LEVEL II ENERGY AUDIT

Sacramento City Unified School District
5735 47th Avenue
Sacramento, California 95824

DLR Group
1050 20th Street, Suite 250
Sacramento, California 95811

PREPARED BY:
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EMG PROJECT #:

136988.19R000-070.268

DATE OF REPORT:

November 22, 2019

ONSITE DATE:

September 3, 2019

ZERO NET ENERGY ASHRAE LEVEL II AUDIT

CALIFORNIA MONTESSORI PROJECT – CAPITOL CAMPUS

2635 Chestnut Hill Drive

Sacramento, CA 95826

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Certification

EMG has completed an Energy Audit of California Montessori Project - Capitol Campus located at 2635 Chestnut Hill Drive in Sacramento, CA. EMG visited the site on September 3, 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, CA. 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: Henry Guo
Energy Auditor
Project Manager

Reviewed by: 

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 California Montessori Project - Capitol Campus 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	Building 001	School	5,768	51
2	Building 002	School	9,876	87
3	Building 003	School	10,479	93
4	Building 004	School	11,489	101
5	P01 – Portable Classroom 14	School	983	8
6	P02 – Portable Classroom 15	School	960	8
7	P03 – Portable Classroom 19 & 20	School	1800	16
8	P04 – 4th R	School	1920	17

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 six 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)*	$124,519 *(In Current Dollars)*
Estimated Annual Cost Savings *(Current Dollars Only)*	$14,949 *(In Current Dollars)*
ECM Effective Payback	8.33 years
Estimated Annual Energy Savings	35.20%
Estimated Annual Energy Utility Cost Savings *(Excluding Water)*	31.68%

Estimated Annual Water Cost Saving	1.16%

Solar Photovoltaic (PV) Screening for CALIFORNIA MONTESSORI PROJECT - CAPITOL CAMPUS

SOLAR ROOFTOP PHOTOVOLTAIC ANALYSIS		
Estimated Number of Panels	5	
Estimated KW Rating	101	KW
Potential Annual kWh Produced	153,302	kWh
% of Current Electricity Uses	97.7%	
FINANCIAL SUMMARY		
Investment Cost	$354,900	
Estimated Energy Cost Savings	$27,594	
Payback without Incentives	12.9	Years
Incentive Payback but without SRECs	7.8	Years
Payback with All Incentives	7.8	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)	25 kBtu/ft^2
Post ECM Site Energy Use Intensity (EUI)	16 kBtu/ft^2
SOURCE ENERGY USE INTENSITY (EUI)	**RATING**
Current Source Energy Use Intensity (EUI)	54 kBtu/ft^2
Post ECM Source Energy Use Intensity (EUI)	37 kBtu/ft^2
BUILDING COST INTENSITY (BCI)	**RATING**
Current Building Cost Intensity	$0.81/ft^2
Post ECM Building Cost Intensity	$0.55/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	378 MMbtu
Total CO_2 Emissions Reduced	26.85 $MtCO_2$/Yr
Total Cars Off the Road (Equivalent)*	5
Total Acres of Pine Trees Planted (Equivalent)*	6

**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	1,074,311 kBtu
Total Annual Energy Savings for Non-Renewable Energy Measures	178,02 kBtu
Total Annual Energy Savings from Renewable Energy Measures	523,066 kBtu
Total Annual Energy Savings	701,168 kBtu
Net Energy Consumption from Grid Post Implementation	373,142 kBtu
% Energy Reduction (Annual Energy-Net Energy) / (Annual Energy)	65%

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 California Montessori Project - Capitol Campus

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	$594	383	0	71	$700	$0	$700	0.85	10.05	$5,375	10.00
Totals for No/Low Cost Items		**$594**	**383**	**0**	**71**	**$700**	**$0**	**$700**	**0.85**			
Capital Cost Recommendations												
1	Install Timers On Exhaust Fans Location: Throughout	$2,477	569	5,496	0	$1,719	$0	$1,719	1.44	8.28	$18,043	15.00
2	Upgrade Electric Heating System To Heat Pumps Location: Portable Classrooms	$9,419	0	10,550	0	$1,885	$0	$1,885	5.00	2.98	$18,621	20.00
3	Re-Commission The Building & Its Control Systems Location: Throughout	$19,377	624	9,951	0	$2,587	$0	$2,587	7.49	1.59	$11,502	15.00
4	Upgrade Building Lighting to LED and Install Automatic Lighting Controls Location: Building Interior And Exterior	$53,827	0	20,093	0	$3,589	$3,981	$7,571	7.11	1.68	$36,552	15.00
5	Control External Air Leakage In Commercial Buildings Location: Extrior Doors	$22,583	880	5,073	0	$2,046	$102	$2,149	10.51	1.14	$3,067	15.00
Total For Capital Cost		**$107,684**	**2,073**	**51,164**	**0**	**$11,826**	**$4,084**	**$15,910**	**6.77**			
	Interactive Savings Discount @ 10%		-246	-5,116	-7	-$1,253	-$408	-$1,661				
	Total Contingency Expenses @ 15%	$16,242										
Total for Improvements		**$124,519**	**2,210**	**46,047**	**64**	**$11,273**	**$3,675**	**$14,949**	**8.33**			

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 California Montessori Project - Capitol Campus

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	Install Low Flow Tankless Restroom Fixtures Location: Restrooms	$10,524	0	0	260	$746	$0	$746	14.10	0.85	-$1,616	15.00
2	Add Reflective Coating To Exterior Windows Location: Throughout	$80,482	2,146	11,500	0	$4,835	$242	$5,077	15.85	0.64	-$19,872	15.00
3	Upgrade Insulation Location: Attic/Ceiling Throughout	$109,804	1,793	9,610	0	$4,040	$0	$4,040	27.18	0.64	-$39,448	25.00
4	Replace External Windows Location: Throughout	$254,482	1,469	33,895	0	$7,959	7,959	$79.59	3197.55	0.55	-$114,511	25.00
Total for Improvements		**$10,524**	**0**	**0**	**260**	**$746**	**$0**	**$746**	**14.10**			

2. Introduction

The purpose of this Energy Audit is to provide California Montessori Project - Capitol Campus 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	38
Estimated Facility Occupancy	382
% of Male Occupants	50%

POINT OF CONTACT	
Point of Contact Name	Fong Vang
Point of Contact Title	Plant Manager
Point of Contact – Contact Number	916.325.0910

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

Description:

Building 001 is heated and cooled by two packaged units replaced in 2003 located adjacent to the building. Building 002 is heated and cooled by three split-system heat pumps located on the roof which were replaced in 2003. Buildings 003, 004, and P01 are heated and cooled by 11 total split-system heat pumps on the roofs each feeding a classroom. Building P02 is heated and cooled by a wall-mounted heat pump installed in 1991. Building P03 is heated and cooled by a split-system heat pump replaced in 2017 and a packaged unit replaced in 2007 both mounted the rear of the building. Building P04 is heated and cooled by two wall-mounted heat pumps one of which was installed in 2019 and the other of unknown age.

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

BUILDING CENTRAL HEATING SYSTEM	
Primary Heating System	Forced Air Furnace
Secondary Heating System	Heat pump System
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	Split Systems
Secondary Cooling System	Air Cooled Heat pumps
Hydronic Distribution System	Not Applicable
Cooling Mode Set-point	68 °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 D.

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
$0.18 /kWh	$1.30/therm	$ 2.87/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.

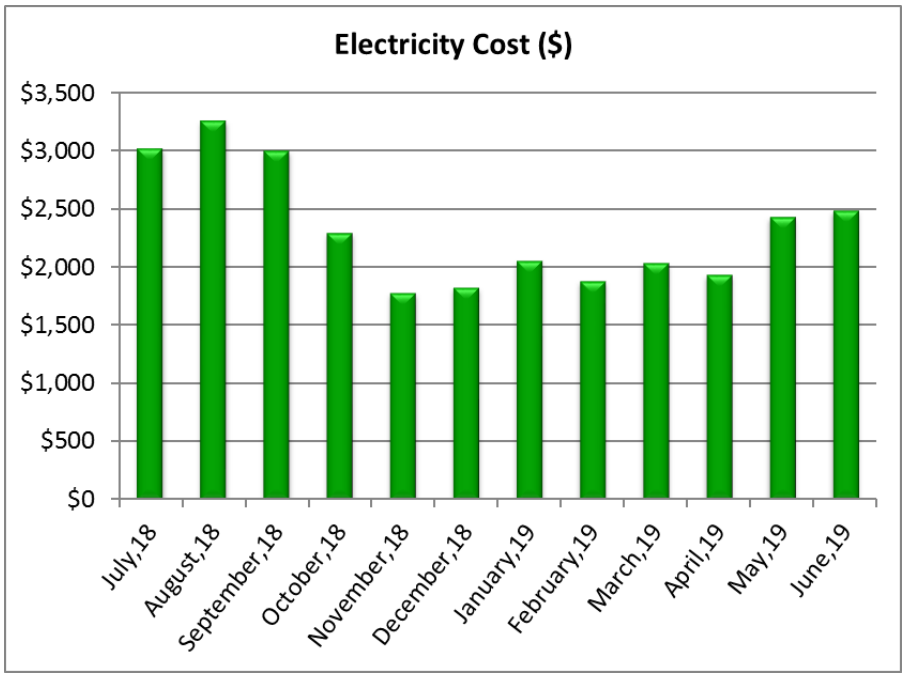
4.1. Electricity

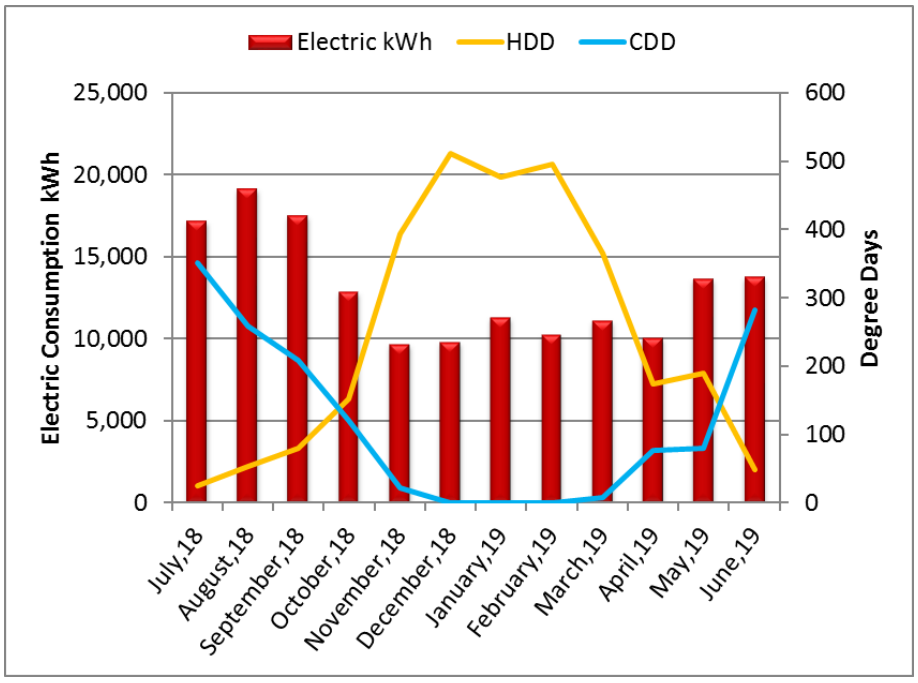
PGE satisfies the electricity requirements for the facility. The primary end uses for electric utility compromises of lighting, cooling, office/school equipment, and appliances in the break room.

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	17,243	$0.18	$3,019
August,18	19,196	$0.17	$3,262
September,18	17,561	$0.17	$3,005
October,18	12,910	$0.18	$2,294
November,18	9,672	$0.18	$1,783
December,18	9,836	$0.19	$1,823
January,19	11,341	$0.18	$2,056
February,19	10,312	$0.18	$1,882
March,19	11,114	$0.18	$2,033
April,19	10,125	$0.19	$1,939
May,19	13,680	$0.18	$2,433
June,19	13,843	$0.18	$2,489
Total/average	**156,832**	**$0.18**	**$28,017**


Electricity Cost ($)
$3,500
$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


Electric kWh
HDD
CDD
Electric Consumption kWh
Degree Days
25,000
20,000
15,000
10,000
5,000
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

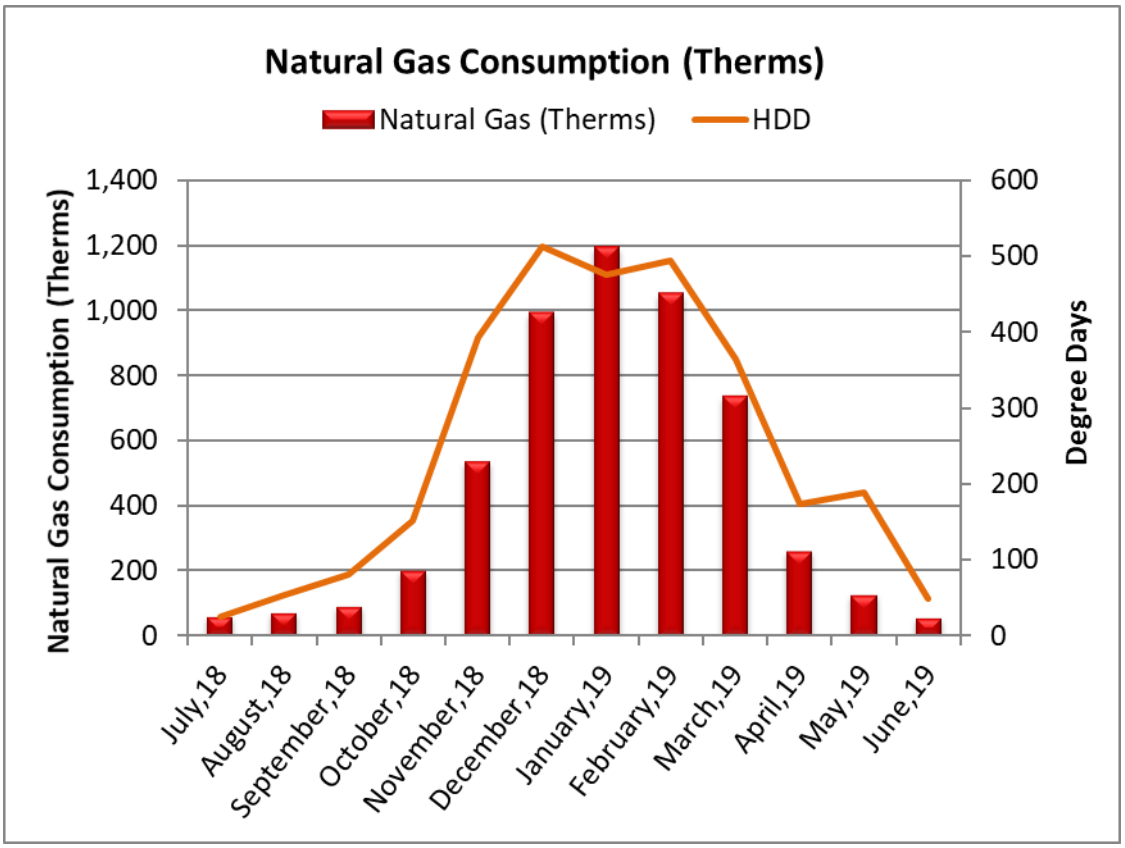
4.2. Natural Gas

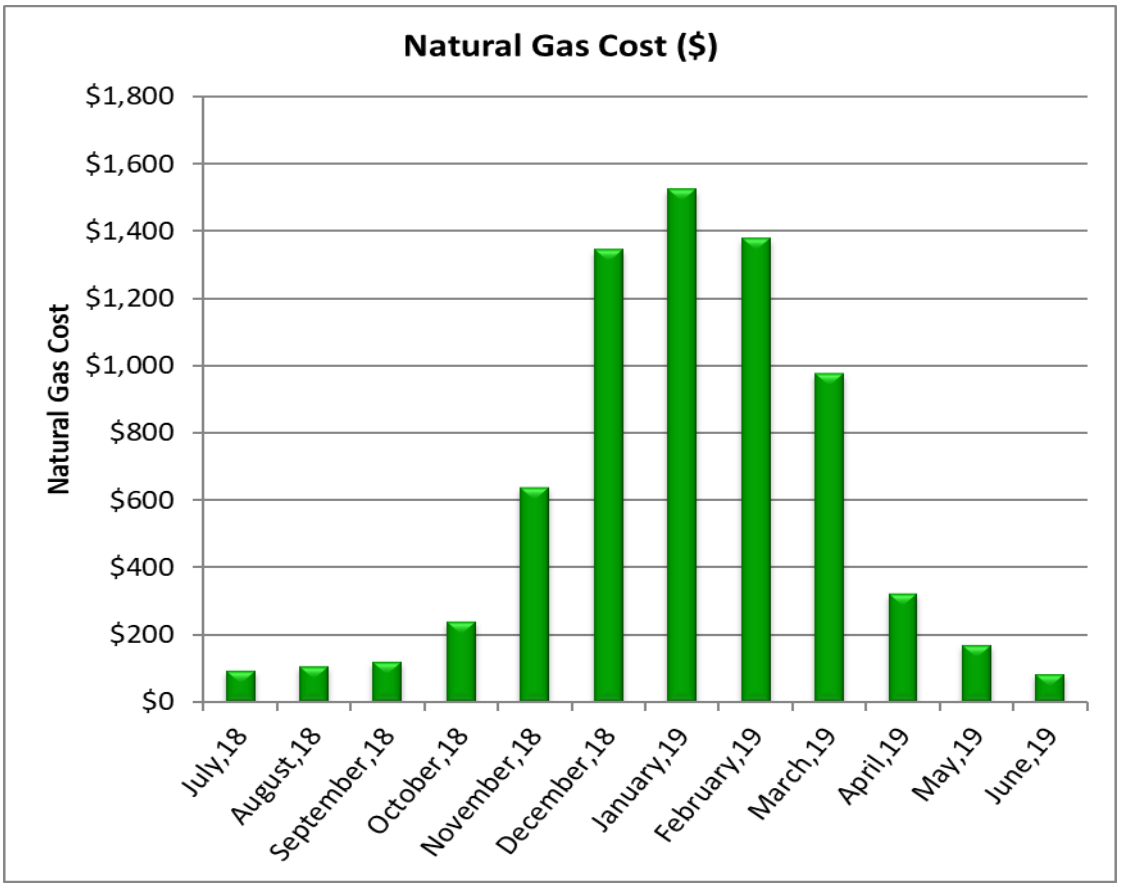
Spurr Gas satisfies the natural gas requirements of the facility. The primary end use of natural gas is for building heating, domestic water heating, and cooking in the cafeteria.

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	61	$1.52	$93
August,18	74	$1.44	$106
September,18	92	$1.31	$120
October,18	201	$1.18	$237
November,18	536	$1.19	$636
December,18	994	$1.35	$1,344
January,19	1,196	$1.28	$1,525
February,19	1,053	$1.31	$1,378
March,19	737	$1.32	$976
April,19	263	$1.23	$322
May,19	128	$1.31	$168
June,19	57	$1.43	$82
Total/average	**5,392**	**$1.30**	**$6,987**


Natural Gas Consumption (Therms)
Natural Gas (Therms)
HDD
Natural Gas Consumption (Therms)
Degree Days
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

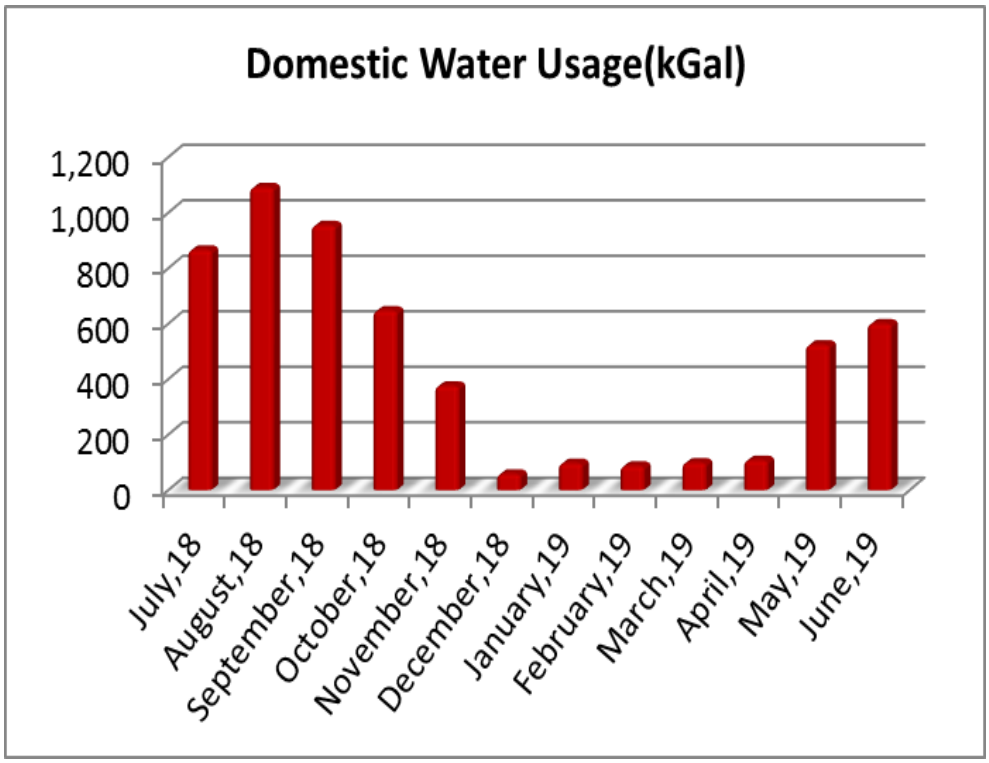

Natural Gas Cost ($)
Natural Gas Cost
$1,800
$1,600
$1,400
$1,200
$1,000
$800
$600
$400
$200
$0
July,18
August,18
September,18
October,18
November,18
December,18
January,19
February,19
March,19
April,19
May,19
June,19

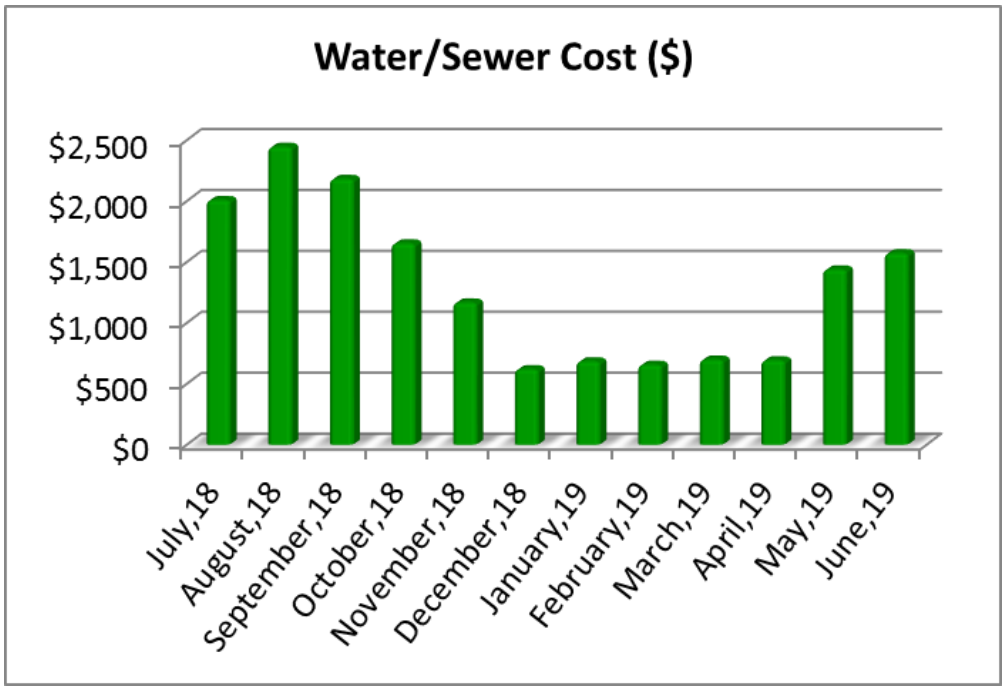
4.3. Water and Sewer

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	867	$2.32	$2,010
August,18	1,092	$2.24	$2,447
September,18	956	$2.28	$2,184
October,18	648	$2.55	$1,654
November,18	377	$3.10	$1,169
December,18	60	$10.42	$622
January,19	98	$6.99	$686
February,19	89	$7.41	$658
March,19	100	$7.00	$700
April,19	109	$6.38	$695
May,19	525	$2.74	$1,440
June,19	601	$2.62	$1,574
Total/average	**5,521**	**$2.87**	**$15,838**


Domestic Water Usage(kGal)
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


Water/Sewer 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

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?	To be analyzed
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	5	
Estimated KW Rating	101	KW
Potential Annual kWh Produced	153,302	kWh
% of Current Electricity Uses	97.7%	
FINANCIAL SUMMARY		
Investment Cost	$354,900	
Estimated Energy Cost Savings	$27,594	
Payback without Incentives	12.9	Years
Incentive Payback but without SRECs	7.8	Years
Payback with All Incentives	7.8	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) **I**nvestment 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	Room Number	Space Served	Quantity
Heat Pump	Bard	T42S1-A05SP4XXE	391H193664461-02	3.5 TON	Building exterior	P04 - 4th R	1
Water Heater	Rheem	G75-75N-1	RRLN0507D16071	70 MBH, 75 GAL	B001, Boiler Rm. Number 1	Building 001	1
Furnace	Lennox	ML195UH070XP36B-58	1717E14060	70 MBH	O020, Classroom 20	P03 - Portable Classrooms 19 & 20	1
Furnace	Carrier	58DLX110---10122	2503A42841	110 MBH	O009, Classroom 9	Building 004	1
Water Heater	A. O. Smith	FGR 40 248	GG02-0802349-248	38 MBH, 40 GAL	B001, boiler rm. number 2	Building 002	1
Condensing Unit/Heat Pump	Carrier	38CK060570	3003E16337	5 TON	Roof	Building 002	1
Condensing Unit/Heat Pump	Carrier	38CK060570	3003E16247	5 TON	Roof	Building 003	1
Heat Pump	Marvair	Illegible	Illegible	3.5 TON	Building exterior	P04 - 4th R	1
Packaged Unit (RTU)	AAON, Inc.	RK-16-2-E0-212: F0CED0E0H00S0X	2003-08-AKGM50895	270 MBH, 16 TON	South Mechanical Yard	Building 001	1
Packaged Unit (RTU)	AAON, Inc.	RK-03-2-F0-212: DACAA000H00S0X	2003-08-AKGB50935	69 MBH, 3 TON	East Mechanical Yard	Building 001	1
Packaged Unit (RTU)	Carrier	48ESN036090301	1807G21319	90 MBH, 3 TON	Building exterior	P03 - Portable Classrooms 19 & 20	1
Condensing Unit/Heat Pump	Carrier	38CK060570	3003E16343	5 TON	Roof	Building 002	1
Condensing Unit/Heat Pump	Carrier	38CK060570	3003E16371	5 TON	Roof	Building 003	1
Condensing Unit/Heat Pump	Carrier	38CK060570	3003E16340	5 TON	Roof	Building 004	1
Condensing Unit/Heat Pump	Carrier	38CK060570	3003E16352	5 TON	Roof	Building 004	1
Condensing Unit/Heat Pump	Carrier	38CK060570	3003E16341	5 TON	Roof	Building 004	1
Condensing Unit/Heat Pump	Carrier	38CK060570	3003E16369	5 TON	Roof	Building 003	1
Condensing Unit/Heat Pump	Carrier	38CK060570	3003E16375	5 TON	Roof	Building 004	1
Condensing Unit/Heat Pump	Carrier	38CK060570	3003E14193	5 TON	Roof	Building 003	1
Condensing Unit/Heat Pump	Carrier	38CK060570	3003E16373	5 TON	Roof	Building 004	1
Condensing Unit/Heat Pump	Carrier	38CK060570	3003E16350	5 TON	Roof	Building 003	1
Condensing Unit/Heat Pump	Carrier	38BRC036300	3197E14967	3 TON	Roof	P01 - Portable Classroom 14	1
Condensing Unit/Heat Pump	Lennox	ML14XC1-036-230B06	1917H13012	3 TON	Building exterior	P03 - Portable Classrooms 19 & 20	1
Condensing Unit/Heat Pump	Carrier	38ARZ008-501	2202G20057	7.5 TON	Roof	Building 002	1
Exhaust Fan	Greenheck	SB-071-4X-QD-R3	03H08774	No tag/plate found	Roof	Building 001	1
Exhaust Fan	Greenheck	SB-071-4X-QD-R3	04D28545	No tag/plate found	Roof	Building 001	1
Exhaust Fan	Greenheck	SB-091-4X-QD-R2	04E13863	No tag/plate found	Roof	Building 001	1
Exhaust Fan	JennAir	18I BCRG	LG	No tag/plate found	Roof	Building 001	1
Exhaust Fan	JennAir	91CRA EG	No tag/plate found	No tag/plate found	Roof	Building 001	1
Exhaust Fan	JennAir	18I BCRG	EG	No tag/plate found	Roof	Building 001	1
Exhaust Fan	Greenheck	SB-091-4X-QD-R2	04E13860	No tag/plate found	Roof	Building 001	1
Furnace	Carrier	58DLX110---10122	Inaccessible	110 MBH	O010, Classroom 10	Building 004	1
Furnace	Carrier	58DLX110---10122	2603A42837	110 MBH	Y001, Classroom 1	Building 002	1
Furnace	Carrier	58DLX110---10122	2603A42845	110 MBH	O011, Classroom 11	Building 004	1
Furnace	Carrier	58DLX110---10122	2603A42836	110 MBH	O012, Classroom 12	Building 004	1
Furnace	Reznor	CAUA200-2	BCH77X2N07896	200 MBH	B001, boiler rm. number 2	Building 002	1
Furnace	Carrier	58DLX110---10122	2603A42825	110 MBH	Y002, Classroom 2	Building 002	1
Furnace	Carrier	58DLX110---10122	2603A42832	110 MBH	O003, Classroom 3	Building 003	1
Furnace	Carrier	58DLX110---10122	2603A42835	110 MBH	O004, Classroom 4	Building 003	1
Furnace	Carrier	58DLX110---10122	2603A42827	110 MBH	O005, Classroom 5	Building 003	1
Furnace	Carrier	58DLX110---10122	2603A42831	110 MBH	O007, Classroom 7	Building 003	1
Furnace	Carrier	58DLX110---10122	2603A42834	110 MBH	O003, Classroom 3	Building 003	1
Furnace	Carrier	58DLX110---10122	Inaccessible	110 MBH	X008, Classroom 8	Building 004	1
Furnace	Carrier	58PAU070-12	2998A07953	70 MBH	O014, Classroom 14	P01 - Portable Classroom 14	1
Heat Pump	Bard	36WH7-A05C	087K910693616	3 TON	Building exterior	P02 - Portable Classroom 15	1
Water Heater	Rheem	82SV30-2	0208R00276	30 GAL	J001, janitor's closet	Building 004	1

APPENDIX C:
Lighting System Schedule

										Lamp Details				Fixture Details				Existing Consumption	
Line No.	Building Name	Interior/ Exterior	Floor	Space Type	Room No.	Additional Area Description	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	Montessori School	Exterior	0	CAFETERIA	Exterior	Building Exterior	-	1	Photosensor	HID	MH	MH400	2	Wallpack-Horizontal	2	0	15	2,280	1,824
2	Montessori School	Exterior	0	CAFETERIA	Exterior	Building Exterior	-	1	Photosensor	HID	HPS	HPS150	3	Wallpack-Horizontal	3	0	8	2,280	1,026
3	Montessori School	Exterior	0	CAFETERIA	Exterior	Building Exterior	-	1	Photosensor	HID	MV	MV175	1	Cobra Head	1	0	18	2,280	399
4	Montessori School	Exterior	0	CAFETERIA	Exterior	Building Exterior	-	1	Photosensor	HID	HPS	HPS250	2	Wallpack-Horizontal	2	0	8	2,280	1,140
5	Montessori School	Exterior	0	CAFETERIA	Exterior	Building Exterior	-	1	Photosensor	HID	MH	MH250	1	Wallpack-Horizontal	1	0	8	2,280	570
6	Montessori School	Exterior	0	CAFETERIA	Exterior	Building Exterior	-	1	Photosensor	HID	HPS	HPS400	3	Wallpack-Horizontal	3	0	10	2,280	2,736
7	Montessori School	Interior	1	KITCHEN	Kitchen	MPR Kitchen	75	2	Light Switch	CFL	CFL - Screw-in	CFL13	5	Surface Mount Can	5	0	8	1,900	124
8	Montessori School	Interior	1	KITCHEN	Kitchen	MPR Kitchen	75	2	Light Switch	Linear Fluorescent	T8	4' 32W T8	2	1x4 Prism Troffer	1	0	8	1,900	122
9	Montessori School	Interior	1	OPEN OFFICE	001-D001	Resource Room	70	1	Light Switch	CFL	CFL - Screw-in	CFL13	2	Surface Mount Can	2	0	8	2,280	59
10	Montessori School	Interior	1	CAFETERIA	001-U00H	MPR	200	2	Light Switch	Linear Fluorescent	T8	4' 32W T8	36	2x4 Parabolic Troffer	12	0	24	2,280	2,627
11	Montessori School	Interior	1	CAFETERIA	001-U00H	MPR	200	2	Light Switch	Linear Fluorescent	T8	4' 32W T8	36	2x4 Parabolic Troffer	12	0	24	2,280	2,627
12	Montessori School	Interior	1	CLASSROOM	14	Portable 14	445	2	Light Switch	Linear Fluorescent	T8	8' 86W T8	6	Strip Fixture	3	0	8	2,280	1,176
13	Montessori School	Interior	1	CLASSROOM	14	Portable 14	445	2	Light Switch	Linear Fluorescent	T8	8' 86W T8	6	Strip Fixture	3	0	8	2,280	1,176
14	Montessori School	Interior	1	CLASSROOM	15	Portable 15	120	2	Light Switch	Linear Fluorescent	T8	4' 32W T8	14	2x4 Parabolic Troffer	7	0	8	2,280	1,021
15	Montessori School	Interior	1	CLASSROOM	15	Portable 15	120	2	Light Switch	Linear Fluorescent	T8	4' 32W T8	16	2x4 Parabolic Troffer	8	0	8	2,280	1,167
16	Montessori School	Interior	1	CLASSROOM	19 & 20	Portable 19 & 20	265	4	Light Switch	Linear Fluorescent	T8	4' 32W T8	24	2x4 Parabolic Troffer	12	0	12	2,280	1,751
17	Montessori School	Interior	1	CLASSROOM	19 & 20	Portable 19 & 20	265	4	Light Switch	Linear Fluorescent	T8	4' 32W T8	24	2x4 Parabolic Troffer	12	0	12	2,280	1,751
18	Montessori School	Interior	1	CLASSROOM	3 thru 12	Building 004	365	20	Light Switch	Linear Fluorescent	T8	4' 32W T8	36	2x4 Parabolic Troffer	12	0	12	2,280	2,627
19	Montessori School	Interior	1	CLASSROOM	002-Y001 / 002-Y002	indergarten 1 & 2	285	6	Light Switch	Linear Fluorescent	T8	4' 32W T8	36	2x4 Parabolic Troffer	12	0	12	2,280	2,627
20	Montessori School	Interior	1	CLASSROOM	002-Y001 / 002-Y002	indergarten 1 & 2	285	6	Light Switch	Incan/H/MR	Incan	I60-A19	2	Recessed Can-hor8"	2	0	8	2,280	274
21	Montessori School	Interior	1	OPEN OFFICE	002-H001	Main Office	100	3	Light Switch	Linear Fluorescent	T8	4' 32W T8	10	1x4 Parabolic Troffer	5	0	8	2,280	730
22	Montessori School	Interior	1	OFFICE	002-C00E	Dean's Office	-	2	Light Switch	Linear Fluorescent	T8	4' 32W T8	6	2x4 Parabolic Troffer	3	0	10	2,280	438
23	Montessori School	Interior	1	OPEN OFFICE	002-H001	Main Office	100	3	Light Switch	Linear Fluorescent	T8	4' 32W T8	10	2x4 Parabolic Troffer	5	0	8	2,280	730
24	Montessori School	Interior	1	OFFICE	002-C00C	Office	250	1	Light Switch	Linear Fluorescent	T8	4' 32W T8	6	1x4 Parabolic Troffer	3	0	10	2,280	438
25	Montessori School	Interior	1	OFFICE	002-C00P	Principal	200	1	Light Switch	Linear Fluorescent	T8	4' 32W T8	4	1x4 Parabolic Troffer	2	0	10	2,280	292
26	Montessori School	Interior	1	OPEN OFFICE	None	achers / Break ro	305	1	Light Switch	Linear Fluorescent	T8	4' 32W T8	4	2x4 Parabolic Troffer	2	0	10	2,280	292
27	Montessori School	Interior		RESTROOM	003-T003 & 004-T001	Boys & Girls RRS	65	4	Light Switch	CFL	CFL - Screw-in	CFL13	3	Surface Mount Can	3	0	10	2,280	89
28	Montessori School	Interior	1	STORAGE	003-S001	Book Room	75	1	Light Switch	Incan/H/MR	Incan	I60-A19	6	Jelly Jar-vert	6	0	10	722	260
29	Montessori School	Interior	1	CLASSROOM	P04	Club Montessori	185	10	Light Switch	Linear Fluorescent	T8	4' 32W T8	6	2x4 Parabolic Troffer	2	0	8	2,280	438
30	Montessori School	Interior	1	CLASSROOM	P04	Club Montessori	185	10	Light Switch	Linear Fluorescent	T8	4' 32W T8	3	2x4 Parabolic Troffer	1	0	8	2,280	219
31	Montessori School	Interior	1	CLASSROOM	P04	Club Montessori	185	10	Light Switch	Linear Fluorescent	T8	4' 32W T8	3	2x4 Parabolic Troffer	1	0	8	2,280	219
32	Montessori School	Interior	1	CLASSROOM	P04	Club Montessori	185	10	Light Switch	Linear Fluorescent	T8	4' 32W T8	3	2x4 Parabolic Troffer	1	0	8	2,280	219
33	Montessori School	Interior	1	CLASSROOM	P04	Club Montessori	185	10	Light Switch	Linear Fluorescent	T8	4' 32W T8	3	2x4 Parabolic Troffer	1	0	8	2,280	219
34	Montessori School	Interior	1	CLASSROOM	P04	Club Montessori	185	10	Light Switch	Linear Fluorescent	T8	4' 32W T8	6	2x4 Parabolic Troffer	2	0	8	2,280	438
35	Montessori School	Interior	1	RESTROOM	004-T003	Men's Restroom	65	1	Light Switch	CFL	CFL - Screw-in	CFL13	4	Surface Mount Can	2	0	8	2,280	119
36	Montessori School	Interior		STORAGE	002-Y001 / 002-Y002	rgarten Storage (	125	2	Light Switch	CFL	CFL - Screw-in	CFL13	2	Surface Mount Can	1	0	12	722	19
37	Montessori School	Interior		RESTROOM	002-Y001 / 002-Y002	dergarten Restro	150	2	Light Switch	CFL	CFL - Screw-in	CFL13	2	Surface Mount Can	1	0	12	2,280	59
38	Montessori School	Interior		ESTROOM - PRIVAT	002-C00E	ns Office Restro	-	1	Light Switch	Incan/H/MR	Incan	I60-A19	2	Can-Surf Mount	1	0	10	950	114
	Totals												340		157			81,434	32,152

									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	Montessori School	Exterior	0	CAFETERIA	Exterior	Building Exterior	Photosensor	1	HID	MH	MH400; Wallpack-Horizontal	2	2	15	2,280	1,824	ECM	RF - Replace Entire Fixture	Photo Sensor	40W LED Wall Pack	2,052	164	1,660
2	Montessori School	Exterior	0	CAFETERIA	Exterior	Building Exterior	Photosensor	1	HID	HPS	HPS150; Wallpack-Horizontal	3	3	8	2,280	1,026	ECM	RF - Replace Entire Fixture	Photo Sensor	30W LED Wall Pack	2,052	185	841
3	Montessori School	Exterior	0	CAFETERIA	Exterior	Building Exterior	Photosensor	1	HID	MV	MV175; Cobra Head	1	1	18	2,280	399	ECM	RF - Replace Entire Fixture	Photo Sensor	75W LED Cobra	2,052	154	245
4	Montessori School	Exterior	0	CAFETERIA	Exterior	Building Exterior	Photosensor	1	HID	HPS	HPS250; Wallpack-Horizontal	2	2	8	2,280	1,140	ECM	RF - Replace Entire Fixture	Photo Sensor	37W LED Wall Pack	2,052	152	988
5	Montessori School	Exterior	0	CAFETERIA	Exterior	Building Exterior	Photosensor	1	HID	MH	MH250; Wallpack-Horizontal	1	1	8	2,280	570	ECM	RF - Replace Entire Fixture	Photo Sensor	70W LED Wallpack	2,052	144	426
6	Montessori School	Exterior	0	CAFETERIA	Exterior	Building Exterior	Photosensor	1	HID	HPS	HPS400; Wallpack-Horizontal	3	3	10	2,280	2,736	ECM	RF - Replace Entire Fixture	Photo Sensor	37W LED Wall Pack	2,052	228	2,508
7	Montessori School	Interior	1	KITCHEN	Kitchen	MPR Kitchen	Light Switch	2	CFL	CFL - Screw-in	CFL13; Surface Mount Can	5	5	8	1,900	124	ECM	RB - Replace Bulb	Retain Existing Controls	6W LED A19	1,900	105	19
8	Montessori School	Interior	1	KITCHEN	Kitchen	MPR Kitchen	Light Switch	2	Linear Fluorescent	T8	4' 32W T8; 1x4 Prism Troffer	1	2	8	1,900	122	ECM	RB - Replace Bulb	Retain Existing Controls	4' 17W LED T8	1,900	65	57
9	Montessori School	Interior	1	OPEN OFFICE	001-D001	Resource Room	Light Switch	1	CFL	CFL - Screw-in	CFL13; Surface Mount Can	2	2	8	2,280	59	ECM	RB - Replace Bulb	Retain Existing Controls	6W LED A19	2,280	50	9
10	Montessori School	Interior	1	CAFETERIA	001-U00H	MPR	Light Switch	2	Linear Fluorescent	T8	4' 32W T8; 2x4 Parabolic Troffer	12	36	24	2,280	2,627	ECM	RB - Replace Bulb	Ceiling Mounted	4' 17W LED T8	1,938	1,186	1,441
11	Montessori School	Interior	1	CAFETERIA	001-U00H	MPR	Light Switch	2	Linear Fluorescent	T8	4' 32W T8; 2x4 Parabolic Troffer	12	36	24	2,280	2,627	ECM	RB - Replace Bulb	Ceiling Mounted	4' 17W LED T8	1,938	1,186	1,441
13	Montessori School	Interior	1	CLASSROOM	14	Portable 14	Light Switch	2	Linear Fluorescent	T8	8' 86W T8; Strip Fixture	3	6	8	2,280	1,176	ECM	RB - Replace Bulb	Ceiling Mounted	8' 40W LED T8	1,938	465	711
15	Montessori School	Interior	1	CLASSROOM	15	Portable 15	Light Switch	2	Linear Fluorescent	T8	4' 32W T8; 2x4 Parabolic Troffer	8	16	8	2,280	1,167	ECM	RB - Replace Bulb	Ceiling Mounted	4' 17W LED T8	1,938	527	640
17	Montessori School	Interior	1	CLASSROOM	19 & 20	Portable 19 & 20	Light Switch	4	Linear Fluorescent	T8	4' 32W T8; 2x4 Parabolic Troffer	12	24	12	2,280	1,751	ECM	RB - Replace Bulb	Ceiling Mounted	4' 17W LED T8	1,938	791	960
19	Montessori School	Interior	1	CLASSROOM	002-Y001 / 002-Y002	Kindergarten 1 & 2	Light Switch	6	Linear Fluorescent	T8	4' 32W T8; 2x4 Parabolic Troffer	12	36	12	2,280	2,627	ECM	RB - Replace Bulb	Ceiling Mounted	4' 17W LED T8	1,938	1,186	1,441
21	Montessori School	Interior	1	OPEN OFFICE	002-H001	Main Office	Light Switch	3	Linear Fluorescent	T8	4' 32W T8; 1x4 Parabolic Troffer	5	10	8	2,280	730	ECM	RB - Replace Bulb	Retain Existing Controls	4' 17W LED T8	2,280	388	342
22	Montessori School	Interior	1	OFFICE	002-C00E	Dean's Office	Light Switch	2	Linear Fluorescent	T8	4' 32W T8; 2x4 Parabolic Troffer	3	6	10	2,280	438	ECM	RB - Replace Bulb	Retain Existing Controls	4' 17W LED T8	2,280	233	205
24	Montessori School	Interior	1	OFFICE	002-C00C	Office	Light Switch	1	Linear Fluorescent	T8	4' 32W T8; 1x4 Parabolic Troffer	3	6	10	2,280	438	ECM	RB - Replace Bulb	Ceiling Mounted	4' 17W LED T8	1,938	198	240
25	Montessori School	Interior	1	OFFICE	002-C00P	Principal	Light Switch	1	Linear Fluorescent	T8	4' 32W T8; 1x4 Parabolic Troffer	2	4	10	2,280	292	ECM	RB - Replace Bulb	Ceiling Mounted	4' 17W LED T8	1,938	132	160
26	Montessori School	Interior	1	OPEN OFFICE	None	Teachers / Break room	Light Switch	1	Linear Fluorescent	T8	4' 32W T8; 2x4 Parabolic Troffer	2	4	10	2,280	292	ECM	RB - Replace Bulb	Ceiling Mounted	4' 17W LED T8	1,938	132	160
27	Montessori School	Interior		RESTROOM	003-T003 & 004-T001	Boys & Girls RRS	Light Switch	4	CFL	CFL - Screw-in	CFL13; Surface Mount Can	3	3	10	2,280	89	ECM	RB - Replace Bulb	Ceiling Mounted	6W LED A19	1,938	64	25
28	Montessori School	Interior	1	STORAGE	003-S001	Book Room	Light Switch	1	Incan/H/MR	Incan	I60-A19; Jelly Jar-vert	6	6	10	722	260	ECM	RB - Replace Bulb	Ceiling Mounted	11W LED A19	614	41	219
32	Montessori School	Interior	1	CLASSROOM	P04	Club Montessori	Light Switch	10	Linear Fluorescent	T8	4' 32W T8; 2x4 Parabolic Troffer	1	3	8	2,280	219	ECM	RB - Replace Bulb	Ceiling Mounted	4' 17W LED T8	1,938	99	120
33	Montessori School	Interior	1	CLASSROOM	P04	Club Montessori	Light Switch	10	Linear Fluorescent	T8	4' 32W T8; 2x4 Parabolic Troffer	1	3	8	2,280	219	ECM	RB - Replace Bulb	Ceiling Mounted	4' 17W LED T8	1,938	99	120
34	Montessori School	Interior	1	CLASSROOM	P04	Club Montessori	Light Switch	10	Linear Fluorescent	T8	4' 32W T8; 2x4 Parabolic Troffer	2	6	8	2,280	438	ECM	RB - Replace Bulb	Ceiling Mounted	4' 17W LED T8	1,938	198	240
35	Montessori School	Interior	1	RESTROOM	004-T003	Men's Restroom	Light Switch	1	CFL	CFL - Screw-in	CFL13; Surface Mount Can	2	4	8	2,280	119	ECM	RB - Replace Bulb	Ceiling Mounted	6W LED A19	1,938	85	33
36	Montessori School	Interior		STORAGE	002-Y001 / 002-Y002	ndergarten Storage Clos	Light Switch	2	CFL	CFL - Screw-in	CFL13; Surface Mount Can	1	2	12	722	19	ECM	RB - Replace Bulb	Ceiling Mounted	6W LED A19	614	14	5
37	Montessori School	Interior		RESTROOM	002-Y001 / 002-Y002	Kindergarten Restroom	Light Switch	2	CFL	CFL - Screw-in	CFL13; Surface Mount Can	1	2	12	2,280	59	ECM	RB - Replace Bulb	Ceiling Mounted	6W LED A19	1,938	43	17
38	Montessori School	Interior		RESTROOM - PRIVATE	002-C00E	Deans Office Restroom	Light Switch	1	Incan/H/MR	Incan	I60-A19; Can-Surf Mount	1	2	10	950	114	ECM	RB - Replace Bulb	Retain Existing Controls	11W LED A19	950	21	93
	Totals												340									12,059	20,093

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: 38

Number of Occupied Days/Week (Max 7): 5

KITCHEN FAUCETS			BATHROOM FAUCETS		
Number of Occupants Affected By Retrofit	382		Number of Occupants Affected by Retrofit	382	
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	22		Total Number of Faucet Aerators To Be Replaced	17	
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	2		Estimated Number of Uses Per Day	4	

Annual Water Savings From Installing Low Flow Aerators: 71.07 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:	0.79	EF	Heating Fuel Tariff	$1.30	$/Therm
Hot Water Discharge Temperature at Faucet	110.00	°F	Water Tariff ($/1000 Gal)	$2.87	$/kGal
Equivalent Heating Fuel Savings:	383	Therms	Annual Cost Savings In Form of Water	$204	$
Savings Discounted by 15% to Account For Cold Water Use					
Annual Water Savings	71.07	kGal	Annual Energy Savings From Water Heater	$496	$

COST BENEFIT ANALYSIS				
Estimated Total Annual Cost Savings	$700	$$	Estimated Total Installation Cost	$594 $$
Simple Payback Period	0.85	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: $594 Estimated Annual Cost Savings: $700 Simple Payback Period (Yrs): 0.85

UIC	Install Timers On Exhaust Fans
EAC7A	Location: Throughout

Type of Exhaust Fan: Rooftop Exhaust Fans

EXISTING CONDITION

No. of Timers to Be Installed:	7	Qty	HP of Individual Fan Motor:	0.15	HP
No. of Exhaust Fans:	7		Total kW:	0.78	kW
Existing Daily Hours of Operation/Exhaust Fan:	20.00	Hrs/Day	Annual kWh For All Fans:	5,718	kWh

PROPOSED CONDITION

New Daily Hours With Timers/Exhaust Fan:	12.00	Hrs/Day	New Annual kWh For All Fans:	3,431	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	17	
			No. of Urinals In Building	9	
Total Exhuast CFM From All Fans	630	CFM	Total CFM for All Restroom Exhaust	1,300	CFM
Annual Heating Energy Savings	0	kbtu	Annual Heating Energy Savings	44,928	kbtu
Annual Cooling Energy Savings	0	kbtu	Annual Cooling Energy Savings	22,464	kbtu

Energy & Cost Savings

Estimated Annual Heating Plant Efficiency	79.00	**%**	Estimated Annual Cooling Plant Efficiency	7.00	EER
Annual Heating Energy Savings	569	Therms	Annual Cooling Energy Savings	3,209	kWh
Annual Electric Fan Motor Savings	2,287	kWh			

COST ANALYSIS

Electric Rate:	**$0.18**	$/kWh	Total Annual Electric Savings	5,496	kWh
Material Cost For Timers:	$1,185	$	Total Annual Non Electric Savings	569	Therms
Total Cost for Installing Timers	$2,477	$	Annual Cost savings:	$1,719	$
Simple Payback:	1.44	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:	$1,185	Simple Payback:	1.44	Years
Energy Cost Savings:	$1,719			

UIC	**Upgrade Electric Heating System To Heat Pumps**
EAH11-A	**Location: Portable Classrooms**

ASHRAE Climatic Zone: Zone-3

Portable Classrooms

Select Existing Heating System Type	**Heat Pump - Split System**		**PTAC**		**PTAC**		**PTAC**	
Number of Existing Systems:	3	Qty		Qty		Qty		Qty
Output Capacity of Heating System/Unit:	36,000.00	btuh		kW		kW		kW
Output Capacity of Heating System:	36,000	Btuh	0	Btuh	0	Btuh	0	Btuh
Existing COP of Heating System:	2.40	COP		COP		COP		COP
Estimated Annual Heating Hours:	950	Hrs		Hrs		Hrs		Hrs
Auxiliary Heating In Heatpumps:	5	kW		kW		kW		kW
Cooling Capacity of Each System:	36,000	Btuh		Btuh		Btuh		Btuh
Existing EER of Cooling System:	8.00	EER		EER		EER		EER
Estimated Annual Cooling Hours:	680	Hrs		Hrs		Hrs		Hrs
Install Programmable Thermostats With Heatpumps:	Yes		Yes		Yes		Yes	
Current Energy Consumption From Cooling:	9,180	kWh	0	kWh	0	kWh	0	kWh
Current Energy Consumption From Heating:	12,873	kWh	0	kWh	0	kWh	0	kWh
Total Existing Electric Consumption:	22,053	kWh	0	kWh	0	kWh	0	kWh

Proposed System

Heat pump Type	**Air-Source Split Heat Pump System**		**Air-Source PTHP System**		**Water-Source System**		**Water-Source System**	
Proposed Number of Systems:	3	Qty		Qty		Qty		Qty
Proposed Heat pump Capacity:	36,000	Btuh	-	Btuh	-	Btuh	-	Btuh
Proposed COP:	3.85	COP	-	COP	-	COP	-	COP
Proposed Emergency Heat Rating:	10.55	kW	0.00	kW	0.00	kW	0.00	kW
Proposed Energy Consumption From Cooling:	4,700	kWh	0	kWh	0	kWh	0	kWh
Proposed Energy Consumption From Heating:	6,803	kWh	0	kWh	0	kWh	0	kWh
Total Proposed Electric Consumption:	11,503	kWh	0	kWh	0	kWh	0	kWh
Total Electric Savings:	10,550	kWh	0	kWh	0	kWh	0	kWh
Total Cost For Replacement:	$9,418.72		$0.00		$0.00		$0.00	
Annual Energy Cost Savings:	$1,885		$0		$0		$0	
Individual Simple Payback	5.00	Yrs	-	Yrs	-	Yrs	-	Yrs

Total Initial Investment:	$9,418.72	Total Annual Electric Savings	10,550 kWh
Total Annual Cost Savings	$1,884.74	Overall Simple Payback Period:	5.00 Yrs

UIC	Re-Commission The Building & Its Control Systems		
EAC10	Location: Throughout		
Enter the Total Area of The Facility	43,275	SqFt	
Select the Type of Heating Fuel:	Natural Gas	*(Select)*	
Estimated Annual Heating Fuel Consumption:	4,162	Therms	
Is the Property Cooled?	Yes	*(Select)*	
Estimated Annual Electrical Energy Consumed For Cooling:	66,339	kWh	
Estimated Energy Savings From Re-Commissioning on Building Systems:	15%	*(Select)*	
Estimated Heating Energy Saving Post Re-Commissioning:	624	Therms	
Estimated Cooling Energy Saving Post Re-Commissioning:	9,951	kWh	
Average Heating Fuel Rate Paid By The Property:	$1.30	$/Therm	
Average Electrical Rate Paid By The Property:	$0.18	$/kWh	
Annual Energy Cost Savings:	$2,587	$	
Estimated Cost For Re-Commissioning The Facility: *(LBNL 2009 Report on Building Commissioning)*	$19,377	$	
Simple Payback Period:	7.49	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: $19,377 Simple Payback: 7.49 Years
Energy Cost Savings: $2,587

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	296	157	340	20,093	$3,588.67	$3,981.30

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	6	14	14	108	$19	$377
Circiline	T9	0	0	0	0	$0	$0
Incan/H/MR	H	0	0	0	0	$0	$0
Incan/H/MR	Incan	3	9	9	543	$97	$1,210
Incan/H/MR	MR	0	0	0	0	$0	$0
HID	HPS	3	8	8	4,338	$775	$196
HID	MH	2	3	3	2,086	$373	$85
HID	MV	1	1	1	245	$44	$33
HID	QL	0	0	0	0	$0	$0
Linear Fluorescent	T8	23	122	122	12,773	$2,281	$2,081
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	0	0	0	0	$0	$0
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	6	Ceiling Mounted	125
Wall Mounted	0		

Initial Investment		**Equipment Rentals**	
Material Cost	$20,951.65	Scissor Lift 26' - Interior Space:	$370.00
Labor Cost	$31,855.59	Bucket Truck - Exterior Spaces	$650.00
Local Electric Rate:	$0.17 $/kWh	Estimated Annual Energy Savings:	20,093
Hourly Labor Rate For Electrician:	$72.40	Estimated Annual Energy Cost Savings:	$3,589
Budgeted Initial Investment:	$53,827	Estimated Annual O&M Cost Savings:	$3,981
Estimated Return on Investment: *(Including O&M Savings)*	7.11 Years	Estimated Annual Cost Savings:	$7,570

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):	3,246
Insert Proposed Estimated Air Change Rate/Hr (ACH 2):	0.35	Cubic Feet/Min (CFM 2):	2,272
Estimated Space Volume Under Consideration	389,475.00 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):	2,963		Annual Cooling Degree Days(CDD):	1,407	
Estimated Total Annual Input Heating Energy Savings	880	Therms	Estimated Total Annual Input Cooling Energy Savings	5,073	kWh
Cost/Unit of Heating Fuel:	$1.30	$/Therm	Cost/Unit For Electricity	$0.18	$$
Estimated Annual Heating Cost Savings	$1,140	$$	Estimated Annual Cooling Cost Savings	$906	$$

Cost Analysis

Install Flush Mounted, Vinyl Door Sweeps ?	Yes	Total Length of Door Sweeps to Be Installed: *(3.5' Standard Width Door)*	229 LF
Install Window Air Conditioner Covers For Winter:	Yes	Number of Air Conditioner Covers To Be Installed: *(Covers would meet HUD Chapter-12 Energ Conservation Compliance Section 329C)*	2
Estimated Annual O&M Savings	$102	Estimated Length of Joints To Be Re-Caulked: *(Includes Demolition and Re-Caulking)*	4450 LF
Total Estimated Annual Cost Savings	$2,149	Total Cost For Controlling Air Leakage	$22,583
Simple Pay Back Period	10.51 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:	$22,583	Simple Pay Back Perio	10.51 Yrs
Annual Energy Cost Savings	$2,149		

UIC	Install Low Flow Tankless Restroom Fixtures
EAP4	Location: Restrooms

ECM FOR DETERMINING WATER SAVINGS IN COMMERCIAL PROPERTIES

Number of Males	191	
Number of Females	191	
Number of Occupied Days Per Week (Max 7)	5	
Number of Occupied Weeks/Year (Max 52)	38	
Number of Urinals To Be Retrofitted	9	
Number of Water Closets To Be Retrofitted	17	
No. of Water Closets With Separate Flush Tank *(Typical Residential Type)*	1	
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?	No	
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**	0.125	GPF

***(1992 EpACT Energy Act Mandates 1.0GPF Max on Urinals)*

Estimated Annual Water Savings From Urinal	0.00	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		16	
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		130.06	kGal
Estimated Annual Water Savings From Female Users		130.06	kGal
Total Water Savings From Water Closets		260.13	kGal

Water & Cost Saving Calculations

Water Savings Calculation

Water Savings By The Use of Low Flow Water Closet Flush Valves/Yr	260.13	kgal
Water Savings By The Use of Low Flow Urinal Flush Valves/ Yr	0.00	kgal
Total Annual Water Savings in kgal	260.13	kgal

Cost Savings Calculations

Enter Water Tariff Rate ($/1000Gal)	$2.87	$$
Estimated Cost Savings From Water	$747	$$

Estimated Cost of Retrofit

Cost For Replacing Existing Urinal Fixture With A Low Flow Fixture *(Includes Labor)*	$0	$$
Cost For Replacing Existing Flush Valves With Low Flow - Dual Flush Valves ($80 Per Unit) *(Up For Liquid Waste And Down For Solid Waste)* *(Includes Labor)*	$10,524	$$
Estimated Total Cost For Retrofit	$10,524	$$
Simple Pay Back Period	14.10	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:	$10,524	Simple Payback Period:	14.10 Yrs
Annual Cost Savings:	$747		

UIC	Add Reflective Coating To Exterior Windows
EAE1	Location: Throughout

ENTER EXISTING CONDITIONS

Total Sq.Ft window area:	5,676	sq.ft	Select The Existing Window Type:	Metal Frame & Double Glazing	*(Select)*
Approximate number of windows:	310		Existing U-value of window: (1/R)	0.87	Btu/ ft²·°F·h
ASHRAE Climatic Zone	Zone-3		New U-value with Double pane Low E window: (1/R)	0.45	Btu/ ft²·°F·h
Select Type of Heating Fuel	Natural Gas	*(Select)*	Is the Property Cooled ?	Yes	*(Select)*

WINTER

Net heating plant & distribution system efficiency:	79.00	%
Annual Heating Degree Days (HDD):	2,963	
Heat loss through Existing Window/ Yr :	351,160	kBtu/Yr
Estimated Heat Loss With New Windows:	181,634	kBtu/Yr
Annual Heat Loss Reduction:	169,525	kBtu/Yr
Estimated Total Annual Input Heating Energy Savings	2,146	Therms

SUMMER

Cooling Plant Efficiency (EER):	7.00	EER
Annual Cooling Degree Days (CDD):	1,407	
Energy Loss Through Existing Single Pane Window/Yr	166,750	kBtu/Yr
Estimated Energy Loss With New Windows:	86,250	kBtu/Yr
Annual Energy Loss Reduction:	80,500	kBtu/Yr
Annual Cooling Fuel Savings During Summer Season	11,500	Kwh

ENERGY & COST ANALYSIS

Insert Cost of Heating Fuel:	$1.30	$/Therm	Annual Heating Cost Savings:	$2,780.92 $
Insert Cost of Cooling Fuel:	$0.18	$/kWh	Annual Cooling Cost Savings:	$2,054.38 $
Estimated Annual O&M Savings	$242	$	Total Annual Cost Savings From Heating & Cooling:	$4,835 $
Total Annual cost savings:	**$5,077**	**$**		
Cost of window upgrade:	$80,482		Cost For Up-grading Windows	$53,922
			Total project cost:	$53,922
Simple payback:	15.85	**years**	*Type of Recommendation*	Capital Cost ECM Recommendation

ECM DESCRIPTION:

When the existing windows are not justified for complete replacement retrofit due to financial, functional, historical building restrictions or aesthetic reasons, higher performance low-emissivity (low-E) and reflective coating films can improve the performance of the windows for a lower cost and reduce the desired heating or cooling load. Low-emissivity (Low-E) coatings on glazing or glass control the heat transfer through a double paned or higher glazing window. A Low-E coating is a microscopically thin, virtually invisible, metallic oxide layer deposited directly on one or more panes of glass. Different types of Low-E coatings have been designed to allow for high solar gain, moderate solar gain, or low solar gain. A high solar gain coating is applied to reduce heat conduction and intended for cold climates. To keep the heat inside, the Low-E coating should be applied to the inside pane of glass. A low solar gain coating is used for hot climates and designed to reduce solar heat gain by blocking admission of the infrared portion of the sunlight spectrum. To keep the sun's heat out, the Low-E coating should be applied to the outside pane of glass. Tinted and reflective films can also be used on single paned and multi-paned windows to reduce solar heat gain to reduce the cooling load for hotter climates.

Summary:

Initial Investment:	$80,482	Simple Payback Period:	15.85 Yrs
Annual Energy Cost Savings:	$5,077		

UIC	**Upgrade Insulation**
EAE3B	**Location: Attic/Ceiling Throughout**

ENTER EXISTING CONDITION

Property Zone	Surface Under Consideration	Min. R-Value
Zone-3	**Ceiling/Attic**	R-30

Source: 2009 IECC For Residential Bldgs

"-" Not Specified

Enter Total Surface Area Under Consideration: 43,275 Sq.Ft

Existing Net Effective R-Value: (Sq.Ft deg F/btu) 13

Proposed Net Effective R-Value: (Sq.Ft deg F/btu) 30

ENTER CLIMATIC & SYSTEM DATA

Annual Cooling Degree Days (CDD): 1,407

Annual Heating Degree Days (HDD): 2,963

Estimated Annual Cooling Plant Efficiency (EER): 7.00 EER

Estimated Annual Heating Plant Efficiency: % 79.00 %

WINTER			SUMMER		
Select Type of Heating Fuel	**Natural Gas**	(Select)	Is the Property Cooled ?	**Yes**	(Select)
Annual Conduction Losses From Existing Insulation	244,236	kBtu	Annual Conduction Losses From Existing Insulation	115,977	Kbtu
Annual Conduction Losses From Proposed Insulation	102,579	kBtu	Annual Conduction Losses From Proposed Insulation	48,710	kBtu
Savings In Conduction Losses After Adding Insulation	141,657	kBtu	Savings In Conduction Losses After Adding Insulation	67,267	kBtu
Estimated Total Annual Input Heating Energy Savings	1,793	Therms	Estimated Total Annual Input Cooling Energy Savings	9,610	kWh
Cost of Heating Fuel/Unit:	$1.30	$/Therm	Cost of Electricity/Unit	$0.18	$/kWh
Annual Heating Cost Savings	$2,324	$$	Annual Cooling Cost Savings	$1,717	$$

COST ANALYSIS

Estimated O&M Savings	$0.00	$$	Estimated Cost To Add Insulation/Sqft	$1.70	
Total Estimated Annual Cost Savings	$4,040	$$	Estimated Total Installation Cost	$109,804	$$
Simple Pay Back Period	27.18	Years	*Type of Recommendation*	Capital Cost ECM Recommendation	

UIC	Replace External Windows
EAE2	Location: Throughout

ENTER EXISTING CONDITIONS

Existing and Proposed Window Properties

Total Sq.Ft window area:	5,676	sq.ft
Approximate number of windows:	310	
Total existing window area:	5,676	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) *AHRAE 90.1 Recommended Value*	0.35	Btu/ ft²·°F·h

Existing & Proposed Air Leakage Through Windows

Insert Existing Estimated Air Change Rate/Hr (ACH 1): *(Existing Air Changes Per Hour, 1.5 is very leaky and 0.35 ideal)*	0.75	
Insert Proposed Estimated Air Change Rate/Hr (ACH 2):	0.53	
Estimated Space Volume Under Consideration	389,475.00	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:	2,963	HDD
Estimated Total Annual Input Heating Energy Savings By Replacing Windows	49.05	Therms
Estimated Total Annual Input Heating Energy Savings Achieved By Controlling Air Leakage Through Windows	1,420	Therms
Estimated Total Input Heating Fuel Savings From Replacing Windows	1,469	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	26,286	kWh
Estimated Total Annual Input Cooling Energy Savings Achieved By Controlling Air Leakage Through Windows	7,609	kWh
Estimated Total Input Cooling Fuel Savings From Replacing Windows	33,895	kWh

ENERGY & COST ANALYSIS

Insert Cost of Heating Fuel:	$1.30	$/Therm	Annual Heating Cost Savings:	$1,903.62 $$
Insert Cost of Cooling Fuel:	$0.18	$/kWh	Annual Cooling Cost Savings:	$6,055.05 $$
Total Annual Cost Savings	$8,038		Total Annual Cost Savings From Heating & Cooling:	$7,959 $$
Cost of window upgrade:	$254,482		Estimated Annual O&M Savings	$80 $
Simple payback:	31.66	**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:	$254,482	Simple Payback	31.66 Yrs
Annual Energy Cost Savings:	$8,038		

APPENDIX F:
Solar PV

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

Select State: Northern California **Electric Rate:** $0.1800 $/KWH Annual Electric Consumption: 156,832 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	60.90	61	3	92,072	92,072	$16,573	$213,150	12.9	$0	$63,945	$2,026	$0	7.8
3	Building 3	1	15	15	1	22,980	22,980	$4,136	$53,200	12.9	$0	$15,960	$506	$0	7.8
5	Building 5	1	25	25	1	38,250	38,250	$6,885	$88,550	12.9	$0	$26,565	$842	$0	7.8
4							0	$0	$0		$0	$0	$0	$0	
5							0	$0	$0		$0	$0	$0	$0	
6							0	$0	$0		$0	$0	$0	$0	
							0	$0	$0		$0	$0	$0	$0	
							0	$0	$0		$0	$0	$0	$0	
							0	$0	$0		$0	$0	$0	$0	
							0	$0	$0		$0	$0	$0	$0	
		3		**101**	**4**	**153,302.0**	**153,302**	**$27,594**	**$354,900**	**12.86**	**$0**	**$106,470**	**$3,373**	**$0**	**7.78**

Solar Rooftop Photovoltaic Analysis		
Total Number of Roofs	3	
Estimated Number of Panels	4	
Estimated KW Rating	101	KW
Potential Annual KWh Produced	153,302	KWh
% of Current Electricity Load	97.7%	

Financial Analysis		
Investment Cost	$354,900	
Estimated Energy Cost Savings	$27,594	
Potential Rebates	$106,470	
Potential Annual Incentives	$3,373	
Payback without Incentives	12.9	years
Incentive Payback but without SRECS	7.8	years
Payback with All Incentives	7.8	years

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The expected range is based on 30 years of actual weather data at the given location and is intended to provide an indication of the variation you might see. For more information, please refer to this NREL report: The Error Report.

The energy output range is based on analysis of 30 years of historical weather data for nearby , and is intended to provide an indication of the possible interannual variability in generation for a Fixed (open rack) PV system at this location.

RESULTS

92,072 kWh/Year*

System output may range from 89,936 to 93,951 kWh per year near this location.

Month	Solar Radiation (kWh / m^2 / day)	AC Energy (kWh)	Value ($)
January	2.95	4,320	756
February	3.75	4,921	861
March	5.69	8,001	1,400
April	6.64	8,948	1,566
May	7.41	9,917	1,736
June	7.97	10,241	1,792
July	8.05	10,398	1,820
August	7.85	10,102	1,768
September	7.00	8,880	1,554
October	5.41	7,260	1,271
November	3.69	5,100	893
December	2.75	3,983	697
Annual	**5.76**	**92,071**	**$ 16,114**

Location and Station Identification

Requested Location	5330-A Gibbons Drive Suite 700 sacramento
Weather Data Source	Lat, Lon: 38.65, -121.34 1.3 mi
Latitude	38.65° N
Longitude	121.34° W

PV System Specifications *(Commercial)*

DC System Size	60.9 kW
Module Type	Standard
Array Type	Fixed (roof mount)
Array Tilt	20°
Array Azimuth	180°
System Losses	15%
Inverter Efficiency	96%
DC to AC Size Ratio	1.2

Economics

Average Retail Electricity Rate	0.175 $/kWh

Performance Metrics

Capacity Factor	17.3%

NREL
NATIONAL RENEWABLE ENERGY LABORATORY

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The energy output range is based on analysis of 30 years of historical weather data for nearby , and is intended to provide an indication of the possible interannual variability in generation for a Fixed (open rack) PV system at this location.

RESULTS

22,980 kWh/Year*

System output may range from 22,447 to 23,449 kWh per year near this location.

Month	Solar Radiation (kWh / m^2 / day)	AC Energy (kWh)	Value ($)
January	2.95	1,078	189
February	3.75	1,228	215
March	5.69	1,997	349
April	6.64	2,233	391
May	7.41	2,475	433
June	7.97	2,556	447
July	8.05	2,595	454
August	7.85	2,521	441
September	7.00	2,216	388
October	5.41	1,812	317
November	3.69	1,273	223
December	2.75	994	174
Annual	**5.76**	**22,978**	**$ 4,021**

Location and Station Identification

Requested Location	5330-A Gibbons Drive Suite 700 sacramento
Weather Data Source	Lat, Lon: 38.65, -121.34 1.3 mi
Latitude	38.65° N
Longitude	121.34° W

PV System Specifications *(Commercial)*

DC System Size	15.2 kW
Module Type	Standard
Array Type	Fixed (roof mount)
Array Tilt	20°
Array Azimuth	180°
System Losses	15%
Inverter Efficiency	96%
DC to AC Size Ratio	1.2

Economics

Average Retail Electricity Rate	0.175 $/kWh

Performance Metrics

Capacity Factor	17.3%

NREL
NATIONAL RENEWABLE ENERGY LABORATORY

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The expected range is based on 30 years of actual weather data at the given location and is intended to provide an indication of the variation you might see. For more information, please refer to this NREL report: The Error Report.

The energy output range is based on analysis of 30 years of historical weather data for nearby , and is intended to provide an indication of the possible interannual variability in generation for a Fixed (open rack) PV system at this location.

RESULTS

38,250 kWh/Year*

System output may range from 37,363 to 39,030 kWh per year near this location.

Month	Solar Radiation (kWh / m^2 / day)	AC Energy (kWh)	Value ($)
January	2.95	1,795	314
February	3.75	2,044	358
March	5.69	3,324	582
April	6.64	3,718	651
May	7.41	4,120	721
June	7.97	4,255	745
July	8.05	4,320	756
August	7.85	4,197	734
September	7.00	3,689	646
October	5.41	3,016	528
November	3.69	2,119	371
December	2.75	1,655	290
Annual	**5.76**	**38,252**	**$ 6,696**

Location and Station Identification

Requested Location	5330-A Gibbons Drive Suite 700 sacramento
Weather Data Source	Lat, Lon: 38.65, -121.34 1.3 mi
Latitude	38.65° N
Longitude	121.34° W

PV System Specifications *(Commercial)*

DC System Size	25.3 kW
Module Type	Standard
Array Type	Fixed (roof mount)
Array Tilt	20°
Array Azimuth	180°
System Losses	15%
Inverter Efficiency	96%
DC to AC Size Ratio	1.2

Economics

Average Retail Electricity Rate	0.175 $/kWh

Performance Metrics

Capacity Factor	17.3%