LEVEL II ENERGY AUDIT

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

DLR GROUP
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Sacramento, California 95958

PREPARED BY:
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EMG PROJECT #:

136988.19R000-058.268

DATE OF REPORT:

October 26, 2019

ONSITE DATE:

August 8, 2019

ZERO NET ENERGY ASHRAE LEVEL II AUDIT

G. W. CARVER SCHOOL OF ARTS AND SCIENCE

10101 Systems Parkway

Sacramento, California 95827

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Certification

EMG has completed an Energy Audit of G. W. Carver School of Arts and Science located at 10101 Systems Parkway in Sacramento, California 95827. EMG visited the site on August 8, 2019.

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

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

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

Estimated installation costs are based on EMG's experience on similar projects and industry standard cost estimating tools including *RS Means and Whitestone CostLab*. In developing the installed costs, EMG also considered the area correction factors for labor rates for Sacramento, California 95827. Since actual installed costs may vary widely for particular installation based on labor & material rates at time of installation, EMG does not guarantee installed cost estimates and shall in no event be liable should actual installed costs vary from the estimated costs herein. We strongly encourage the owner to confirm these cost estimates independently. EMG does not guarantee the costs savings estimated in this report. EMG shall in no event be liable should the actual energy savings vary from the savings estimated herein.

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

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

Prepared by: Noah Strafford
Energy Auditor
Project Manager

Reviewed by:

Bhaskar Ale, CEM

Technical Report Reviewer for

Kaustubh Anil Chabukswar, CEM CRM
Program Manager

1. Executive Summary

The purpose of this Energy Audit is to provide Sacramento City Unified School District and G. W. Carver School of Arts and Science 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	Administration/Gymnasium (A)	School Building	16,500	70-100
2	Classrooms 200's (B)	School Building	5,800	20-40
3	Classrooms 300's (C)	School Building	5,800	20-40
4	Classrooms 400's (D)	School Building	5,800	20-40
5	Classrooms 500's (E)	School Building	5,800	20-40
6	Library and Classrooms 800's (F)	School Building	12,000	20-40
7	Toilets (J & K)	Restrooms	2,000	5-15

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

1.1. Energy Conservation Measures

EMG has identified three 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)*	$49,520 *(In Current Dollars)*
Estimated Annual Cost Savings *(Current Dollars Only)*	$8,194 *(In Current Dollars)*
ECM Effective Payback	6.04 years
Estimated Annual Energy Savings	11.38%
Estimated Annual Energy Utility Cost Savings *(Excluding Water)*	12.46%
Estimated Annual Water Cost Saving	0.41%

Solar Photovoltaic (PV) Screening for G. W. CARVER SCHOOL OF ARTS AND SCIENCE

Solar Rooftop Photovoltaic Analysis		
Estimated Number of Panels	315	
Estimated KW Rating	99	KW
Potential Annual kWh Produced	150,453	kWh
% of Current Electricity Uses	52.9%	
Financial Summary		
Investment Cost	$347,550	
Estimated Energy Cost Savings	$24,223	
Payback without Incentives	14.3	Years
Incentive Payback but without SRECs	8.7	Years
Payback with All Incentives	8.7	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)	29 kBtu/ft^2
Post ECM Site Energy Use Intensity (EUI)	26 kBtu/ft^2
Source Energy Use Intensity (Eui)	**Rating**
Current Source Energy Use Intensity (EUI)	72 kBtu/ft^2
Post ECM Source Energy Use Intensity (EUI)	63 kBtu/ft^2
Building Cost Intensity (Bci)	**Rating**
Current Building Cost Intensity	$0.99 /ft^2
Post ECM Building Cost Intensity	$0.87 /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	176 MMbtu
Total CO_2 Emissions Reduced	14.85 $MtCO_2$/Yr
Total Cars Off the Road (Equivalent)*	3
Total Acres of Pine Trees Planted (Equivalent)*	3

**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	1,548,322 kBtu
Total Annual Energy Savings for Non-Renewable Energy Measures	176,234 kBtu
Total Annual Energy Savings from Renewable Energy Measures	513,346 kBtu
Total Annual Energy Savings	689,580 kBtu
Net Energy Consumption from Grid Post Implementation	858,742 kBtu
% Energy Reduction (Annual Energy-Net Energy) / (Annual Energy)	45%

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 G.W. Carver School of Arts and Science

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	$762	117	0	25	$304	$0	$304	2.51	3.40	$1,829	10.00
Totals for No/Low Cost Items		**$762**	**117**	**0**	**25**	**$304**	**$0**	**$304**	**2.51**			
Capital Cost Recommendations												
1	Upgrade Building Lighting to LED and Install Automatic Lighting Controls Location: Building Interior And Exterior	$38,667	0	41,292	0	$6,647	$1,544	$8,191	4.72	2.53	$59,120	15.00
2	Install On-Demand Ventilation on Air Handlers Location: Rooftop Make Up Air Handlers - Admin/ Gym	$3,632	428	139	0	$580	$29	$609	5.96	1.43	$1,565	10.00
Total For Capital Cost		**$42,299**	**428**	**41,431**	**0**	**$7,227**	**$1,573**	**$8,801**	**4.81**			
	Interactive Savings Discount @ 10%		-54	-4,143	-2	-$753	-$157	-$910				
	Total Contingency Expenses @ 15%	$6,459										
Total for Improvements		**$49,520**	**490**	**37,288**	**22**	**$6,778**	**$1,416**	**$8,194**	**6.04**			

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 G.W. Carver School of Arts and Science

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	$25,381	0	0	182	$1,113	$0	$1,113	22.80	0.52	-$12,091	15.00
2	Replace Existing Water Heater With New Energy Efficient Units Location: Throughout - Buildings E, F, J And K	$6,891	0	1,367	0	$220	$0	$220	31.31	0.44	-$3,864	18.00
Total for Improvements		**$25,381**	**0**	**0**	**182**	**$1,113**	**$0**	**$1,113**	**22.80**			

2. Introduction

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

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

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

ENERGY AND WATER USING EQUIPMENT

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

BUILDING ENVELOPE

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

RECOMMENDATIONS FOR ENERGY SAVINGS OPPORTUNITIES

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

ANALYSIS OF ENERGY CONSUMPTION

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

ENERGY AUDIT PROCESS

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

REPORTING

The EMG Energy Audit Report includes:

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

3. Facility Overview and Existing Conditions

3.1. Building Occupancy and Point of Contact

Facility Schedule	
Hours of Operations / Week	40
Operational Weeks / Year	37
Estimated Facility Occupancy	290
% of Male Occupants	50%

Point Of Contact	
Point of Contact Name	Dean Bolnder
Point of Contact Title	District facility operations specialist
Point of Contact – Contact Number	916.529.8116

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

Description:

Heating and cooling to all spaces is provided primarily by rooftop package units utilizing natural gas for heating. The admin/ gymnasium building is also served by make up air units utilizing natural gas for heating. A single ductless split system provides additional heating and cooling to the admin building.

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

Building Central Heating System	
Primary Heating System	Rooftop Packaged Units
Secondary Heating System	Make up Air Unit with gas heat
Hydronic Distribution System	Not Applicable
Primary Heating Fuel	Natural Gas
Heating Mode Set-point	69 °F
Heating Mode- Set-back Temperature	53 °F

Building Cooling System	
Primary Cooling System	Packaged Units
Secondary Cooling System	Ductless Split Units

Building Cooling System	
Hydronic Distribution System	Not Applicable
Cooling Mode Set-point	73 °F
Cooling Mode- Set-back Temperature	93 °F

Air Distribution System	
Building Ventilation	Rooftop Exhaust Fans
On-Demand Ventilation System in Use?	No
Energy Recovery Wheel / Enthalpy Wheel Exhaust Fans	No

Domestic Hot Water System	
Primary Domestic Water Fuel	Natural Gas

3.3. Lighting

Description:

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

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

4. Utility Analysis

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

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

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

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

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

Utility Rates used for Cost Analysis

Electricity (Blended Rate)	Natural Gas	Water / Sewer
$0.16 /kWh	$1.30 /therm	$6.12 /kGal

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

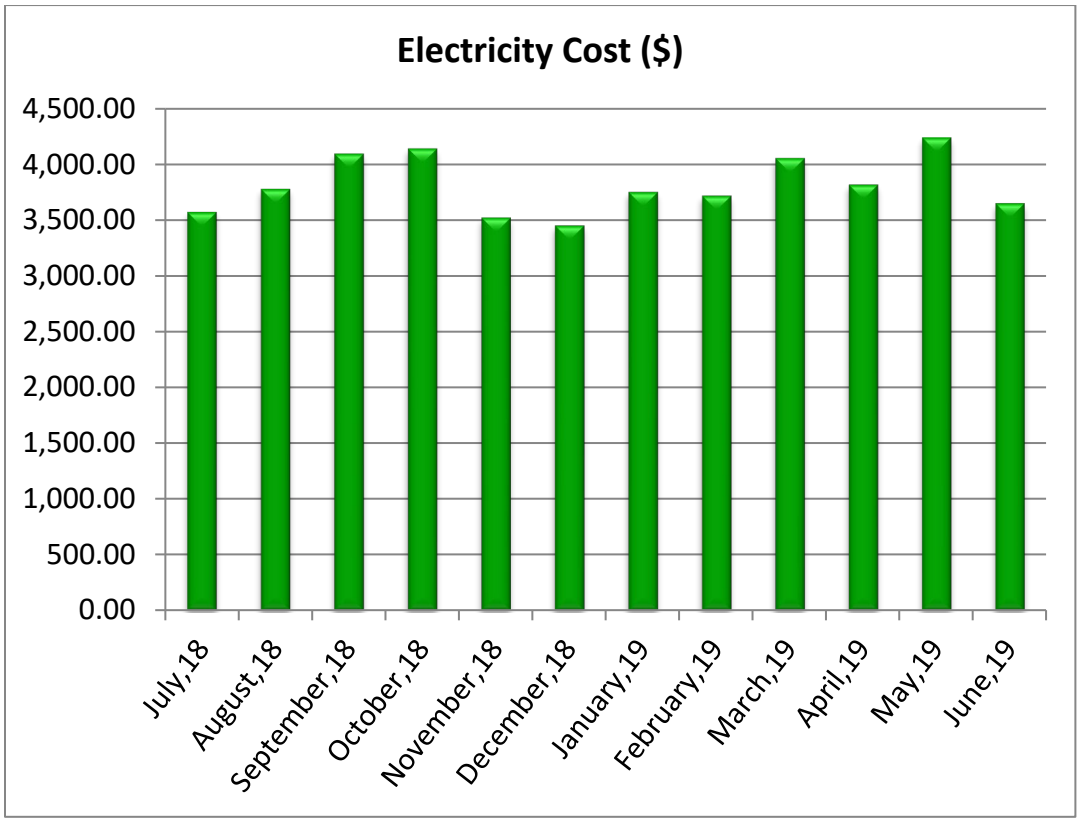
4.1. Electricity

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

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

Electric Consumption and Cost Data

Billing Month	Consumption (Kwh)	Unit Cost/Kwh	Total Cost
July,18	17,959	0.20	$3,571
August,18	21,879	0.17	$3,778
September,18	26,773	0.15	$4,093
October,18	26,604	0.16	$4,139
November,18	22,243	0.16	$3,520
December,18	21,621	0.16	$3,450
January,19	23,687	0.16	$3,751
February,19	24,016	0.15	$3,717
March,19	26,096	0.16	$4,053
April,19	23,925	0.16	$3,817
May,19	27,176	0.16	$4,239
June,19	22,404	0.16	$3,650
Total/average	284,385	**0.16**	**$45,778**


Electricity Cost ($)
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4,000.00
3,500.00
3,000.00
2,500.00
2,000.00
1,500.00
1,000.00
500.00
0.00
July,18
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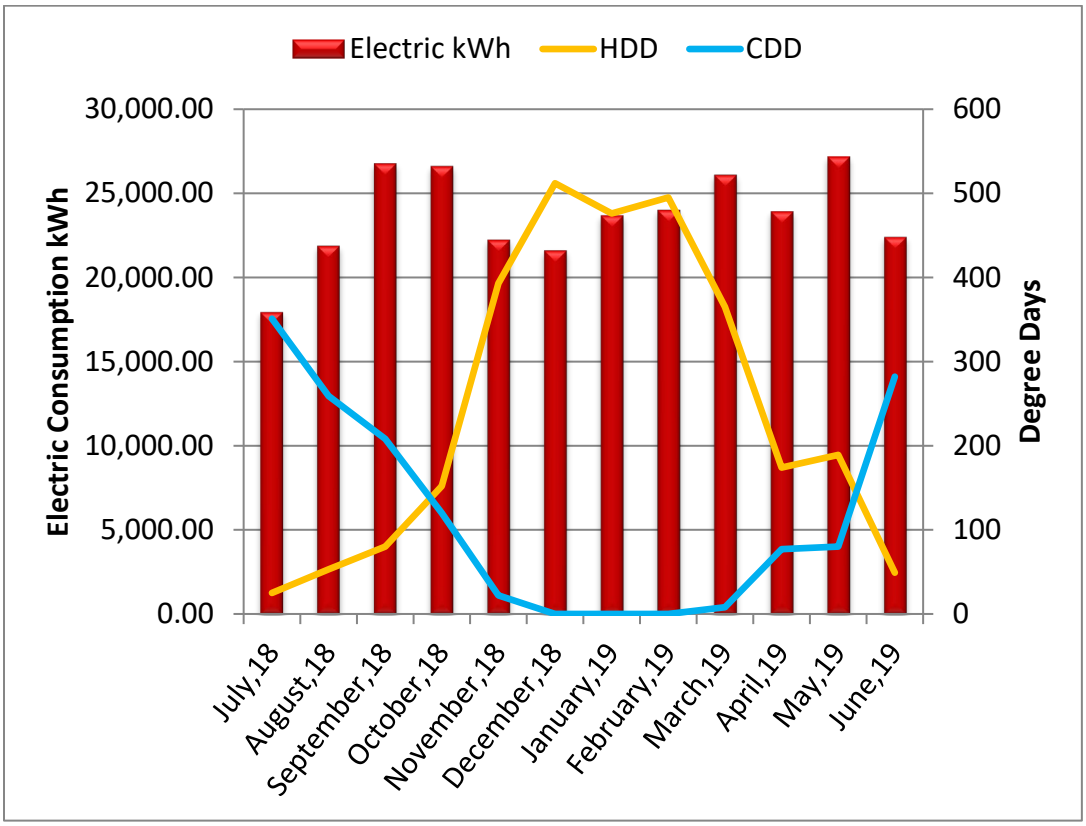
January,19
February,19
March,19
April,19
May,19
June,19


Electric kWh
HDD
CDD
Electric Consumption kWh
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25,000.00
20,000.00
15,000.00
10,000.00
5,000.00
0.00
Degree Days
600
500
400
300
200
100
0
July,18
August,18
September,18
October,18
November,18
December,18
January,19
February,19
March,19
April,19
May,19
June,19

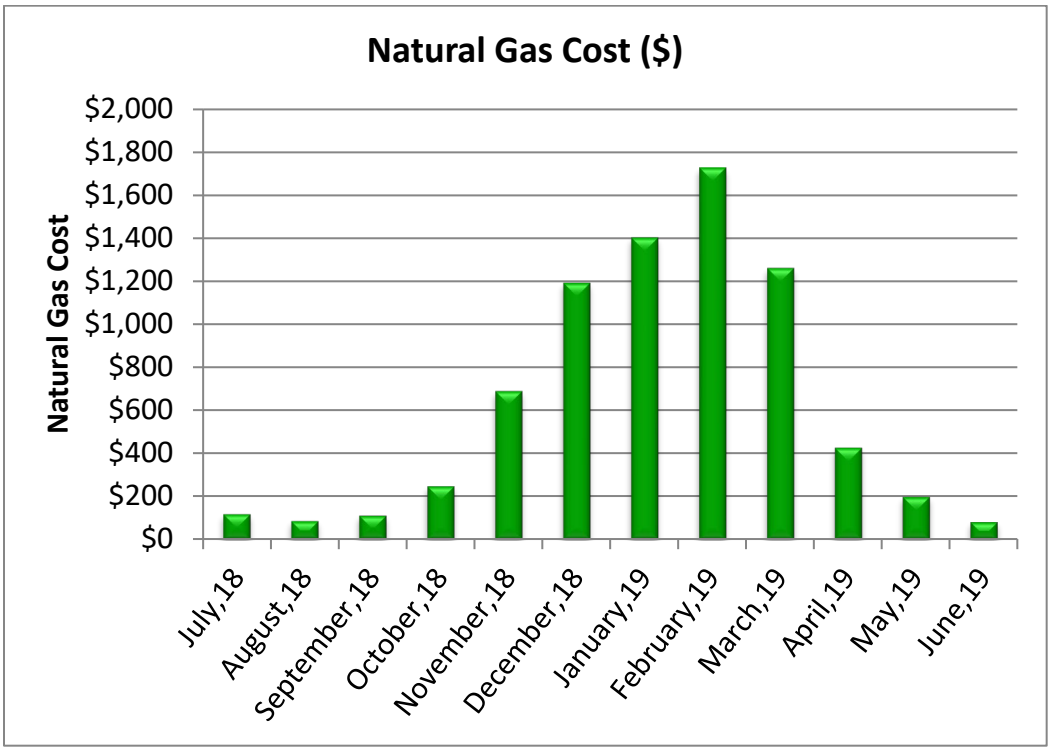
4.2. Natural Gas

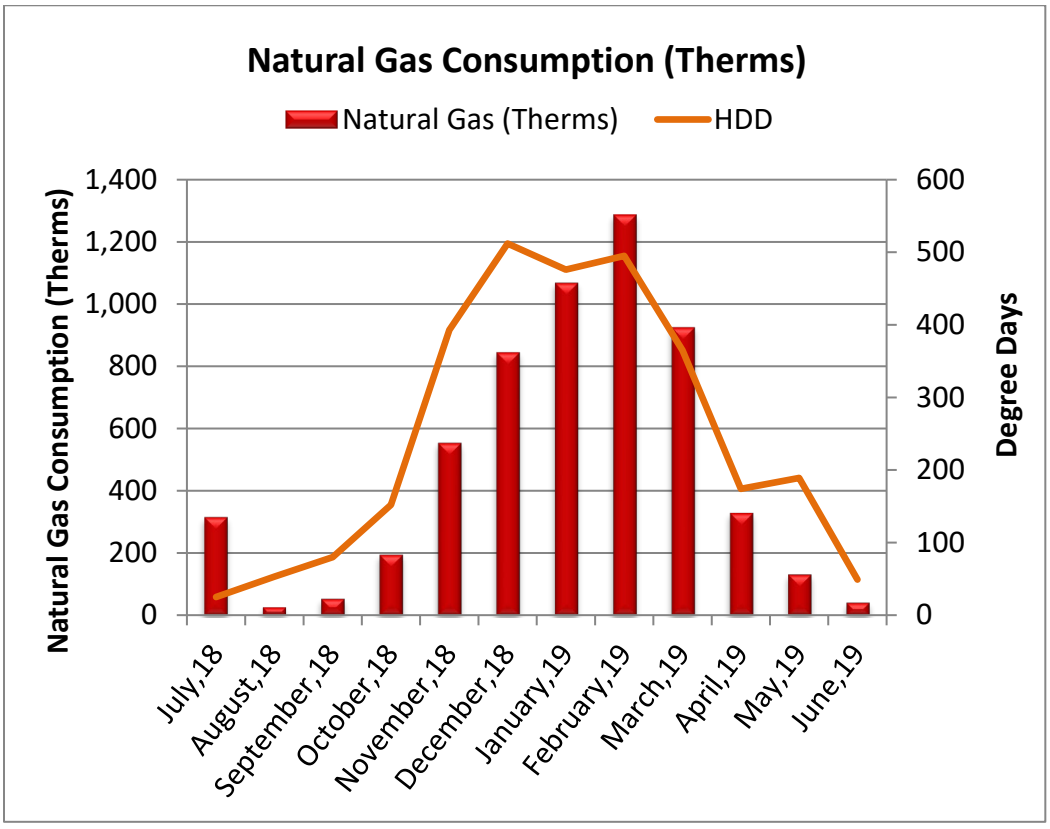
PGE satisfies the natural gas requirements of the facility. The primary end use of natural gas is for building heating, domestic water heating, and cooking in the cafeteria.

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

Natural Gas Consumption and Cost Data

Billing Month	Consumption (Therms)	Unit Cost/Therm	Total Cost
July,18	317	$0.37	$118
August,18	27	$3.18	$86
September,18	55	$2.04	$111
October,18	196	$1.27	$248
November,18	555	$1.24	$690
December,18	845	$1.41	$1,191
January,19	1,069	$1.31	$1,402
February,19	1,288	$1.34	$1,726
March,19	926	$1.36	$1,260
April,19	330	$1.29	$427
May,19	133	$1.50	$199
June,19	42	$1.94	$82
Total/average	**5,780**	**$1.30**	**$7,540**


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


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

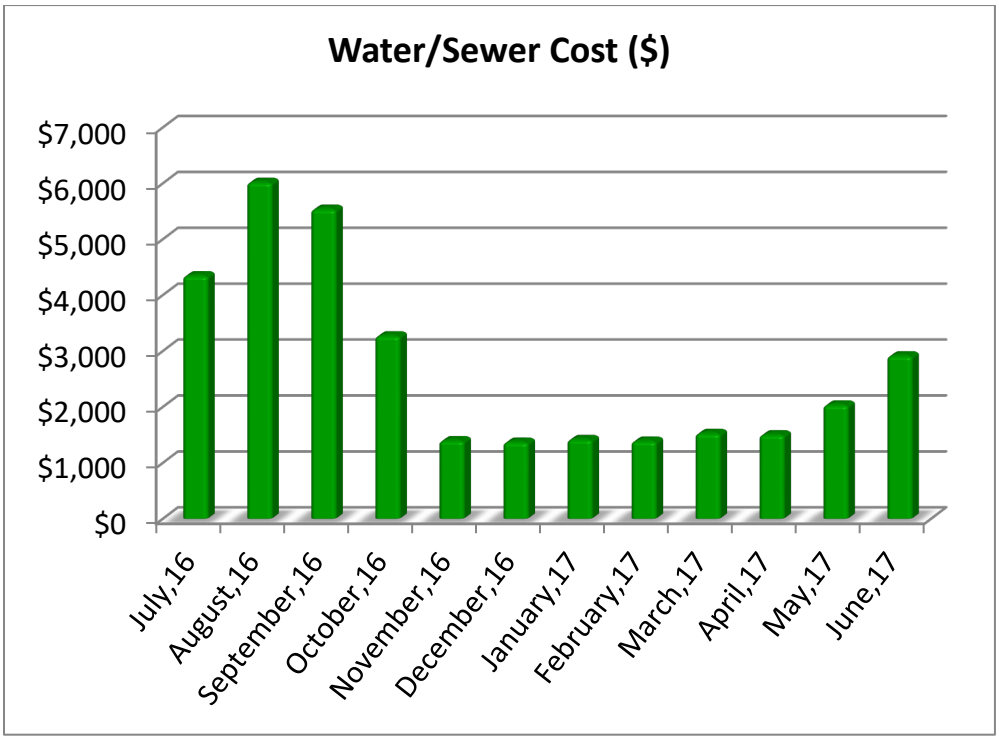
4.3. Water and Sewer

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 cost data provided for water in the facility.

Note: The utility bills for July 2016- June 2017 was used instead of July 2018 - June 2019 due to unknown fluctuation in the consumption data.

Water and Sewer Consumption and Cost Data

Billing Month	Consumption (Kgal)	Unit Cost/Kgal	Total Cost
July,16	765	$5.69	$4,356
August,16	1,118	$5.39	$6,028
September,16	999	$5.55	$5,547
October,16	442	$7.42	$3,281
November,16	23	$61.13	$1,406
December,16	18	$76.61	$1,379
January,17	37	$38.57	$1,427
February,17	297	$4.71	$1,398
March,17	317	$4.85	$1,536
April,17	311	$4.86	$1,511
May,17	423	$4.83	$2,044
June,17	615	$4.75	$2,923
Total	5,365	$6.12	$32,836


Water/Sewer Cost ($)
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$5,000
$4,000
$3,000
$2,000
$1,000
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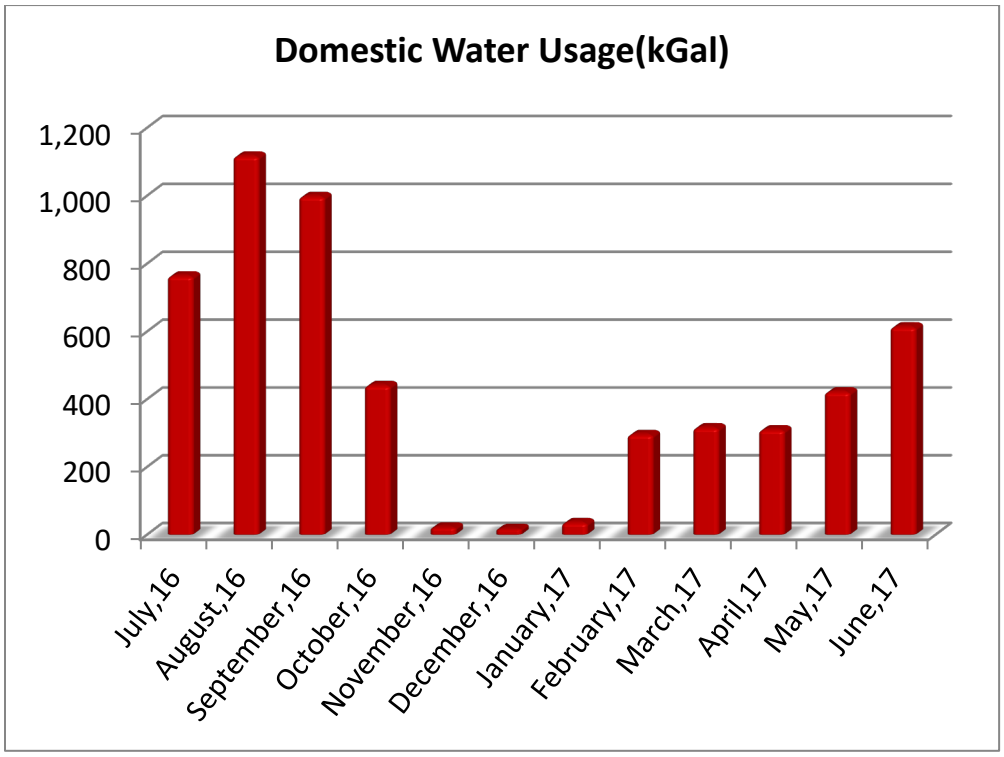
May,17
June,17


Domestic Water Usage(kGal)
1,200
1,000
800
600
400
200
0
July,16
August,16
September,16
October,16
November,16
December,16
January,17
February,17
March,17
April,17
May,17
June,17

5. Renewable Energy Discussions

5.1. Rooftop Solar Photovoltaic Feasibility

Solar Energy Feasibility

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

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

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

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

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

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

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

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

Solar Rooftop Photovoltaic Analysis		
Estimated Number of Panels	315	
Estimated KW Rating	99	KW
Potential Annual kWh Produced	150,453	kWh
% of Current Electricity Uses	52.9%	
Financial Summary		
Investment Cost	$347,550	
Estimated Energy Cost Savings	$24,223	
Payback without Incentives	14.3	Years
Incentive Payback but without SRECs	8.7	Years
Payback with All Incentives	8.7	Years

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

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

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

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

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

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

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

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

6. Operations and Maintenance Plan

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

Building Envelope

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

Heating and Cooling

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

Central Domestic Hot Water Heater

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

Lighting Improvements

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

Existing Equipment and Replacements

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

7. Appendices

APPENDIX A: Glossary of Terms

APPENDIX B: Mechanical Equipment Inventory

APPENDIX C: Lighting System Schedule

APPENDIX D: ECM Checklist

APPENDIX E: ECM Calculations

APPENDIX F: Solar PV

APPENDIX A:
Glossary of Terms

Glossary of Terms and Acronyms

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

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

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

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

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

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

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

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

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

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

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

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

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

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

APPENDIX B:
Mechanical Equipment Inventory

Mechanical Inventory								
System	Make	Model	Serial Number	Input Capacity	Output Capacity	Room Number	Space Served	Quantity
Air Handler (AHU)	Reznor	RDH300-S-2	EBGC83Y9N01774	300 MBH	243 MBH	Roof-girls locker	Admin/Gym (A)	1
Air Handler (AHU)	Reznor	RDH225-S-2	EBGC83Y9NO1773	225 MBH	182 MBH	Roof-boys locker	Admin/Gym (A)	1
Ductless Split System	Bryant	38BNC018301	Illegible	1.5 TON	-	Roof-admin	Admin/Gym (A)	1
Exhaust Fan	No tag/plate found	No tag/plate found	No tag/plate found	5000-8000 CFM	-	Roof	Classrooms 200s (B)	1
Exhaust Fan	Twin City	BCRD-100C	C07-231991-9	1001 - 2000 CFM	-	Roof-admin	Admin/Gym (A)	1
Exhaust Fan	Twin City Fan Co.	BCRUR-160A	C07-231991-6	1001 - 2000 CFM	-	Roof-admin	Admin/Gym (A)	1
Exhaust Fan	Twin City	BCRD-160G	B07-231991-8	1001 - 2000 CFM	-	Roof-boys locker	Admin/Gym (A)	1
Exhaust Fan	No tag/plate found	No tag/plate found	No tag/plate found	5000-8000 CFM	-	Roof	Classrooms 300s (C)	1
Exhaust Fan	No tag/plate found	No tag/plate found	No tag/plate found	5000-8000 CFM	-	Roof	Classrooms 400s (D)	1
Exhaust Fan	No tag/plate found	No tag/plate found	No tag/plate found	5000-8000 CFM	-	Roof	Classrooms 500s (E)	1
Exhaust Fan	Twin City	BCRD-180C	C07-231991-7	1001 - 2000 CFM	-	Roof-girls locker	Admin/Gym (A)	1
Exhaust Fan	Twin City	DCRD-60	C07-231991-1-4	1001 - 2000 CFM	-	Roof	Classrooms 500s (E)	1
Packaged Unit (RTU)	Aaon	Illegible	Illegible	180 MBh	146 MBH	Roof	Library and Classrooms 800s (F)	1
Packaged Unit (RTU)	Aaon	RM-A05-3-0-AA01-222	Illegible	90 MBH	73 MBH	Roof	Classrooms 400s (D)	1
Packaged Unit (RTU)	Aaon	RM-A05-3-0-AA01-222	200702-AMGE31734	90 MBH	73 MBH	Roof	Classrooms 400s (D)	1
Packaged Unit (RTU)	Aaon	RM-A05-3-0-AA01-222	200702-AMGE31731	90 MBH	73 MBH	Roof	Classrooms 400s (D)	1
Packaged Unit (RTU)	Aaon	RM-A05-3-0-AA01-222	200702-AMGE31727	90 MBH	73 MBH	Roof	Classrooms 300s (C)	1
Packaged Unit (RTU)	Aaon	RM-A05-3-0-AA01-222	Illegible	90 MBH	73 MBH	Roof	Classrooms 300s (C)	1
Packaged Unit (RTU)	Aaon	RM-A05-3-0-AA01-222	200702-AMGE31733	90 MBH	73 MBH	Roof	Classrooms 400s (D)	1
Packaged Unit (RTU)	Aaon	RM-A05-3-0-AA01-222	200702-AMGE31729	90 MBH	73 MBH	Roof	Classrooms 300s (C)	1
Packaged Unit (RTU)	Aaon	RM-A07-3-0-AA01-222	Illegible	180 MBH	146 MBH	Roof	Library and Classrooms 800s (F)	1
Packaged Unit (RTU)	Aaon	RM-A05-3-0-AA01-222	Illegible	90 MBH	73 MBH	Roof	Classrooms 300s (C)	1
Packaged Unit (RTU)	Aaon	Illegible	Illegible	180 MBH	146 MBH	Roof	Library and Classrooms 800s (F)	1
Packaged Unit (RTU)	Aaon	RM-006-3-0-AA01-232	200702-AMGE31740	180 MBH	146 MBH	Roof	Library and Classrooms 800s (F)	1
Packaged Unit (RTU)	Aaon	Illegible	Illegible	180 MBH	146 MBH	Roof	Library and Classrooms 800s (F)	1
Packaged Unit (RTU)	AAON, Inc.	RM-A05-3-0-AA01-222	200702-AMGE31738	90 MBH	73 MBH	500s	Classrooms 500s (E)	1
Packaged Unit (RTU)	AAON, Inc.	RM-A05-3-0- AA01-222	200702-AMGE31735	90 MBH	73 MBH	500s	Classrooms 500s (E)	1
Packaged Unit (RTU)	AAON, Inc.	RN 040-3-0-AA02-2A2	200702-BNGV02644	540 MBH	437 MBH	Roof	Admin/Gym (A)	1
Packaged Unit (RTU)	AAON, Inc.	RM-007-3-0-AA01-232	200702-AMGG31745	180 MBH	146 MBH	Roof-admin	Admin/Gym (A)	1
Packaged Unit (RTU)	AAON, Inc.	RM-A05-3-0-AA01-222	200702-AMGE31736	90 MBH	73 MBH	500s	Classrooms 500s (E)	1
Packaged Unit (RTU)	AAON, Inc.	RM-013-3-0-AA02-232	200702-AMGK31717	180 MBH	146 MBH	Roof-admin	Admin/Gym (A)	1
Packaged Unit (RTU)	AAON, Inc.	RM- A05-3-0-AA01-222	200702-AMGE31725	90 MBH	73 MBH	Roof	Classrooms 200s (B)	1
Packaged Unit (RTU)	AAON, Inc.	RM-A05-3-0-AA01-222	200702-AMGE31726	90 MBH	73 MBH	Roof	Classrooms 200s (B)	1
Packaged Unit (RTU)	AAON, Inc.	RM-A05-3-0- AA01-222	200702-AMGE31737	90 MBH	73 MBH	500s	Classrooms 500s (E)	1
Packaged Unit (RTU)	AAON, Inc.	RM-A05-3-0-AA01-222	200702-AMGE31723	90 MBH	73 MBH	Roof	Classrooms 200s (B)	1
Packaged Unit (RTU)	AAON, Inc.	RM-A05-3-0-AA01-222	200702-AMGE31724	90 MBH	73 MBH	Roof	Classrooms 200s (B)	1
Water Heater	A. O. Smith	DEN 80 110	D07M004182	80 GAL, 6kW	-	Utility room	Library and Classrooms 800s (F)	1
Water Heater	A. O. Smith	Inaccessible	Inaccessible	10 GAL, 6kW	-	Janitorial room	Toilets (K)	1
Water Heater	A. O. Smith	DEL 10 102	D07M002237	10 gal, 6kW	-	Janitorial closet	Toilets (J)	1
Water Heater	A. O. Smith	BTH 199 970	D07M004715	100 GAL/199 MBH	-	Utility room	Admin/Gym (A)	1
Water Heater	A. O. Smith	BTH 250A 970	D07M005667	100 GAL/240 MBH	-	Utility room	Admin/Gym (A)	1
Water Heater	A. O. Smith	ECT 52 200	J07J046011	50 GAL, 3.5kW	-	Classrooms-505	Classrooms 500s (E)	1

APPENDIX C:
Lighting System Schedule

									Lamp Details				Fixture Details				Existing Consumption	
Line No.	Building Name	Interior/ Exterior	Floor	Space Type	Room No.	LUX	Control Quantity	Existing Control	Technology	Sub-Technology	Lamp Type	Total Lamps	Fixture Type	Fixture Quantity	24x7 Fixture Count	Fixture Height	Annual Hours	Existing Annual kWh
1	James carver	Interior		OfFICE	Building A 134	328	2	Light Switch	Linear Fluorescent	T8	4' 32W T8	18	2x4 Prism Troffer	6	0	8	2,220	1,279
2	James carver	Interior		RESTROOM	A 134	314	4	Light Switch	Linear Fluorescent	T8	4' 32W T8	8	2x4 Prism Troffer	4	0	8	2,220	568
3	James carver	Interior		OFFICE	A 130	-	1	Light Switch	Linear Fluorescent	T8	4' 32W T8	3	2x4 Prism Troffer	1	0	8	2,220	213
4	James carver	Interior		OFFICE	A principal	160	2	Light Switch	Linear Fluorescent	T8	4' 32W T8	12	2x4 Prism Troffer	4	0	8	2,220	852
5	James carver	Interior		OFFICE	A 128	-	4	Light Switch	Linear Fluorescent	T8	4' 32W T8	36	2x4 Prism Troffer	12	0	8	2,220	2,557
6	James carver	Interior		OFFICE	A 123	-	2	Light Switch	Linear Fluorescent	T8	4' 32W T8	6	2x4 Prism Troffer	2	0	8	2,220	426
7	James carver	Interior		OFFICE	A	-	2	Light Switch	Linear Fluorescent	T8	4' 32W T8	30	2x4 Prism Troffer	10	0	8	2,220	2,131
8	James carver	Interior		HALLWAY	A	-	1	Timer	Linear Fluorescent	T8	4' 32W T8	5	2x4 Prism Troffer	5	0	8	2,220	355
9	James carver	Interior		HALLWAY	A entrance	-	3	Light Switch	Linear Fluorescent	T8	4' 32W T8	4	Industrial	2	0	8	2,220	284
10	James carver	Interior		HALLWAY	A entrance	-	3	Light Switch	CFL	CFL - 4 Pin	CFL26	34	Recessed Can-hor6"	17	0	8	2,220	1,962
11	James carver	Interior		GYMNASIUM	A	420	2	Light Switch	Linear Fluorescent	T8	4' 32W T8	100	2x4 Prism Troffer	25	0	35	2,220	7,104
12	James carver	Interior		STORAGE	A 118	-	6	Light Switch	Linear Fluorescent	T8	4' 32W T8	12	2x4 Prism Troffer	6	0	8	703	270
13	James carver	Interior		KITCHEN	A 116	-	4	Light Switch	Linear Fluorescent	T8	4' 32W T8	60	2x4 Prism Troffer	30	0	8	1,850	3,552
14	James carver	Interior		RESTROOM	A	-	6	Light Switch	Linear Fluorescent	T8	4' 32W T8	12	2x4 Prism Troffer	6	0	8	2,220	852
15	James carver	Interior		RESTROOM	A	155	6	Light Switch	Linear Fluorescent	T8	4' 32W T8	12	2x4 Prism Troffer	6	0	8	2,220	852
16	James carver	Interior		CLASSROOM	B 204	480	12	Light Switch	Linear Fluorescent	T8	4' 32W T8	120	Industrial	60	0	8	1,480	5,683
17	James carver	Interior		OFFICE	B	-	2	Light Switch	Linear Fluorescent	T8	4' 32W T8	12	2x4 Prism Troffer	4	0	8	2,220	852
18	James carver	Interior		STORAGE	B 207	-	1	Light Switch	Linear Fluorescent	T8	4' 32W T8	2	2x4 Prism Troffer	1	0	8	703	45
19	James carver	Interior		RESTROOM	B	-	1	Light Switch	Linear Fluorescent	T8	4' 32W T8	2	2x4 Prism Troffer	1	0	8	2,220	142
20	James carver	Interior		CLASSROOM	C 304	-	12	Light Switch	Linear Fluorescent	T8	4' 32W T8	120	Industrial	60	0	8	1,480	5,683
21	James carver	Interior		OFFICE	C 305 and D 405	-	6	Light Switch	Linear Fluorescent	T8	4' 32W T8	36	2x4 Prism Troffer	12	0	8	2,220	2,557
22	James carver	Interior		STORAGE	C 307 and 407	-	3	Light Switch	Linear Fluorescent	T8	4' 32W T8	6	2x4 Prism Troffer	3	0	8	703	135
23	James carver	Interior		RESTROOM	C,D,E	-	3	Light Switch	Linear Fluorescent	T8	4' 32W T8	6	2x4 Prism Troffer	3	0	8	2,220	426
24	James carver	Interior		STORAGE	B	-	5	Light Switch	Linear Fluorescent	T8	4' 32W T8	10	2x4 Prism Troffer	10	0	8	703	225
25	James carver	Interior		RESTROOM	Restroom	-	2	Ceiling-Mounted Sensor	Linear Fluorescent	T8	4' 32W T8	8	2x4 Prism Troffer	4	0	8	2,220	568
26	James carver	Interior		RESTROOM	Restroom	-	1	Ceiling-Mounted Sensor	Linear Fluorescent	T8	4' 32W T8	6	2x4 Prism Troffer	3	0	8	2,220	426
27	James carver	Interior		CLASSROOM	D 404	372	12	Light Switch	Linear Fluorescent	T8	4' 32W T8	120	Industrial	60	0	8	1,480	5,683
28	James carver	Exterior		HALLWAY	Exterior	-	1	Timer	CFL	CFL - 4 Pin	CFL26	190	Surface Mount Can	95	0	8	2,220	10,967
29	James carver	Interior		CLASSROOM	801	338	12	Light Switch	Linear Fluorescent	T8	4' 32W T8	192	Industrial	96	0	8	1,480	9,093
30	James carver	Interior		STORAGE	809 B	-	2	Light Switch	Linear Fluorescent	T8	4' 32W T8	14	2x4 Prism Troffer	7	0	8	703	315
31	James carver	Interior		LIBRARY	805A	-	5	Light Switch	Linear Fluorescent	T8	4' 32W T8	129	2x4 Prism Troffer	43	0	8	2,220	9,164
32	James carver	Interior		OFFICE	806	-	4	Light Switch	Linear Fluorescent	T8	4' 32W T8	12	2x4 Prism Troffer	4	0	8	2,220	852
33	James carver	Interior		RESTROOM	Sep restroom	-	1	Ceiling-Mounted Sensor	Linear Fluorescent	T8	4' 32W T8	6	2x4 Prism Troffer	3	0	8	2,220	426
34	James carver	Interior		RESTROOM	Sep	-	1	Ceiling-Mounted Sensor	Linear Fluorescent	T8	4' 32W T8	4	2x4 Prism Troffer	2	0	8	2,220	284
35	James carver	Interior		CLASSROOM	E 504	-	12	Light Switch	Linear Fluorescent	T8	4' 32W T8	120	Industrial	60	0	8	1,480	5,683
36	James carver	Exterior		HALLWAY	Exterior	-	1	Timer	HID	MH	MH250	16	Pole Post Top	16	0	8	2,220	8,880
37	James carver	Interior		LOCKER ROOM	A	-	2	Light Switch	Linear Fluorescent	T8	4' 32W T8	22	2x4 Prism Troffer	11	0	8	2,220	1,563
38	James carver	Interior		LOCKER ROOM	A	-	1	Light Switch	Linear Fluorescent	T8	4' 32W T8	22	2x4 Prism Troffer	11	0	8	2,220	1,563
39	James carver	Interior		OFFICE	A101	-	4	Light Switch	Linear Fluorescent	T8	4' 32W T8	8	2x4 Prism Troffer	4	0	8	2,220	568
	Totals											1,535		709			74,925	95,047

								Fixture Details						Existing Consumption				Proposed- Post Retrofit				
Line No.	Building Name	Interior/ Exterior	Floor	Space Type	Room No.	Existing Control	Control Quantity	Technology	Sub-Technology	Lamp- Fixture	Fixture Quantity	Total Lamps	Fixture Height	Annual Hours	Existing Annual kWh	ECM	ECM Type	Recommended Sensor	LED Lamp Retrofit	Annual Hours of Operation	Proposed Annual kWh	Annual Savings From LED Retrofit
																						kWh
1	James carver	Interior		OFFICE	Building A 134	Light Switch	2	Linear Fluorescent	T8	4' 32W T8; 2x4 Prism Troffer	6	18	8	2,220	1,279	ECM	RB - Replace Bulb	Wall Mounted	4' 17W LED T8	2,220	679	599
2	James carver	Interior		RESTROOM	A 134	Light Switch	4	Linear Fluorescent	T8	4' 32W T8; 2x4 Prism Troffer	4	8	8	2,220	568	ECM	RB - Replace Bulb	Wall Mounted	4' 17W LED T8	2,220	302	266
3	James carver	Interior		OFFICE	A 130	Light Switch	1	Linear Fluorescent	T8	4' 32W T8; 2x4 Prism Troffer	1	3	8	2,220	213	ECM	RB - Replace Bulb	Wall Mounted	4' 17W LED T8	2,220	113	100
4	James carver	Interior		OFFICE	A principal	Light Switch	2	Linear Fluorescent	T8	4' 32W T8; 2x4 Prism Troffer	4	12	8	2,220	852	ECM	RB - Replace Bulb	Wall Mounted	4' 17W LED T8	2,220	453	400
5	James carver	Interior		OFFICE	A 128	Light Switch	4	Linear Fluorescent	T8	4' 32W T8; 2x4 Prism Troffer	12	36	8	2,220	2,557	ECM	RB - Replace Bulb	Wall Mounted	4' 17W LED T8	2,220	1,359	1,199
6	James carver	Interior		OFFICE	A 123	Light Switch	2	Linear Fluorescent	T8	4' 32W T8; 2x4 Prism Troffer	2	6	8	2,220	426	ECM	RB - Replace Bulb	Wall Mounted	4' 17W LED T8	2,220	226	200
7	James carver	Interior		OFFICE	A	Light Switch	2	Linear Fluorescent	T8	4' 32W T8; 2x4 Prism Troffer	10	30	8	2,220	2,131	ECM	RB - Replace Bulb	Wall Mounted	4' 17W LED T8	2,220	1,132	999
8	James carver	Interior		HALLWAY	A	Timer	1	Linear Fluorescent	T8	4' 32W T8; 2x4 Prism Troffer	5	5	8	2,220	355	ECM	RB - Replace Bulb	Retain Existing Controls	4' 17W LED T8	2,220	189	167
9	James carver	Interior		HALLWAY	A entrance	Light Switch	3	Linear Fluorescent	T8	4' 32W T8; Industrial	2	4	8	2,220	284	ECM	RB - Replace Bulb	Ceiling Mounted	4' 17W LED T8	2,220	151	133
10	James carver	Interior		HALLWAY	A entrance	Light Switch	3	CFL	CFL - 4 Pin	CFL26; Recessed Can-horiÓ	17	34	8	2,220	1,962			Ceiling Mounted					
11	James carver	Interior		GYMNASIUM	A	Light Switch	2	Linear Fluorescent	T8	4' 32W T8; 2x4 Prism Troffer	25	100	35	2,220	7,104	ECM	RB - Replace Bulb	Ceiling Mounted	4' 17W LED T8	2,220	3,774	3,330
12	James carver	Interior		STORAGE	A 118	Light Switch	6	Linear Fluorescent	T8	4' 32W T8; 2x4 Prism Troffer	6	12	8	703	270	ECM	RB - Replace Bulb	Wall Mounted	4' 17W LED T8	703	143	127
13	James carver	Interior		KITCHEN	A 116	Light Switch	4	Linear Fluorescent	T8	4' 32W T8; 2x4 Prism Troffer	30	60	8	1,850	3,552	ECM	RB - Replace Bulb	Wall Mounted	4' 17W LED T8	1,850	1,887	1,665
14	James carver	Interior		RESTROOM	A	Light Switch	6	Linear Fluorescent	T8	4' 32W T8; 2x4 Prism Troffer	6	12	8	2,220	852	ECM	RB - Replace Bulb	Wall Mounted	4' 17W LED T8	2,220	453	400
15	James carver	Interior		RESTROOM	A	Light Switch	6	Linear Fluorescent	T8	4' 32W T8; 2x4 Prism Troffer	6	12	8	2,220	852	ECM	RB - Replace Bulb	Wall Mounted	4' 17W LED T8	2,220	453	400
16	James carver	Interior		CLASSROOM	B 204	Light Switch	12	Linear Fluorescent	T8	4' 32W T8; Industrial	60	120	8	1,480	5,683	ECM	RB - Replace Bulb	Wall Mounted	4' 17W LED T8	1,480	3,019	2,664
17	James carver	Interior		OFFICE	B	Light Switch	2	Linear Fluorescent	T8	4' 32W T8; 2x4 Prism Troffer	4	12	8	2,220	852	ECM	RB - Replace Bulb	Wall Mounted	4' 17W LED T8	2,220	453	400
18	James carver	Interior		STORAGE	B 207	Light Switch	1	Linear Fluorescent	T8	4' 32W T8; 2x4 Prism Troffer	1	2	8	703	45	ECM	RB - Replace Bulb	Wall Mounted	4' 17W LED T8	703	24	21
19	James carver	Interior		RESTROOM	B	Light Switch	1	Linear Fluorescent	T8	4' 32W T8; 2x4 Prism Troffer	1	2	8	2,220	142	ECM	RB - Replace Bulb	Wall Mounted	4' 17W LED T8	2,220	75	67
20	James carver	Interior		CLASSROOM	C 304	Light Switch	12	Linear Fluorescent	T8	4' 32W T8; Industrial	60	120	8	1,480	5,683	ECM	RB - Replace Bulb	Wall Mounted	4' 17W LED T8	1,480	3,019	2,664
21	James carver	Interior		OFFICE	C 305 and D 405	Light Switch	6	Linear Fluorescent	T8	4' 32W T8; 2x4 Prism Troffer	12	36	8	2,220	2,557	ECM	RB - Replace Bulb	Wall Mounted	4' 17W LED T8	2,220	1,359	1,199
22	James carver	Interior		STORAGE	C 307 and 407	Light Switch	3	Linear Fluorescent	T8	4' 32W T8; 2x4 Prism Troffer	3	6	8	703	135	ECM	RB - Replace Bulb	Wall Mounted	4' 17W LED T8	703	72	63
23	James carver	Interior		RESTROOM	C,D,E	Light Switch	3	Linear Fluorescent	T8	4' 32W T8; 2x4 Prism Troffer	3	6	8	2,220	426	ECM	RB - Replace Bulb	Wall Mounted	4' 17W LED T8	2,220	226	200
24	James carver	Interior		STORAGE	B	Light Switch	5	Linear Fluorescent	T8	4' 32W T8; 2x4 Prism Troffer	10	10	8	703	225	ECM	RB - Replace Bulb	Wall Mounted	4' 17W LED T8	703	120	105
25	James carver	Interior		RESTROOM	Restroom	Ceiling-Mounted Sensor	2	Linear Fluorescent	T8	4' 32W T8; 2x4 Prism Troffer	4	8	8	2,220	568	ECM	RB - Replace Bulb	Wall Mounted	4' 17W LED T8	2,220	302	266
26	James carver	Interior		RESTROOM	Restroom	Ceiling-Mounted Sensor	1	Linear Fluorescent	T8	4' 32W T8; 2x4 Prism Troffer	3	6	8	2,220	426	ECM	RB - Replace Bulb	Retain Existing Controls	4' 17W LED T8	2,220	226	200
27	James carver	Interior		CLASSROOM	D 404	Light Switch	12	Linear Fluorescent	T8	4' 32W T8; Industrial	60	120	8	1,480	5,683	ECM	RB - Replace Bulb	Wall Mounted	4' 17W LED T8	1,480	3,019	2,664
28	James carver	Exterior		HALLWAY	Exterior	Timer	1	CFL	CFL - 4 Pin	CFL26; Surface Mount Can	95	190	8	2,220	10,967			Ceiling Mounted					
29	James carver	Interior		CLASSROOM	801	Light Switch	12	Linear Fluorescent	T8	4' 32W T8; Industrial	96	192	8	1,480	9,093	ECM	RB - Replace Bulb	Wall Mounted	4' 17W LED T8	1,480	4,831	4,262
30	James carver	Interior		STORAGE	809 B	Light Switch	2	Linear Fluorescent	T8	4' 32W T8; 2x4 Prism Troffer	7	14	8	703	315	ECM	RB - Replace Bulb	Wall Mounted	4' 17W LED T8	703	167	148
31	James carver	Interior		LIBRARY	805A	Light Switch	5	Linear Fluorescent	T8	4' 32W T8; 2x4 Prism Troffer	43	129	8	2,220	9,164	ECM	RB - Replace Bulb	Ceiling Mounted	4' 17W LED T8	2,220	4,868	4,296
32	James carver	Interior		OFFICE	806	Light Switch	4	Linear Fluorescent	T8	4' 32W T8; 2x4 Prism Troffer	4	12	8	2,220	852	ECM	RB - Replace Bulb	Wall Mounted	4' 17W LED T8	2,220	453	400
33	James carver	Interior		RESTROOM	Sep restroom	Ceiling-Mounted Sensor	1	Linear Fluorescent	T8	4' 32W T8; 2x4 Prism Troffer	3	6	8	2,220	426	ECM	RB - Replace Bulb	Retain Existing Controls	4' 17W LED T8	2,220	226	200
34	James carver	Interior		RESTROOM	Sep	Ceiling-Mounted Sensor	1	Linear Fluorescent	T8	4' 32W T8; 2x4 Prism Troffer	2	4	8	2,220	284	ECM	RB - Replace Bulb	Retain Existing Controls	4' 17W LED T8	2,220	151	133
35	James carver	Interior		CLASSROOM	E 504	Light Switch	12	Linear Fluorescent	T8	4' 32W T8; Industrial	60	120	8	1,480	5,683	ECM	RB - Replace Bulb	Wall Mounted	4' 17W LED T8	1,480	3,019	2,664
36	James carver	Exterior		HALLWAY	Exterior	Timer	1	HID	MH	MH250; Pole Post Top	16	16	8	2,220	8,880	ECM	RB - Replace Bulb	Ceiling Mounted	54W LED Post	2,220	1,918	6,962
37	James carver	Interior		LOCKER ROOM	A	Light Switch	2	Linear Fluorescent	T8	4' 32W T8; 2x4 Prism Troffer	11	22	8	2,220	1,563	ECM	RB - Replace Bulb	Retain Existing Controls	4' 17W LED T8	2,220	830	733
38	James carver	Interior		LOCKER ROOM	A	Light Switch	1	Linear Fluorescent	T8	4' 32W T8; 2x4 Prism Troffer	11	22	8	2,220	1,563	ECM	RB - Replace Bulb	Wall Mounted	4' 17W LED T8	2,220	830	733
39	James carver	Interior		OFFICE	A101	Light Switch	4	Linear Fluorescent	T8	4' 32W T8; 2x4 Prism Troffer	4	8	8	2,220	568	ECM	RB - Replace Bulb	Wall Mounted	4' 17W LED T8	2,220	302	266
	Totals											1,535									40,826	41,292

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	37
		Number of Occupied Days/Week (Max 7)	5

KITCHEN FAUCETS			BATHROOM FAUCETS		
Number of Occupants Affected By Retrofit	290		Number of Occupants Affected by Retrofit	290	
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	19		Total Number of Faucet Aerators To Be Replaced	31	
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	1.5	GPM	GPM of Proposed Faucet Aerator	0.5	GPM
Estimated Number of Uses Per Day	2		Estimated Number of Uses Per Day	2	

Annual Water Savings From Installing Low Flow Aerators: 24.72 kGal

WATER & ENERGY SAVING CALCULATION			COST SAVING CALCULATION		
Select Type of Water Heater Fuel:	Natural Gas	(Select)	Property Location in United States	North Central Localities	
Energy Factor of Domestic Hot Water Heater:	0.90	EF	Heating Fuel Tariff	$1.30	$/Therm
Hot Water Discharge Temperature at Faucet	110.00	°F	Water Tariff ($/1000 Gal)	$6.12	$/kGal
Equivalent Heating Fuel Savings: *Savings Discounted by 15% to Account For Cold Water Use*	117	Therms	Annual Cost Savings In Form of Water	$151	$
Annual Water Savings	24.72	kGal	Annual Energy Savings From Water Heater	$152	$

COST BENEFIT ANALYSIS				
Estimated Total Annual Cost Savings	$304	$$	Estimated Total Installation Cost	$762 $$
Simple Payback Period	2.51	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: $762 Estimated Annual Cost Savings: $304 Simple Payback Period (Yrs): 2.51

UIC	Install Low Flow Tankless Restroom Fixtures
EAP4	Location: Restrooms

ECM FOR DETERMINING WATER SAVINGS IN COMMERCIAL PROPERTIES

Number of Males	145	
Number of Females	145	
Number of Occupied Days Per Week (Max 7)	5	
Number of Occupied Weeks/Year (Max 52)	35	
Number of Urinals To Be Retrofitted	14	
Number of Water Closets To Be Retrofitted	41	
No. of Water Closets With Separate Flush Tank *(Typical Residential Type)*	0	
Estimated Restroom Usage/Individual/Day *Default is 4 Uses/Day For Residential/Office*	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** ***(1992 EpACT Energy Act Mandates 1.0GPF Max on Urinals)*	0.125	GPF
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		41	
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		90.94	kGal
Estimated Annual Water Savings From Female Users		90.94	kGal
Total Water Savings From Water Closets		181.89	kGal

Water & Cost Saving Calculations

Water Savings Calculation

Water Savings By The Use of Low Flow Water Closet Flush Valves/Yr	181.89	kgal
Water Savings By The Use of Low Flow Urinal Flush Valves/ Yr	0.00	kgal
Total Annual Water Savings in kgal	181.89	kgal

Cost Savings Calculations

Enter Water Tariff Rate ($/1000Gal)	$6.12	$$
Estimated Cost Savings From Water	$1,113	$$

Estimated Cost of Retrofit

Cost For Replacing Existing Urinal Fixture With A Low Flow Fixture	$0 *(Includes Labor)*	$$
Cost For Replacing Existing Flush Valves With Low Flow - Dual Flush Valves ($80 Per Unit) *(Up For Liquid Waste And Down For Solid Waste)*	$25,381 *(Includes Labor)*	$$
Estimated Total Cost For Retrofit	$25,381	$$
Simple Pay Back Period	22.80	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:	$25,381	Simple Payback Period:	22.80 Yrs
Annual Cost Savings:	$1,113		

UIC	Replace Existing Water Heater With New Energy Efficient Units
EAD3	**Location: Throughout - Buildings E, F, J and K**

		Toilets		Library and Classrooms		Classrooms			
Step 1	**Existing Water Heater Details**								
	Number of Water Heaters Being Replaced:	2		1		1			
	Select Existing Hot Water Heater Fuel	Electric		Electric		Electric		Natural Gas	
	Insert Energy Factor of Existing Water Heater	0.77	EF	0.77	EF	0.77	EF		EF
	Input Existing Water Heater Input Rating	6.00	kW	6.00	kW	3.50	kW		kBtus
	Select One Method For Calculation	Annual Heating Hours		Annual Heating Hours		Annual Heating Hours		Annual Heating Hours	
	Insert Average Annual Hours of Operation	400	hrs	400	hrs	400	hrs		hrs
	Annual Water Heater Energy Consumption/Heater	2,400	kWh	2,400	kWh	1,400	kWh	0	Therms
	Total Estimated Annual Energy Consumption For all Heaters	4,800	kWh	2,400	kWh	1,400	kWh	0	Therms
	Total Estimated Annual Operating Energy Costs For all Heaters	$773	$	$386	$	$225	$	$0	$
Step 2	**Proposed New Water Heater**								
	Proposed Hot Water Heater Fuel	Electric		Electric		Electric		Natural Gas	
	Capacity of the Proposed New Water Heater	10-Gal,1.6-kW		80-Gal,4.5-kW		50-Gal,4.5-kW		100-Gal,150-kBtu	
	Energy Factor of Proposed Water Heater	0.89	EF	0.95	EF	0.95	EF	0.95	EF
	Proposed Water Heater Input Rating	1.60	kW	4.50	kW	4.50	kW	150.00	kBtuh
	Annual kBtuh Consumption For All The Proposed Water Heaters	14,169	kBtuh	6,637	kBtuh	3,872	kBtuh	0	kBtuh
	Estimated Annual Water Heater Fuel Consumption (All Heaters)	4,153	kWh	1,945	kWh	1,135	kWh	0	Therms
	Estimated Total Annual Energy Costs	$668	$	$313		$183		$0	
Step 3	**Energy & Cost Saving Calculation**								
	Estimated Cost of New Water Heater/Unit	$672	$	$1,927	$	$1,347	$	$7,760	$
	Total Estimated Installation Cost	$2,005	$	$2,876	$	$2,010	$	$0	$
	Total Estimated Annual Cost Savings	$104	$	$73	$	$43	$	$0	$
	Total Annual Cost Savings:	$220		Total Initial Investment::		$6,891			
	Simple Pay Back Period	31.31							
	Type of Recommendation	Capital Cost ECM Recommendation							

ECM SUMMARY:

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

SUMMARY:

Initial Investment: $2,005 Simple Payback: 31.31 yrs

Annual Cost Savings: $104

UIC	Install On-Demand Ventilation on Air Handlers
EAC1	Location: Rooftop Make up Air handlers - Admin/ Gym

ENTER EXISTING CONDITION

Estimated Facility Sq.Ft Under Consideration:	16500	Sq.ft	No. of Sensors To Be Installed (One/AHU)	2	Qty
Outside Air Intake CFM (Cubic Feet/Min):	2970.00	CFM	Estimated Savings From On-Demand Ventilation	15%	CFM

WINTER			SUMMER		
Select Type of Heating Fuel	Natural Gas	(Select)	Is The Building Cooled?	Yes	(Select)
Estimated Annual Heating Plant Efficiency *(COP in Case of Heat Pumps Only Max 4.5)*	80.00	%	Estimated Annual Cooling Plant Efficiency (EER)	10.80	EER
Annual Heating Degree Days(HDD):	2,963		Annual Cooling Degree Days(CDD):	1,407	
Estimated Annual Energy Consumed For Heating Outside Air During Winter	228,099	kbtu/Yr	Estimated Annual Energy Consumed For Cooling Outside Air During Summer	108,314	kbtu/Yr
Estimated Annual Input Heating Energy Savings By Use of On-Demand Ventilation System	42,769	kbtu/Yr	Estimated Annual Input Cooling Energy Savings By Use of On-Demand Ventilation System	1,504	kbtu/Yr
Estimated Intake Annual Heating Fuel Savings:	428	Therms	Estimated Annual Intake Cooling Fuel Savings:	139	kWh
Cost/Unit of Heating Fuel:	$1.30	$/Therm	Cost/Unit For Electricity	$0.16	$$
Estimated Annual Heating Cost Savings	$558	$$	Estimated Annual Cooling Cost Savings	$22	$$

COST ANALYSIS

Estimated Annual O&M Savings	$29.01	$$	Estimated Installation Cost (Including Labor)	$1,816	$$
Total Estimated Annual Cost Savings	$609	$$	Total Estimated Installation Cost	$3,632	$$
Simple Pay Back Period	5.96	Yrs	*Type of Recommendation*	Capital Cost ECM Recommendation	

ECM DESCRIPTION:

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

SUMMARY:

Initial Investment:	$3,632	Simple Payback (Yrs)	5.96
Energy Cost Savings:	$609		

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	37	597	1,311	41,292	$6,648.01	$1,544.45

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	0	0	0	0	$0	$0
Circiline	T9	0	0	0	0	$0	$0
Incan/H/MR	H	0	0	0	0	$0	$0
Incan/H/MR	Incan	0	0	0	0	$0	$0
Incan/H/MR	MR	0	0	0	0	$0	$0
HID	HPS	0	0	0	0	$0	$0
HID	MH	1	16	16	6,962	$1,121	$127
HID	MV	0	0	0	0	$0	$0
HID	QL	0	0	0	0	$0	$0
Linear Fluorescent	T8	36	581	581	34,330	$5,527	$1,417
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	0	Ceiling Mounted	11
Wall Mounted	133		

Initial Investment			**Equipment Rentals**	
Material Cost	$14,428.00		Scissor Lift 26' - Interior Spaces	$370.00
Labor Cost	$23,869.28		Bucket Truck - Exterior Spaces	$0.00
Local Electric Rate:	$0.16	$/kWh	Estimated Annual Energy Savings:	41,292
Hourly Labor Rate For Electrician:	$82.45		Estimated Annual Energy Cost Savings:	$6,648
Budgeted Initial Investment:	$38,667		Estimated Annual O&M Cost Savings:	$1,544
Estimated Return on Investment: *(Including O&M Savings)*	4.72	Years	Estimated Annual Cost Savings:	$8,192

APPENDIX F:
Solar PV

UIC	Install Fixed Tilt Solar Photovoltaic System
EAR-2	Details: G.W. Carver School

Select State: Northern California **Electric Rate:** $0.16 $/KWH Annual Electric Consumption: 284,385 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	13.40	13	43	20,303	20,303	$3,269	$46,900	14.3	$0	$14,070	$447	$0	8.7
2	Building 2	1	34	34	107	50,909	50,909	$8,196	$117,600	14.3	$0	$35,280	$1,120	$0	8.7
3	Building 3	1	9	9	29	13,939	13,939	$2,244	$32,200	14.3	$0	$9,660	$307	$0	8.7
4	Building 4	1	11	11	34	16,363	16,363	$2,634	$37,800	14.3	$0	$11,340	$360	$0	8.7
5	Building 5	1	11	11	34	16,212	16,212	$2,610	$37,450	14.3	$0	$11,235	$357	$0	8.7
6	Building 6	1	10	10	31	15,000	15,000	$2,415	$34,650	14.3	$0	$10,395	$330	$0	8.7
7	Building 7	1	12	12	37	17,727	17,727	$2,854	$40,950	14.3	$0	$12,285	$390	$0	8.7
		7		**99**	**315**	**150,453.0**	**150,453**	**$24,223**	**$347,550**	**14.35**	**$0**	**$104,265**	**$3,310**	**$0**	**8.68**

Solar Rooftop Photovoltaic Analysis		
Total Number of Roofs	7	
Estimated Number of Panels	315	
Estimated KW Rating	99	KW
Potential Annual KWh Produced	150,453	KWh
% of Current Electricity Load	52.9%	

Financial Analysis		
Investment Cost	$347,550	
Estimated Energy Cost Savings	$24,223	
Potential Rebates	$104,265	
Potential Annual Incentives	$3,310	
Payback without Incentives	14.3	years
Incentive Payback but without SRECS	8.7	years
Payback with All Incentives	8.7	years