		Natural Gas		Electric	
	Insert Energy Factor of Existing Water Heater	0.50	EF	0.50	EF		EF		EF
	Input Existing Water Heater Input Rating	400.00	kBtus	33.00	kBtus		kBtus		kW
	Select One Method For Calculation	Annual DWH Load		Annual Heating Hours		Annual DWH Load		Annual DWH Load	
	Insert Annual Water Heater Energy Consumption/Heater	1,000	Therms	654	hrs		Therms		kWh
	Annual Hours of Operation	250	hrs	216	Therms	#DIV/0!	hrs	#DIV/0!	hrs
	Total Estimated Annual Energy Consumption For all Heaters	1,000	Therms	647	Therms	0	Therms	0	kWh
	Total Estimated Annual Operating Energy Costs For all Heaters	$1,359	$	$880	$	$0	$	$0	$
Step 2	**Proposed New Water Heater**								
	Proposed Hot Water Heater Fuel	Natural Gas		Natural Gas		Electric		Natural Gas	
	Capacity of the Proposed New Water Heater	100-Gal,250-kBtu		29-Gal,40-kBtu					
	Energy Factor of Proposed Water Heater	0.95	EF	0.61	EF	0.00	EF	0.00	EF
	Proposed Water Heater Input Rating	250.00	kBtuh	40.00	kBtuh	0.00	kW	0.00	kBtuh
	Annual kBtuh Consumption For All The Proposed Water Heaters	52,632	kBtuh	53,070	kBtuh	#DIV/0!	kBtuh	#DIV/0!	kBtuh
	Estimated Annual Water Heater Fuel Consumption (All Heaters)	526	Therms	531	Therms	0	kWh	0	Therms
	Estimated Total Annual Energy Costs	$715	$	$721		$0		$0	
Step 3	**Energy & Cost Saving Calculation**								
	Estimated Cost of New Water Heater/Unit	$8,640	$	$1,029	$	$0	$	$0	$
	Total Estimated Installation Cost	$12,896	$	$4,608	$	$0	$	$0	$
	Total Estimated Annual Cost Savings	$644	$	$159	$	$0	$	$0	$
	Total Annual Cost Savings:	$802		Total Initial Investment::		$17,503			
	Simple Pay Back Period	21.81							
	Type of Recommendation	Capital Cost ECM Recommendation							

ECM SUMMARY:

Electric resistance is the most expensive method for heating domestic hot water. A natural gas or propane fired water system provide more units of heat with direct burning of fuel while high wattage draw is required for electric water heaters to create resistance heat. This electric usage can be seen with the increase power demand for the site and the additional kWh consumption. The installation process of the gas/propane fired water heater requires additional measures with tying a gas line or fuel tank to the system along with installing an exhaust gas vent. This process is not a costly retrofit if a current gas line or tank is at the site. The hot water exhaust duct can be tied to the existing gas fired furnaces or boilers for an easy retrofit.

SUMMARY:

Initial Investment: $12,896 Simple Payback: 21.81 yrs

Annual Cost Savings: $644

UIC	Control External Air Leakage In Commercial Buildings
EAE4A	Location: Extrior Doors

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)*	0.50	Cubic Feet/Min (CFM 1):	1,620
Insert Proposed Estimated Air Change Rate/Hr (ACH 2):	0.35	Cubic Feet/Min (CFM 2):	1,134
Estimated Space Volume Under Consideration	194,400.00 Cu.Ft		

WINTER			SUMMER		
Select Type of Heating Fuel	Natural Gas (Select)		Is The Building Cooled?	Yes	
Estimated Annual Heating Plant Efficiency	85.00	%	Estimated Annual Cooling Plant Efficiency	7.00	EER
Annual Heating Degree Days(HDD):	2,943		Annual Cooling Degree Days(CDD):	1,407	
Estimated Total Annual Input Heating Energy Savings	436	Therms	Estimated Total Annual Input Cooling Energy Savings	2,532	kWh
Cost/Unit of Heating Fuel:	$1.36	$/Therm	Cost/Unit For Electricity	$0.15	$$
Estimated Annual Heating Cost Savings	$593	$$	Estimated Annual Cooling Cost Savings	$385	$$

Cost Analysis

Install Flush Mounted, Vinyl Door Sweeps ?	Yes	Total Length of Door Sweeps to Be Installed: *(3.5' Standard Width Door)*	72 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	$49	Estimated Length of Joints To Be Re-Caulked: *(Includes Demolition and Re-Caulking)*	1400 LF
Total Estimated Annual Cost Savings	$1,027	Total Cost For Controlling Air Leakage	$7,080
Simple Pay Back Period	6.89 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:	$7,080	Simple Pay Back Perioc	6.89 Yrs
Annual Energy Cost Savings:	$1,027		

UIC	Replace External Windows
EAE2	Location: Throughout

ENTER EXISTING CONDITIONS

Existing and Proposed Window Properties

Total Sq.Ft window area:	6,144	sq.ft
Approximate number of windows:	372	
Total existing window area:	6,144	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):	1.00	
(Existing Air Changes Per Hour, 1.5 is very leaky and 0.35 ideal)		
Insert Proposed Estimated Air Change Rate/Hr (ACH 2):	0.70	
Estimated Space Volume Under Consideration	413,496.00	Cu. Ft
Is the Property Cooled ?	Yes	*(Select)*

WINTER

Select Type of Heating Fuel	Natural Gas	*(Select)*
Net heating plant & distribution system efficiency:	79.00	**%**
Annual Heating Hours:	2,943	HDD
Estimated Total Annual Input Heating Energy Savings By Replacing Windows	52.73	Therms
Estimated Total Annual Input Heating Energy Savings Achieved By Controlling Air Leakage Through Windows	1,996	Therms
Estimated Total Input Heating Fuel Savings From Replacing Windows	2,049	Therms

SUMMER

Select Type of Cooling Fuel:	Electric	*(Default)*
Cooling Plant Efficiency **(EER)**:	7.00	**EER**
Annual Cooling Hours:	1,407	CDD
Annual Total Input Cooling Fuel Savings During Summer Season By Replacing Windows	28,453	kWh
Estimated Total Annual Input Cooling Energy Savings Achieved By Controlling Air Leakage Through Windows	10,771	kWh
Estimated Total Input Cooling Fuel Savings From Replacing Windows	39,225	kWh

ENERGY & COST ANALYSIS

Insert Cost of Heating Fuel:	$1.36	$/Therm	Annual Heating Cost Savings:	$2,784.78	$$
Insert Cost of Cooling Fuel:	$0.15	$/kWh	Annual Cooling Cost Savings:	$5,971.73	$$
Total Annual Cost Savings	$8,844		Total Annual Cost Savings From Heating & Cooling:	$8,757	$$
Cost of window upgrade:	$305,379		Estimated Annual O&M Savings	$88	$
Simple payback:	34.53	**Yrs**	*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:	$305,379	Simple Payback	34.53 Yrs
Annual Energy Cost Savings:	$8,844		

APPENDIX F:
Solar PV

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

Select State: Northern California **Electric Rate:** $0.15 $/KWH Annual Electric Consumption: 394,838 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	46.50	47	148	77,515	77,515	$11,798	$162,750	13.8	$0	$48,825	$1,705	$0	8.2
2	Building 2	1	9	9	28	14,503	14,503	$2,207	$30,450	13.8	$0	$9,135	$319	$0	8.2
3	Building 3	1	13	13	41	21,504	21,504	$3,273	$45,150	13.8	$0	$13,545	$473	$0	8.2
4	Building 4	1	8	8	26	13,836	13,836	$2,106	$29,050	13.8	$0	$8,715	$304	$0	8.2
5	Building 5	1	8	8	24	12,836	12,836	$1,954	$26,950	13.8	$0	$8,085	$282	$0	8.2
6				0	0		0	$0	$0		$0	$0	$0	$0	
7				0	0		0	$0	$0		$0	$0	$0	$0	
8				0	0		0	$0	$0		$0	$0	$0	$0	
9				0	0		0	$0	$0		$0	$0	$0	$0	
10				0	0		0	$0	$0		$0	$0	$0	$0	
		5		**84**	**267**	**140,194.0**	**140,194**	**$21,338**	**$294,350**	**13.79**	**$0**	**$88,305**	**$3,084**	**$0**	**8.21**

Solar Rooftop Photovoltaic Analysis		
Total Number of Roofs	5	
Estimated Number of Panels	267	
Estimated KW Rating	84	KW
Potential Annual KWh Produced	140,194	KWh
% of Current Electricity Load	35.5%	

Financial Analysis		
Investment Cost	$294,350	
Estimated Energy Cost Savings	$21,338	
Potential Rebates	$88,305	
Potential Annual Incentives	$3,084	
Payback without Incentives	13.8	years
Incentive Payback but without SRECS	8.2	years
Payback with All Incentives	8.2	years