# LEVEL II ENERGY AUDIT

A Bureau Veritas Group Company

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

## DLR GROUP
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**EMG PROJECT #:**
136988.19R000-071.268

**DATE OF REPORT:**
October 25, 2019

**ONSITE DATE:**
September 26-27, 2019

**ZERO NET ENERGY ASHRAE LEVEL II AUDIT**

## CAPITOL COLLEGIATE ACADEMY
2118 Meadowview Road
Sacramento, California 95832

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# Certification

EMG has completed an Energy Audit of Capitol Collegiate Academy located at 2118 Meadowview Road in Sacramento, California 95832. EMG visited the site on September 26-27, 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 95832. Since actual installed costs may vary widely for particular installation based on labor and material rates at time of installation, EMG does not guarantee installed cost estimates and shall in no event be liable should actual installed costs vary from the estimated costs herein. We strongly encourage the owner to confirm these cost estimates independently. EMG does not guarantee the costs savings estimated in this report. EMG shall in no event be liable should the actual energy savings vary from the savings estimated herein.

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

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

**Prepared by:** Rashad Alnial
Energy Auditor
Project Manager

**Reviewed by:**

Al Diefert
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 Capitol Collegiate Academy with a baseline of energy usage and the relative energy efficiency of the facility and specific recommendations for Energy Conservation Measures. Information obtained from these analyses may be used to support a future application to an Energy Conservation Program, Federal and Utility grants towards energy conservation, support performance contracting, justify a municipal bond funded improvement program, or as a basis for replacement of equipment or systems.

| Building # | Structures Assessed | Building Type | EMG Calculated Area (SF) | Estimated Occupancy |
|---|---|---|---|---|
| 1 | Classrooms 1 to 4 | School Building | 5,535 | 75-100 |
| 2 | Restrooms | School Building | 451 | 1-6 |
| 3 | Classrooms 6 to 10 | School Building | 5,294 | 75-100 |
| 4 | Administration | School Building | 2,155 | 25-50 |
| 5 | Kindergarten | School Building | 2,847 | 25-50 |
| 6 | Multipurpose | School Building | 4,720 | 75-100 |
| 7 | Portable Classrooms 11 to 15 | School Building | 4,800 | 75-100 |
| 8 | Portable Classrooms 34 and 35 | School Building | 1,800 | 20-40 |
| 9 | Portable Clinic | School Building | 900 | 5-10 |
| 10 | Portable Classrooms | School Building | 1,920 | 20-40 |
| 11 | Head Start | School Building | 1,440 | 20-40 |

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)* | $ 89,521 *(In Current Dollars)* |
| Estimated Annual Cost Savings *(Current Dollars Only)* | $7,138 *(In Current Dollars)* |

| Item | Estimate |
|---|---|
| ECM Effective Payback | 12.54 years |
| Estimated Annual Energy Savings | 9% |
| Estimated Annual Energy Utility Cost Savings *(Excluding Water)* | 10% |
| Estimated Annual Water Cost Saving | 2% |

**Solar Photovoltaic (PV) Screening for CAPITOL COLLEGIATE ACADEMY**

| Solar Rooftop Photovoltaic Analysis | | |
|---|---|---|
| Estimated Number of Panels | 69 | |
| Estimated KW Rating | 124 | KW |
| Potential Annual kWh Produced | 191,313 | kWh |
| % of Current Electricity Uses | 96.2% | |
| **Financial Summary** | | |
| Investment Cost | $434,700 | |
| Estimated Energy Cost Savings | $32,523 | |
| Payback without Incentives | 13.4 | Years |
| Incentive Payback but without SRECs | 8.1 | Years |
| Payback with All Incentives | 8.1 | 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) | 40 kBtu/ft$^2$ |
| Post ECM Site Energy Use Intensity (EUI) | 36 kBtu/ft$^2$ |
| **Source Energy Use Intensity (EUI)** | **Rating** |
| Current Source Energy Use Intensity (EUI) | 90 kBtu/ft$^2$ |
| Post ECM Source Energy Use Intensity (EUI) | 82 kBtu/ft$^2$ |
| **Building Cost Intensity (BCI)** | **Rating** |
| Current Building Cost Intensity | $1.32/ft$^2$ |
| Post ECM Building Cost Intensity | $1.19/ft$^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 | 111 MMbtu |
| Total $CO_2$ Emissions Reduced | 9.05 $MtCO_2$/Yr |
| Total Cars Off the Road (Equivalent)* | 2 |
| Total Acres of Pine Trees Planted (Equivalent)* | 2 |

**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 | 1,265,282 kBtu |
| Total Annual Energy Savings for Non-Renewable Energy Measures | 110,911 kBtu |
| Total Annual Energy Savings from Renewable Energy Measures | 652,760 kBtu |
| Total Annual Energy Savings | 763,671 kBtu |
| Net Energy Consumption from Grid Post Implementation | 501,611 kBtu |
| % Energy Reduction (Annual Energy-Net Energy) / (Annual Energy) | 60% |

## 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 Capitol Collegiate Academy

| 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<br>Location: Restrooms | $625 | 418 | 0 | 59 | $890 | $0 | $890 | 0.70 | 12.16 | $6,968 | 10.00 |
| **Totals for No/Low Cost Items** | | **$625** | **418** | **0** | **59** | **$890** | **$0** | **$890** | **0.70** | | | |
| **Capital Cost Recommendations** | | | | | | | | | | | | |
| 1 | Replace Existing Water Heater With New Energy Efficient Units<br>Location: Mechanical Closet | $1,270 | 0 | 1,063 | 0 | $184 | $0 | $184 | 6.91 | 1.99 | $1,258 | 18.00 |
| 2 | Upgrade Building Lighting to LED and Install Automatic Lighting Controls<br>Location: Building Interior And Exterior | $75,950 | 0 | 22,792 | 0 | $3,942 | $2,915 | $6,857 | 11.08 | 1.08 | $5,909 | 15.00 |
| **Total For Capital Cost** | | **$77,220** | **0** | **23,855** | **0** | **$4,126** | **$2,915** | **$7,041** | **10.97** | | | |
| | *Interactive Savings Discount @ 10%* | | -42 | -2,385 | -6 | -$502 | -$291 | -$793 | | | | |
| | *Total Contingency Expenses @ 15%* | $11,677 | | | | | | | | | | |
| **Total for Improvements** | | **$89,521** | **377** | **21,469** | **53** | **$4,515** | **$2,623** | **$7,138** | **12.54** | | | |

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 Capitol Collegiate Academy

| ECM # | Description of ECM | Initial Investment | Annual Energy Savings | | Annual Water Savings | Cost Savings | Estimated Annual O&M Savings | Total Estimated Annual Cost Savings | Payback | S.I.R. | Life Cycle Savings | Expected Useful Life (EUL) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $ | Natural Gas | Electricity | kgal | $ | $ | $ | Years | | $ | Years |
| 1 | Replace Rooftop Package Unit<br>Location: Roof | $73,750 | 133 | 16,306 | 0 | $2,994 | $150 | $3,144 | 23.46 | 0.63 | -$26,978 | 20.00 |
| 2 | Install Low Flow Tankless Restroom Fixtures<br>Location: Restrooms | $17,582 | 0 | 0 | 129 | $748 | $0 | $748 | 23.50 | 0.51 | -$8,650 | 15.00 |
| 3 | Retrofit Apartment Tank Toilets to Dual Flush<br>Location: | $315 | 0 | 0 | 2 | $9 | $0 | $9 | 35.67 | 0.42 | -$183 | 20.00 |
| 4 | Replace External Windows<br>Location: Throughout Building | $22,986 | 40 | 977 | 0 | $222 | $2 | $224 | 102.58 | 0.17 | -$19,084 | 25.00 |
| **Total for Improvements** | | **$114,633** | **173** | **17,283** | **130** | **$3,973** | **$152** | **$4,125** | **27.79** | | | |

# 2. Introduction

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

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

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

### Energy and Water Using Equipment

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

### Building Envelope

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

### Recommendations for Energy Savings Opportunities

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

### Analysis of Energy Consumption

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

### Energy Audit Process

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

### Reporting

The EMG Energy Audit Report includes:

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

# 3. Facility Overview and Existing Conditions

## 3.1. Building Occupancy and Point of Contact

| Facility Schedule | |
|---|---|
| Hours of Operations / Week | 35 |
| Operational Weeks / Year | 37 |
| Estimated Facility Occupancy | 391 |
| % of Male Occupants | 45% |

| Point of Contact | |
|---|---|
| Point of Contact Name | Annie Narayan |
| Point of Contact Title | Assistant Principal of Operations |
| Point of Contact – Contact Number | 661.301.4642 |

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

**Description:**

Heating and cooling are mainly provided by rooftop packaged units and heat pumps. Heating is supplemented by forced air furnaces.

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

| Building Central Heating System | |
|---|---|
| Primary Heating System | Rooftop Package Units |
| Secondary Heating System | Forced Air Furnace |
| 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 | Package Units |
| Secondary Cooling System | Split Systems |

| Building Cooling System | |
|---|---|
| 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 |
|---|---|---|
| $0.17/kWh | $1.31/therm | $ 5.82/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.

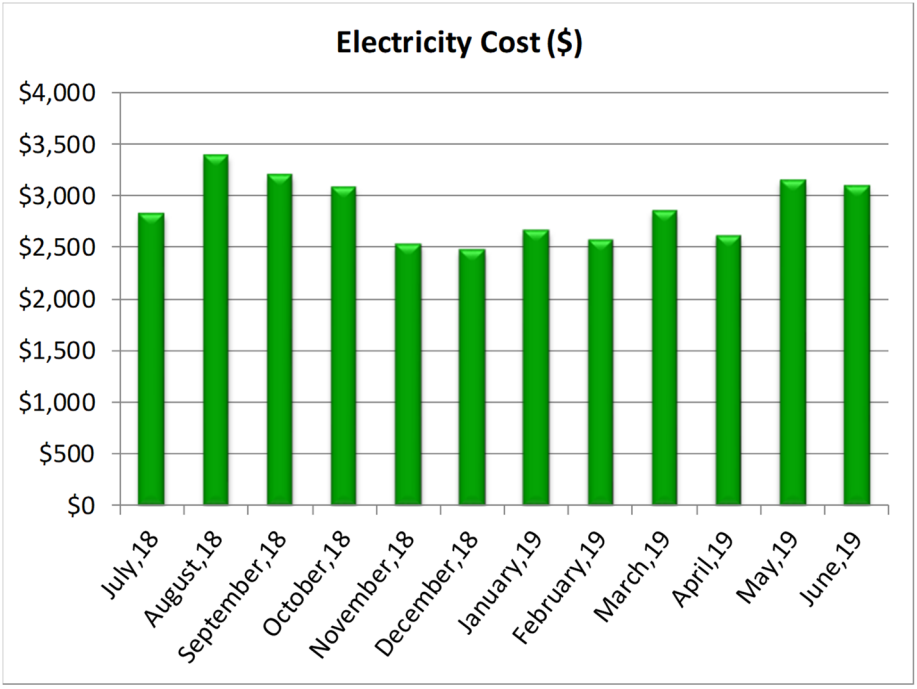
## 4.1. Electricity

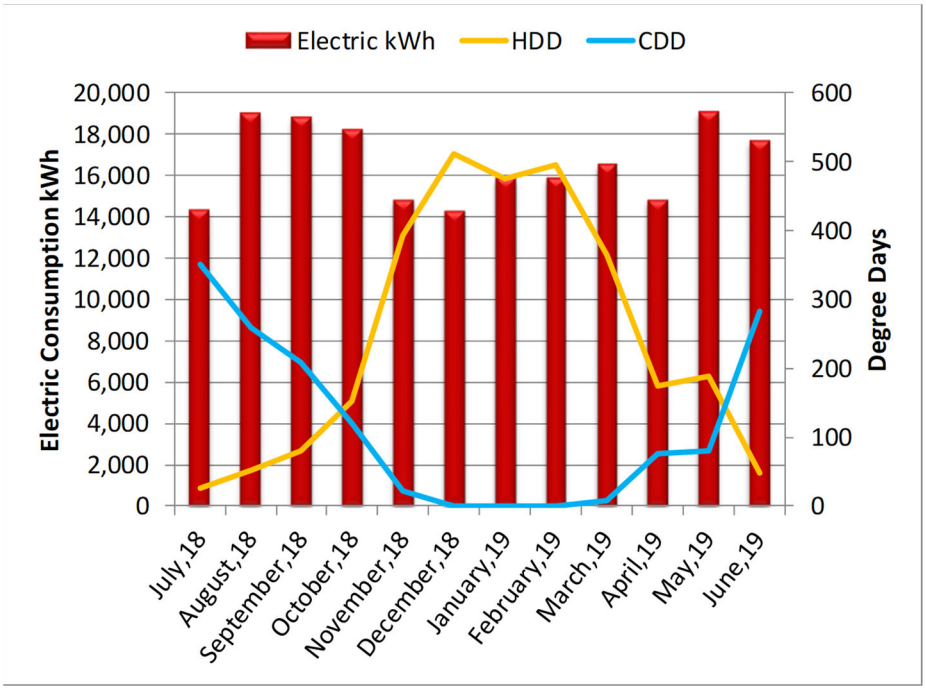
PGE satisfies the electricity requirements for the facility. The primary end uses for electric utility compromises of lighting, cooling, office/school equipment, and appliances in the break room.

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 | 14,305 | $0.20 | $2,828 |
| August,18 | 18,992 | $0.18 | $3,383 |
| September,18 | 18,772 | $0.17 | $3,198 |
| October,18 | 18,191 | $0.17 | $3,084 |
| November,18 | 14,757 | $0.17 | $2,533 |
| December,18 | 14,237 | $0.17 | $2,475 |
| January,19 | 15,835 | $0.17 | $2,664 |
| February,19 | 15,868 | $0.16 | $2,569 |
| March,19 | 16,543 | $0.17 | $2,846 |
| April,19 | 14,796 | $0.18 | $2,605 |
| May,19 | 19,032 | $0.17 | $3,141 |
| June,19 | 17,641 | $0.18 | $3,091 |
| **Total/average** | **198,969** | **$0.17** | **$34,417** |


Electricity Cost ($)
$4,000
$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
20,000
18,000
16,000
14,000
12,000
10,000
8,000
6,000
4,000
2,000
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

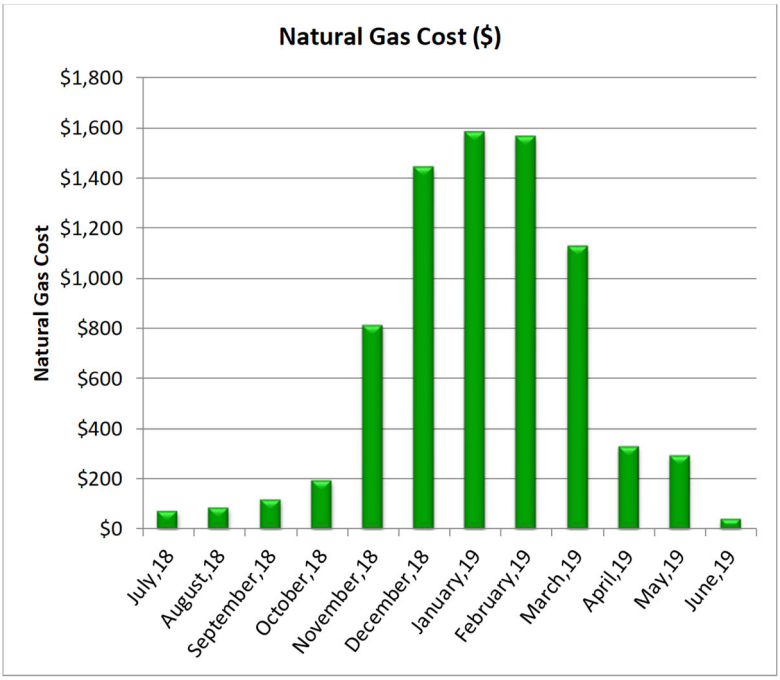
## 4.2. Natural Gas

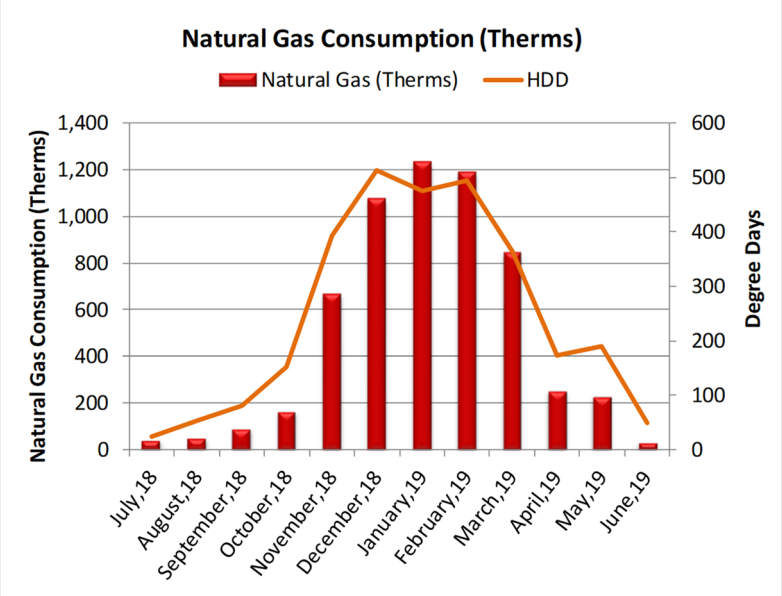
Spurr Gas satisfies the natural gas requirements of the facility. The primary end use of natural gas is for building heating, domestic water heating, and cooking in the cafeteria.

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 | 42 | $1.75 | $73 |
| August,18 | 53 | $1.60 | $85 |
| September,18 | 90 | $1.31 | $118 |
| October,18 | 162 | $1.19 | $193 |
| November,18 | 670 | $1.21 | $809 |
| December,18 | 1,074 | $1.34 | $1,443 |
| January,19 | 1,233 | $1.29 | $1,584 |
| February,19 | 1,189 | $1.32 | $1,564 |
| March,19 | 845 | $1.33 | $1,125 |
| April,19 | 253 | $1.31 | $331 |
| May,19 | 226 | $1.30 | $293 |
| June,19 | 29 | $1.32 | $39 |
| **Total/average** | **5,864** | **$1.31** | **$7,658** |


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

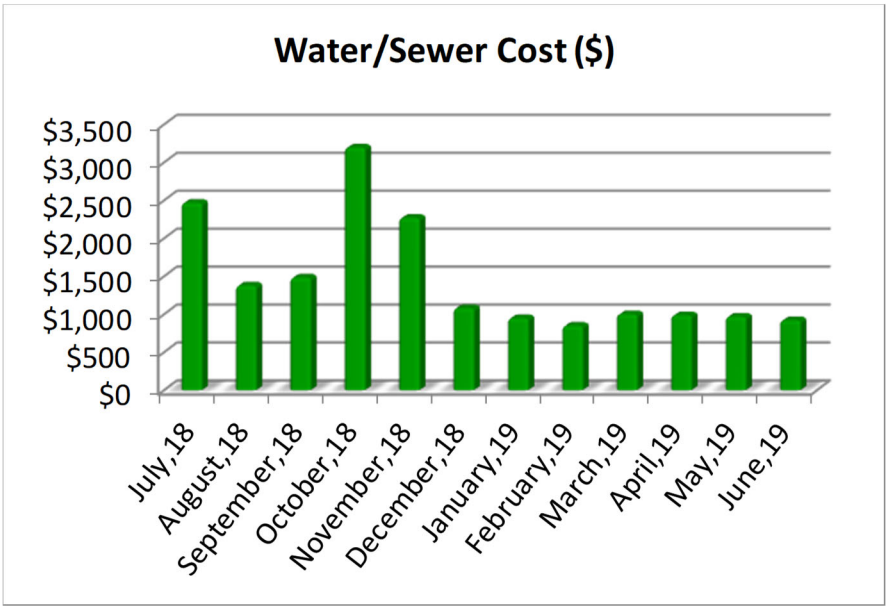

Natural Gas Consumption (Therms)
Natural Gas (Therms)
HDD
Natural Gas Consumption (Therms)
1,400
1,200
1,000
800
600
400
200
0
Degree Days
600
500
400
300
200
100
0
July,18
August,18
September,18
October,18
November,18
December,18
January,19
February,19
March,19
April,19
May,19
June,19

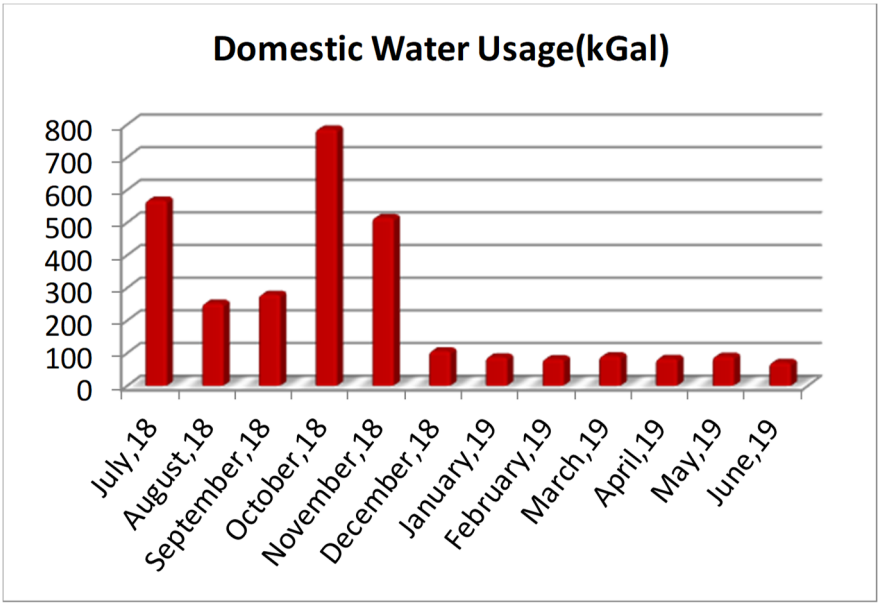
## 4.3. Water and Sewer

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

**Water and Sewer Consumption and Cost Data**

| Billing Month | Consumption (Kgal) | Unit Cost/Kgal | Total Cost |
|---|---|---|---|
| July,18 | 569 | $4.35 | $2,475 |
| August,18 | 254 | $5.46 | $1,384 |
| September,18 | 281 | $5.30 | $1,489 |
| October,18 | 787 | $4.07 | $3,202 |
| November,18 | 516 | $4.41 | $2,276 |
| December,18 | 108 | $10.09 | $1,087 |
| January,19 | 89 | $10.71 | $954 |
| February,19 | 83 | $10.25 | $854 |
| March,19 | 92 | $10.92 | $1,006 |
| April,19 | 84 | $11.75 | $993 |
| May,19 | 91 | $10.67 | $974 |
| June,19 | 72 | $12.83 | $927 |
| **Total/average** | **3,027** | **$5.82** | **$17,621** |


Water/Sewer 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


Domestic Water Usage(kGal)
800
700
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

# 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? | **Yes** |
| Is the property located in a state eligible for net metering? | **Yes** |

A solar feasibility analysis of the Capitol Collegiate Academy 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 | 69 | |
| Estimated KW Rating | 124 | KW |
| Potential Annual kWh Produced | 191,313 | kWh |
| % of Current Electricity Uses | 96.2% | |
| **Financial Summary** | | |
| Investment Cost | $434,700 | |
| Estimated Energy Cost Savings | $32,523 | |
| Payback without Incentives | 13.4 | Years |
| Incentive Payback but without SRECs | 8.1 | Years |
| Payback with All Incentives | 8.1 | Years |

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

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

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

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

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

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

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

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

# 6. Operations and Maintenance Plan

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

***Building Envelope***

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

***Heating and Cooling***

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

***Central Domestic Hot Water Heater***

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

***Lighting Improvements***

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

***Existing Equipment and Replacements***

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

# 7. Appendices

APPENDIX A: Glossary of Terms

APPENDIX B: Mechanical Equipment Inventory

APPENDIX C: Lighting System Schedule

APPENDIX D: ECM Checklist

APPENDIX E: ECM Calculations

APPENDIX F: Solar PV

# APPENDIX A:
# Glossary of Terms

## Glossary of Terms and Acronyms

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

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

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

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

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

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

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

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

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

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

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

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

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

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

# APPENDIX B:
# Mechanical Equipment Inventory

| Mechanical Inventory | | | | | | |
|---|---|---|---|---|---|---|
| System | Make | Model | Serial Number | Input Capacity | Location | Location- Floor |
| Condensing Unit/Heat Pump | Lennox | ML14XC1-036-230806 | 1917H13014 | 3 TON | Capitol Collegiate Academy / Portable Classrooms 34 and 35 (P02) | Classroom - O035 |
| Condensing Unit/Heat Pump | Lennox | ML14XC1-036-230806 | 1917H13024 | 3 TON | Capitol Collegiate Academy / Portable Classrooms 34 and 35 (P02) | Classroom - O034 |
| Condensing Unit/Heat Pump | Day & Nite | 597CN060-D | 3796E04621 | 5 TON | Capitol Collegiate Academy / Administration (004) | Office |
| Domestic Circulation/Booster Pump | Berkeley Pumps\ US Electric Motors | B080A | No tag/plate found | 10 HP | Capitol Collegiate Academy / Site | Site |
| Exhaust Fan | | | | 500 CFM | Capitol Collegiate Academy / Multipurpose (006) | Kitchen |
| Exhaust Fan | Penn Ventilator Company | FX8B | No tag/plate found | 1500 CFM | Capitol Collegiate Academy / Restrooms (002) | Roof |
| Exhaust Fan | Penn Ventilator Company | FX8B | No tag/plate found | 1500 CFM | Capitol Collegiate Academy / Restrooms (002) | Roof |
| Furnace | Lennox | Inaccessible | Inaccessible | 100 MBH | Capitol Collegiate Academy / Portable Classrooms 34 and 35 (P02) | Classroom - O035 |
| Furnace | Lennox | Inaccessible | Inaccessible | 100 MBH | Capitol Collegiate Academy / Portable Classrooms 34 and 35 (P02) | Classroom - O034 |

| | | | | | | |
|---|---|---|---|---|---|---|
| Furnace | Bryant | 383KAV060111 | 4496A07899 | 110 MBH | Capitol Collegiate Academy / Administration (004) | Building exterior |
| Heat Pump | Bard | 48WH6-A10C | Inaccessible | 4 TON | Capitol Collegiate Academy / Portable Classrooms (P09) | Former 4th R |
| Heat Pump | Bard | 48WH6-A10C | 107N890629883 | 4 TON | Capitol Collegiate Academy / Portable Classrooms (P09) | Former 4th R |
| Heat Pump | Marvair | 36WH7AO5C | 058F900648726 | 3 TON | Capitol Collegiate Academy / Portable Classrooms 11 to 15 (P01) | Classroom-O013 |
| Heat Pump | Marvair | AVP36HPA05N-1000 BI | FL49789 | 3 TON | Capitol Collegiate Academy / Portable Classrooms 11 to 15 (P01) | Classroom-O014 |
| Heat Pump | Marvair | 36WH7-A05C | 058F9006487 | 3 TON | Capitol Collegiate Academy / Portable Classrooms 11 to 15 (P01) | Classroom-O012 |
| Heat Pump | Berd | WH421-A05VP4XXX | 126L031847440-02 | 3.5 TON | Capitol Collegiate Academy / Portable Classrooms 11 to 15 (P01) | Classroom-O015 |
| Heat Pump | Bard | WH491-A02AP4XXB | 218H011647542-02 | 4 TON | Capitol Collegiate Academy / Head Start (P11) | Building exterior |
| Heat Pump | Bard | ?421-A00VP4XXX | 126F041915778-02 | 4 TON | Capitol Collegiate Academy / Portable Classrooms 11 to 15 (P01) | Classroom - O011 |
| Packaged Unit (RTU) | | | | 5 TON | Capitol Collegiate Academy / Portable Clinic (P08) | Roof |

| | | | | | | |
|---|---|---|---|---|---|---|
| Packaged Unit (RTU) | BDP | 581BPV048072ADAA | 1899G20319 | 4 TON | Capitol Collegiate Academy / Classrooms 6 to 10 (003) | Classroom-O006 |
| Packaged Unit (RTU) | BDP | 561BPV04807ADAA | 2199G20371 | 4 TON | Capitol Collegiate Academy / Classrooms 1 to 4 (001) | Classroom - O005 |
| Packaged Unit (RTU) | BDP | 561BPV04807ADAA | 1899G20322 | 4 TON | Capitol Collegiate Academy / Classrooms 1 to 4 (001) | Classroom - Y030 |
| Packaged Unit (RTU) | BDP | 581BPV150224AEAA | 2299G30679 | 12.5 TON | Capitol Collegiate Academy / Multipurpose (006) | Kitchen - K001 |
| Packaged Unit (RTU) | BDP | 581BPV048072ADAA | 1899G20321 | 4 TON | Capitol Collegiate Academy / Classrooms 6 to 10 (003) | Classroom-O007 |
| Packaged Unit (RTU) | BDP | 561BPV04807ADAA | 2199G20367 | 4 TON | Capitol Collegiate Academy / Classrooms 1 to 4 (001) | Classroom - O004 |
| Packaged Unit (RTU) | BDP | 561BPV04807ADAA | 1899G20324 | 4 TON | Capitol Collegiate Academy / Classrooms 1 to 4 (001) | Classroom - Y040 |
| Packaged Unit (RTU) | BDP | 581BPV036072ADAA | 2099G20246 | 3 TON | Capitol Collegiate Academy / Multipurpose (006) | Stage - U002 |
| Packaged Unit (RTU) | BDP | 581BPV048072ADAA | 1899G20323 | 4 TON | Capitol Collegiate Academy / Classrooms 6 to 10 (003) | Classroom-O008 |
| Packaged Unit (RTU) | BDP | 561BPV04807ADAA | 2199G20346 | 4 TON | Capitol Collegiate Academy / Classrooms 1 to 4 (001) | Classroom - O003 |

| | | | | | | |
|---|---|---|---|---|---|---|
| Packaged Unit (RTU) | Bryant | 583ANW024040AAHD | 2199G11138 | 2 TON | Capitol Collegiate Academy / Multipurpose (006) | Kitchen-K001 |
| Packaged Unit (RTU) | BDP | 581BPV048072ADAA | 1899G20366 | 4 TON | Capitol Collegiate Academy / Classrooms 6 to 10 (003) | Classroom-O009 |
| Packaged Unit (RTU) | BDP | 561BPV04807ADAA | 1899G20320 | 4 TON | Capitol Collegiate Academy / Classrooms 1 to 4 (001) | Classroom - O002 |
| Packaged Unit (RTU) | BDP | 561BPV06007ADAA | 2199G20434 | 5 TON | Capitol Collegiate Academy / Classrooms 1 to 4 (001) | Classroom - O001 |
| Packaged Unit (RTU) | BDP | 581BPV060072ADAA | 1899G20433 | 5 TON | Capitol Collegiate Academy / Classrooms 6 to 10 (003) | Classroom-O010 |
| Packaged Unit (RTU) | Bryant | 583ANW024040AAHD | 2199G11135 | 2 TON | Capitol Collegiate Academy / Classrooms 6 to 10 (003) | Classroom-O008 |
| Water Heater | A. O. Smith | EES 30 917 | GL01-0294421-917 | 30 GAL | Capitol Collegiate Academy / Administration (004) | Janitor - J001 |
| Water Heater | Rheem | 22VR75-70N | RHLN0607U00250 | 75 GAL | Capitol Collegiate Academy / Multipurpose (006) | Janitor - J001 |

# 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 | P011 | Interior | | CLASSROOM | P011 | | - | 1 | Light Switch | Linear Fluorescent | T8 | 4' 32W T8 | 24 | 2x4 Prism Troffer | 12 | 0 | 8 | 1,295 | 995 |
| 2 | P011 | Interior | | RESTROOM | Restroom | | - | 2 | Light Switch | Linear Fluorescent | T8 | 4' 32W T8 | 8 | 2x4 Prism Troffer | 4 | 0 | 8 | 1,295 | 332 |
| 3 | P011 | Interior | | CAFETERIA | Cafeteria | | - | 1 | Light Switch | Linear Fluorescent | T8 | 4' 32W T8 | 4 | 2x4 Prism Troffer | 2 | 0 | 8 | 1,295 | 166 |
| 4 | P011 | Interior | | OFFICE | Office | | - | 1 | Light Switch | Linear Fluorescent | T8 | 4' 32W T8 | 8 | 2x4 Prism Troffer | 4 | 0 | 8 | 1,295 | 332 |
| 5 | P011 | Exterior | | HALLWAY | Exterior | | - | 0 | Timer | CFL | CFL - 2 Pin | CFL13 | 2 | Wallpack-Vertical | 2 | 0 | 8 | 1,295 | 34 |
| 6 | P011 | Exterior | | HALLWAY | Exterior | | - | 0 | Timer | HID | MH | MH400 | 2 | Wallpack-Vertical | 2 | 0 | 8 | 1,295 | 1,036 |
| 7 | P09 and P10 | Interior | | CLASSROOM | P10 | | - | 4 | Light Switch | Linear Fluorescent | T8 | 4' 32W T8 | 48 | 2x4 Prism Troffer | 24 | 0 | 8 | 1,295 | 1,989 |
| 8 | P09 and P10 | Interior | | HALLWAY | Exterior | | - | 0 | Timer | CFL | CFL - 4 Pin | CFL42 | 2 | Surface Mount Can | 2 | 0 | 8 | 1,295 | 109 |
| 9 | P08 | Interior | | OFFICE | Office | | - | 3 | Light Switch | Linear Fluorescent | T8 | 4' 32W T8 | 12 | 2x4 Prism Troffer | 6 | 0 | 8 | 1,295 | 497 |
| 10 | P08 | Interior | | OFFICE | Office | | - | 4 | Light Switch | Linear Fluorescent | T8 | 4' 32W T8 | 8 | 2x4 Prism Troffer | 4 | 0 | 8 | 1,295 | 332 |
| 11 | P09 and P10 | Interior | | HALLWAY | Exterior | | - | 0 | Timer | HID | HPS | HPS50 | 2 | Surface Mount | 2 | 0 | 8 | 1,295 | 130 |
| 12 | P02 | Interior | | CLASSROOM | 35 | | - | 4 | Light Switch | Linear Fluorescent | T8 | 4' 32W T8 | 96 | 2x4 Prism Troffer | 48 | 0 | 8 | 1,295 | 3,978 |
| 13 | P02 | Exterior | | HALLWAY | Exterior | | - | 1 | Timer | HID | HPS | HPS400 | 1 | Wallpack-Horizontal | 1 | 0 | 8 | 1,295 | 518 |
| 14 | P02 | Exterior | | HALLWAY | Exterior | | - | 1 | Timer | CFL | CFL - 4 Pin | CFL42 | 1 | Surface Mount Hor | 1 | 0 | 8 | 1,295 | 54 |
| 15 | P01 | Interior | | HALLWAY | Exterior | | - | 0 | Timer | CFL | CFL - 2 Pin | CFL13 | 5 | Wallpack-Vertical | 5 | 0 | 8 | 1,295 | 84 |
| 16 | 006 | Exterior | | HALLWAY | Exterior | | - | 1 | Timer | CFL | CFL - 2 Pin | CFL13 | 1 | Wallpack-Vertical | 1 | 0 | 8 | 1,295 | 17 |
| 17 | 006 | Exterior | | HALLWAY | Exterior | | - | 1 | Timer | CFL | CFL - 4 Pin | CFL42 | 5 | Surface Mount Can | 5 | 0 | 8 | 1,295 | 272 |
| 18 | 006 | Exterior | | HALLWAY | Exterior | | - | 1 | Timer | HID | HPS | HPS400 | 1 | Wallpack-Horizontal | 1 | 0 | 8 | 1,295 | 518 |
| 19 | 006 | Interior | | CAFETERIA | Multipurpose | | - | 1 | Light Switch | Linear Fluorescent | T8 | 4' 32W T8 | 32 | 2x4 Prism Troffer | 16 | 0 | 8 | 1,295 | 1,326 |
| 20 | 006 | Interior | | AUDITORIUM | Stage | | - | 2 | Light Switch | Linear Fluorescent | T8 | 4' 32W T8 | 12 | 2x4 Prism Troffer | 6 | 0 | 8 | 1,295 | 497 |
| 21 | 006 | Interior | | KITCHEN | Kitchen | | - | 5 | Light Switch | Linear Fluorescent | T8 | 4' 32W T8 | 20 | 2x4 Prism Troffer | 10 | 0 | 8 | 1,295 | 829 |
| 22 | 006 | Interior | | KITCHEN | T001 | | - | 2 | Wall-Mounted Sensor | Linear Fluorescent | T8 | 4' 32W T8 | 4 | 2x4 Prism Troffer | 2 | 0 | 8 | 1,295 | 166 |
| 23 | P01 | Interior | | CLASSROOM | 11 | | - | 10 | Light Switch | Linear Fluorescent | T8 | 4' 32W T8 | 270 | 2x4 Prism Troffer | 90 | 0 | 8 | 1,295 | 11,189 |
| 24 | 003 | Interior | | HALLWAY | Exterior | | - | 1 | Timer | CFL | CFL - 4 Pin | CFL42 | 7 | Surface Mount Can | 7 | 0 | 8 | 1,295 | 381 |
| 25 | 003 | Interior | | CLASSROOM | 10 | | - | 15 | Light Switch | Linear Fluorescent | T8 | 4' 32W T8 | 180 | 2x4 Prism Troffer | 90 | 0 | 8 | 1,295 | 7,459 |
| 26 | 001 | Interior | | OFFICE | 1 | | - | 15 | Light Switch | Linear Fluorescent | T8 | 8' 59W T8 | 120 | Industrial | 60 | 0 | 8 | 1,295 | 9,169 |
| 27 | 001 | Interior | | RESTROOM | T01A | | - | 4 | Light Switch | Linear Fluorescent | T8 | 4' 32W T8 | 8 | Industrial | 4 | 0 | 8 | 1,295 | 332 |
| 28 | 001 | Interior | | RESTROOM | Hallway | | - | 1 | Wall-Mounted Sensor | Linear Fluorescent | T8 | 4' 32W T8 | 4 | 2x4 Prism Troffer | 2 | 0 | 8 | 1,295 | 166 |
| 29 | 001 | Interior | | HALLWAY | Exterior | | - | 1 | Timer | CFL | CFL - 4 Pin | CFL42 | 12 | Surface Mount Can | 12 | 0 | 8 | 1,295 | 653 |
| 30 | 002 | Interior | | STORAGE | Storage | | - | 1 | Light Switch | Linear Fluorescent | T8 | 4' 32W T8 | 4 | 2x4 Prism Troffer | 2 | 0 | 8 | 1,295 | 166 |
| 31 | 002 | Interior | | RESTROOM | Restroom | | - | 2 | Light Switch | Linear Fluorescent | T8 | 4' 32W T8 | 8 | 2x4 Prism Troffer | 4 | 0 | 8 | 1,295 | 332 |
| 32 | 004 | Exterior | | HALLWAY | Exterior | | - | 1 | Timer | CFL | CFL - 4 Pin | CFL42 | 12 | Surface Mount Can | 12 | 0 | 8 | 1,295 | 653 |
| 33 | 005 | Interior | | HALLWAY | Exterior | | - | 0 | Timer | CFL | CFL - 4 Pin | CFL42 | 10 | Surface Mount Can | 10 | 0 | 8 | 1,295 | 544 |
| 34 | 004 | Interior | | OFFICE | H001 | | - | 1 | Light Switch | Linear Fluorescent | T8 | 4' 32W T8 | 8 | 2x4 Prism Troffer | 4 | 0 | 8 | 1,295 | 332 |
| 35 | 004 | Interior | | OFFICE | Office | | - | 2 | Wall-Mounted Sensor | Linear Fluorescent | T8 | 4' 32W T8 | 36 | 2x4 Prism Troffer | 18 | 0 | 8 | 1,295 | 1,492 |
| 36 | 004 | Interior | | OFFICE | C005 | | - | 4 | Wall-Mounted Sensor | Linear Fluorescent | T8 | 4' 32W T8 | 48 | 2x4 Prism Troffer | 24 | 0 | 8 | 1,295 | 1,989 |
| 37 | 005 | Interior | | CLASSROOM | 30 | | - | 8 | Light Switch | Linear Fluorescent | T8 | 4' 32W T8 | 80 | 2x4 Prism Troffer | 40 | 0 | 8 | 1,295 | 3,315 |
| 38 | 005 | Interior | | RESTROOM | Women's | | - | 4 | Light Switch | Linear Fluorescent | T8 | 4' 32W T8 | 8 | 2x4 Prism Troffer | 4 | 0 | 8 | 1,295 | 332 |
| | Totals | | | | | | | | | | | | 1,113 | | 543 | | | 49,210 | 52,709 |

| | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | 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 | P011 | Interior | | CLASSROOM | P011 | | Light Switch | 1 | Linear Fluorescent | T8 | 4' 32W T8; 2x4 Prism Troffer | 12 | 24 | 8 | 1,295 | 995 | ECM | | Wall Mounted | 4' 17W LED T8 | 1,295 | 528 | 466 |
| 2 | P011 | Interior | | RESTROOM | Restroom | | Light Switch | 2 | Linear Fluorescent | T8 | 4' 32W T8; 2x4 Prism Troffer | 4 | 8 | 8 | 1,295 | 332 | ECM | | Wall Mounted | 4' 17W LED T8 | 1,295 | 176 | 155 |
| 3 | P011 | Interior | | CAFETERIA | Cafeteria | | Light Switch | 1 | Linear Fluorescent | T8 | 4' 32W T8; 2x4 Prism Troffer | 2 | 4 | 8 | 1,295 | 166 | ECM | | Wall Mounted | 4' 17W LED T8 | 1,295 | 88 | 78 |
| 4 | P011 | Interior | | OFFICE | Office | | Light Switch | 1 | Linear Fluorescent | T8 | 4' 32W T8; 2x4 Prism Troffer | 4 | 8 | 8 | 1,295 | 332 | ECM | | Wall Mounted | 4' 17W LED T8 | 1,295 | 176 | 155 |
| 5 | P011 | Exterior | | HALLWAY | Exterior | | Timer | 0 | CFL | CFL - 2 Pin | CFL13; Wallpack-Vertical | 2 | 2 | 8 | 1,295 | 34 | | | Photo Sensor | | | | |
| 6 | P011 | Exterior | | HALLWAY | Exterior | | Timer | 0 | HID | MH | MH400; Wallpack-Vertical | 2 | 2 | 8 | 1,295 | 1,036 | ECM | | Photo Sensor | 70W LED Wallpack | 1,295 | 181 | 855 |
| 7 | P09 and P10 | Interior | | CLASSROOM | P10 | | Light Switch | 4 | Linear Fluorescent | T8 | 4' 32W T8; 2x4 Prism Troffer | 24 | 48 | 8 | 1,295 | 1,989 | ECM | | Wall Mounted | 4' 17W LED T8 | 1,295 | 1,057 | 932 |
| 8 | P09 and P10 | Interior | | HALLWAY | Exterior | | Timer | 0 | CFL | CFL - 4 Pin | CFL42; Surface Mount Can | 2 | 2 | 8 | 1,295 | 109 | | | Photo Sensor | | | | |
| 9 | P08 | Interior | | OFFICE | Office | | Light Switch | 3 | Linear Fluorescent | T8 | 4' 32W T8; 2x4 Prism Troffer | 6 | 12 | 8 | 1,295 | 497 | ECM | | Wall Mounted | 4' 17W LED T8 | 1,295 | 264 | 233 |
| 10 | P08 | Interior | | OFFICE | Office | | Light Switch | 4 | Linear Fluorescent | T8 | 4' 32W T8; 2x4 Prism Troffer | 4 | 8 | 8 | 1,295 | 332 | ECM | | Wall Mounted | 4' 17W LED T8 | 1,295 | 176 | 155 |
| 11 | P09 and P10 | Interior | | HALLWAY | Exterior | | Timer | 0 | HID | HPS | HPS50; Surface Mount | 2 | 2 | 8 | 1,295 | 130 | ECM | | Photo Sensor | 25W LED Flood | 1,295 | 65 | 65 |
| 13 | P02 | Exterior | | HALLWAY | Exterior | | Timer | 1 | HID | HPS | HPS400; Wallpack-Horizontal | 1 | 1 | 8 | 1,295 | 518 | ECM | | Wall Mounted | 70W LED Wallpack | 1,295 | 91 | 427 |
| 15 | P01 | Interior | | HALLWAY | Exterior | | Timer | 0 | CFL | CFL - 2 Pin | CFL13; Wallpack-Vertical | 5 | 5 | 8 | 1,295 | 84 | | | Photo Sensor | | | | |
| 17 | 006 | Exterior | | HALLWAY | Exterior | | Timer | 1 | CFL | CFL - 4 Pin | CFL42; Surface Mount Can | 5 | 5 | 8 | 1,295 | 272 | | | Photo Sensor | | | | |
| 19 | 006 | Interior | | CAFETERIA | Multipurpose | | Light Switch | 1 | Linear Fluorescent | T8 | 4' 32W T8; 2x4 Prism Troffer | 16 | 32 | 8 | 1,295 | 1,326 | ECM | | Ceiling Mounted | 4' 17W LED T8 | 1,295 | 704 | 622 |
| 21 | 006 | Interior | | KITCHEN | Kitchen | | Light Switch | 5 | Linear Fluorescent | T8 | 4' 32W T8; 2x4 Prism Troffer | 10 | 20 | 8 | 1,295 | 829 | ECM | | Ceiling Mounted | 4' 17W LED T8 | 1,295 | 440 | 389 |
| 22 | 006 | Interior | | KITCHEN | T001 | | Wall-Mounted Sensor | 2 | Linear Fluorescent | T8 | 4' 32W T8; 2x4 Prism Troffer | 2 | 4 | 8 | 1,295 | 166 | ECM | | Retain Existing Controls | 4' 17W LED T8 | 1,295 | 88 | 78 |
| 24 | 003 | Interior | | HALLWAY | Exterior | | Timer | 1 | CFL | CFL - 4 Pin | CFL42; Surface Mount Can | 7 | 7 | 8 | 1,295 | 381 | | | Photo Sensor | | | | |
| 25 | 003 | Interior | | CLASSROOM | 10 | | Light Switch | 15 | Linear Fluorescent | T8 | 4' 32W T8; 2x4 Prism Troffer | 90 | 180 | 8 | 1,295 | 7,459 | ECM | | Ceiling Mounted | 4' 17W LED T8 | 1,295 | 3,963 | 3,497 |
| 26 | 001 | Interior | | OFFICE | 1 | | Light Switch | 15 | Linear Fluorescent | T8 | 8' 59W T8; Industrial | 60 | 120 | 8 | 1,295 | 9,169 | ECM | | Wall Mounted | 8' 40W LED T8 | 1,295 | 6,216 | 2,953 |
| 27 | 001 | Interior | | RESTROOM | T01A | | Light Switch | 4 | Linear Fluorescent | T8 | 4' 32W T8; Industrial | 4 | 8 | 8 | 1,295 | 332 | ECM | | Wall Mounted | 4' 17W LED T8 | 1,295 | 176 | 155 |
| 28 | 001 | Interior | | RESTROOM | Hallway | | Wall-Mounted Sensor | 1 | Linear Fluorescent | T8 | 4' 32W T8; 2x4 Prism Troffer | 2 | 4 | 8 | 1,295 | 166 | ECM | | Retain Existing Controls | 4' 17W LED T8 | 1,295 | 88 | 78 |
| 32 | 004 | Exterior | | HALLWAY | Exterior | | Timer | 1 | CFL | CFL - 4 Pin | CFL42; Surface Mount Can | 12 | 12 | 8 | 1,295 | 653 | | | Photo Sensor | | | | |
| 33 | 005 | Interior | | HALLWAY | Exterior | | Timer | 0 | CFL | CFL - 4 Pin | CFL42; Surface Mount Can | 10 | 10 | 8 | 1,295 | 544 | | | Photo Sensor | | | | |
| 34 | 004 | Interior | | OFFICE | H001 | | Light Switch | 1 | Linear Fluorescent | T8 | 4' 32W T8; 2x4 Prism Troffer | 4 | 8 | 8 | 1,295 | 332 | ECM | | Ceiling Mounted | 4' 17W LED T8 | 1,295 | 176 | 155 |
| 35 | 004 | Interior | | OFFICE | Office | | Wall-Mounted Sensor | 2 | Linear Fluorescent | T8 | 4' 32W T8; 2x4 Prism Troffer | 18 | 36 | 8 | 1,295 | 1,492 | ECM | | Retain Existing Controls | 4' 17W LED T8 | 1,295 | 793 | 699 |
| 36 | 004 | Interior | | OFFICE | C005 | | Wall-Mounted Sensor | 4 | Linear Fluorescent | T8 | 4' 32W T8; 2x4 Prism Troffer | 24 | 48 | 8 | 1,295 | 1,989 | ECM | | Retain Existing Controls | 4' 17W LED T8 | 1,295 | 1,057 | 932 |
| 37 | 005 | Interior | | CLASSROOM | 30 | | Light Switch | 8 | Linear Fluorescent | T8 | 4' 32W T8; 2x4 Prism Troffer | 40 | 80 | 8 | 1,295 | 3,315 | ECM | | Ceiling Mounted | 4' 17W LED T8 | 1,295 | 1,761 | 1,554 |
| 38 | 005 | Interior | | RESTROOM | Women's | | Light Switch | 4 | Linear Fluorescent | T8 | 4' 32W T8; 2x4 Prism Troffer | 4 | 8 | 8 | 1,295 | 332 | ECM | | Ceiling Mounted | 4' 17W LED T8 | 1,295 | 176 | 155 |
| | Totals | | | | | | | | | | | | 1,113 | | | | | | | | | 27,117 | 22,792 |

# 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 |

| | | | |
|---|---|---|---|
| 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 | 0 | | Number of Occupants Affected by Retrofit | 391 | |
| Do You Want To Replace Kitchen Faucets Aerators | No | *(Select)* | Do You Want To Replace Bathroom Faucets Aerators | Yes | *(Select)* |
| Total Number of Faucet Aerators To Be Replaced | 0 | | Total Number of Faucet Aerators To Be Replaced | 41 | |
| Total Number of Faucets To Be Replaced: | 0 | | Total Number of Faucets To Be Replaced: | 0 | |
| GPM of Existing Faucet Aerators | - | GPM | GPM of Existing Faucet Aerators | 2.2 | GPM |
| GPM of Proposed Faucet Aerator | - | GPM | GPM of Proposed Faucet Aerator | 0.5 | GPM |
| Estimated Number of Uses Per Day | 4 | | Estimated Number of Uses Per Day | 5 | |

Annual Water Savings From Installing Low Flow Aerators: 59.03 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: | 0.60 | EF | Heating Fuel Tariff | $1.31 | $/Therm |
| Hot Water Discharge Temperature at Faucet | 110.00 | °F | Water Tariff ($/1000 Gal) | $5.82 | $/kGal |
| Equivalent Heating Fuel Savings: *Savings Discounted by 15% to Account For Cold Water Use* | 418 | Therms | Annual Cost Savings In Form of Water | $344 | $ |
| Annual Water Savings | 59.03 | kGal | Annual Energy Savings From Water Heater | $546 | $ |

| COST BENEFIT ANALYSIS | | | | | |
|---|---|---|---|---|---|
| Estimated Total Annual Cost Savings | $890 | $$ | Estimated Total Installation Cost | $625 | $$ |
| Simple Payback Period | 0.70 | 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: $625 Estimated Annual Cost Savings: $890 Simple Payback Period (Yrs): 0.70

| UIC | Replace Existing Water Heater With New Energy Efficient Units |
|---|---|
| EAD3 | **Location: Mechanical Closet** |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Step 1 | **Existing Water Heater Details** | | | | | | | | |
| | Number of Water Heaters Being Replaced: | 1 | | | | | | | |
| | Select Existing Hot Water Heater Fuel | Electric | | Natural Gas | | Natural Gas | | Electric | |
| | Insert Energy Factor of Existing Water Heater | 0.78 | EF | | EF | | EF | | EF |
| | Input Existing Water Heater Input Rating | 4.50 | kW | | kBtus | | kBtus | | kW |
| | Select One Method For Calculation | Annual Heating Hours | | Annual Heating Hours | | Annual DWH Load | | Annual DWH Load | |
| | Insert Average Annual Hours of Operation | 1,464 | hrs | | hrs | | Therms | | kWh |
| | Annual Water Heater Energy Consumption/Heater | 6,588 | kWh | 0 | Therms | #DIV/0! | hrs | #DIV/0! | hrs |
| | Total Estimated Annual Energy Consumption For all Heaters | 6,588 | kWh | 0 | Therms | 0 | Therms | 0 | kWh |
| | Total Estimated Annual Operating Energy Costs For all Heaters | $1,140 | $ | $0 | $ | $0 | $ | $0 | $ |
| Step 2 | **Proposed New Water Heater** | | | | | | | | |
| | Proposed Hot Water Heater Fuel | Electric | | Heat Pump | | Electric | | Natural Gas | |
| | Capacity of the Proposed New Water Heater | 30-Gal,3.5-kW | | | | | | | |
| | Energy Factor of Proposed Water Heater | 0.93 | EF | 0.00 | EF | 0.00 | EF | 0.00 | EF |
| | Proposed Water Heater Input Rating | 3.50 | kW | 0.00 | kW | 0.00 | kW | 0.00 | kBtuh |
| | Annual kBtuh Consumption For All The Proposed Water Heaters | 18,853 | kBtuh | #DIV/0! | kBtuh | #DIV/0! | kBtuh | #DIV/0! | kBtuh |
| | Estimated Annual Water Heater Fuel Consumption (All Heaters) | 5,525 | kWh | 0 | kWh | 0 | kWh | 0 | Therms |
| | Estimated Total Annual Energy Costs | $956 | $ | $0 | | $0 | | $0 | |
| Step 3 | **Energy & Cost Saving Calculation** | | | | | | | | |
| | Estimated Cost of New Water Heater/Unit | $851 | $ | $0 | $ | $0 | $ | $0 | $ |
| | Total Estimated Installation Cost | $1,270 | $ | $0 | $ | $0 | $ | $0 | $ |
| | Total Estimated Annual Cost Savings | $184 | $ | $0 | $ | $0 | $ | $0 | $ |
| | Total Annual Cost Savings: | $184 | | Total Initial Investment:: | | $1,270 | | | |
| | Simple Pay Back Period | 6.91 | | | | | | | |
| | *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: $1,270 Simple Payback: 6.91 yrs

Annual Cost Savings: $184

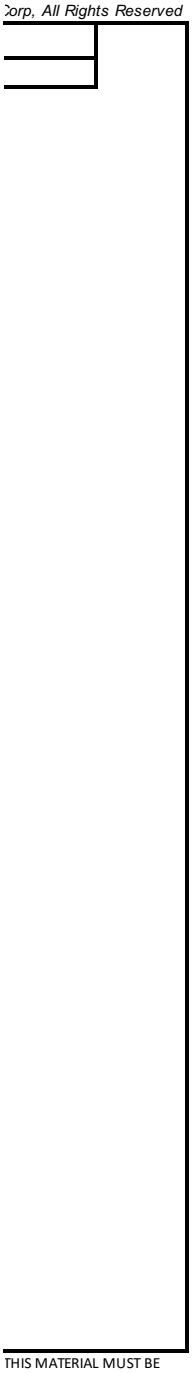
| UIC | Upgrade Building Lighting to LED and Install Automatic Lighting Controls |
|---|---|
| EAL10 | Location: Building Interior and Exterior |

| | No. of ECMs | No. of Fixtures | No. of Lamps | KWh Saved | Energy Cost Saving | O & M Savings |
|---|---|---|---|---|---|---|
| **Upgrade Lighting to LED** | 296 | 486 | 1,056 | 22,792 | $3,874.64 | $2,914.59 |

| 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 | 3 | 4 | 4 | 919 | $156 | $49 |
| HID | MH | 1 | 2 | 2 | 855 | $145 | $20 |
| HID | MV | 0 | 0 | 0 | 0 | $0 | $0 |
| HID | QL | 0 | 0 | 0 | 0 | $0 | $0 |
| Linear Fluorescent | T8 | 24 | 480 | 480 | 21,018 | $3,573 | $2,846 |
| 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 | 1 | Ceiling Mounted | 49 |
| Wall Mounted | 40 | | |

| **Initial Investment** | | | **Equipment Rentals** | |
|---|---|---|---|---|
| Material Cost | $16,853.32 | | Scissor Lift 26' - Interior Spaces | $0.00 |
| Labor Cost | $59,096.50 | | Bucket Truck - Exterior Spaces | $0.00 |
| Local Electric Rate: | $0.17 | $/kWh | Estimated Annual Energy Savings: | 22,792 |
| Hourly Labor Rate For Electrician: | $72.40 | | Estimated Annual Energy Cost Savings: | $3,875 |
| Budgeted Initial Investment: | $75,950 | | Estimated Annual O&M Cost Savings: | $2,915 |
| Estimated Return on Investment: *(Including O&M Savings)* | 11.19 | Years | Estimated Annual Cost Savings: | $6,789 |



| UIC | Replace Rooftop Package Unit |
|---|---|
| EAH12-B | Location: Roof |

| | | | | | |
|---|---|---|---|---|---|
| Estimated Annual Cooling Hours: | 976 | Hrs | Estimated Annual Heating Hours: | 1,464 | Hrs |
| Units to Replace | Air Conditioning: Yes | Heating System: Yes | Existing Type of Heating Fuel: | Natural Gas | |

**Existing Package System**

| | Cooling | | Heating | Total Combined Units | | |
|---|---|---|---|---|---|---|
| Number of Package Units to be Replaced: | 10 | | 10 | 10 | | |
| Capacity of the air conditioner: | 4 | Tons | EER of the Existing Air Conditioner: | 7.44 | | |
| Capacity of Existing Heating System: | 72 | MBH | Input Existing AFUE for the Furnace: | 74% | | |
| Estimated Annual Cooling Consumption: *(For All Units)* | 62,968 | kWh | Estimated Annual Heating Consumption : *(For All Units)* | 14,210 | Therms | |

**Proposed Package System**

| | | | | | |
|---|---|---|---|---|---|
| Capacity of the Proposed Air Conditioner: | 4 | Tons | EER of the Proposed Air Conditioner: | 10.04 | EER |
| Capacity of Proposed Heating System: | Gas Fired -75MBH | MBH | AFUE of Proposed Heating System: | 78% | % |
| Estimated Annual Energy Consumption With New Package Units | | | | | |
| Annual Electric Fuel Consumption: | 46,661 | kWh | Annual Heating Fuel Consumption: | 14,077 | Therms |

**Energy and Cost Analysis**

| | | | | | |
|---|---|---|---|---|---|
| Average Electric Rate: | $0.17 | $/kWh | Average Heating Rate: | $1.31 | $/Therm |
| Estimated Annual Electric Savings : *From All New Package Systems* | 16,306 | kWh | Estimated Annual Heating Savings : *From All New Package Systems* | 13,284 | kBtus |
| Annual Electric Cost Savings: *From All New Package Systems* | $2,821 | | Annual Electric Cost Savings: *From All New Package Systems* | $173 | $ |
| Proposed Type of System to be installed: | Package Heating and Cooling System | | | | |
| Estimated Material and Labor Cost Including Overheads and Profits For All Units: | | | | $73,750.00 | $ |
| Estimated Total Energy Cost Savings From New HVAC System: | | | | $2,994 | $ |
| Estimated O&M Savings: | | | | $150 | |
| Estimated Simple Pay Back Period: | 23.4589886 | Yrs | | | |
| | | | Capital Cost ECM Recommendation | | |

| UIC | Install Low Flow Tankless Restroom Fixtures |
|---|---|
| EAP4 | Location: Restrooms |

**ECM FOR DETERMINING WATER SAVINGS IN COMMERCIAL PROPERTIES**

| | | |
|---|---|---|
| Number of Males | 176 | |
| Number of Females | 215 | |
| Number of Occupied Days Per Week (Max 7) | 5 | |
| Number of Occupied Weeks/Year (Max 52) | 37 | |
| Number of Urinals To Be Retrofitted | 4 | |
| Number of Water Closets To Be Retrofitted | 20 | |
| No. of Water Closets With Separate Flush Tank *(Typical Residential Type)* | 0 | |
| **Estimated Restroom Usage/Individual/Day** *Default is 4 Uses/Day For Residential/Office* | 2 | (Select) |

**Urinal Water Savings**

| | | |
|---|---|---|
| Do you Want To Make Any Changes To The Urinals? | Yes | |
| Estimated Existing Use of Urinal/Day/Man | 80% | |
| Existing Gallons Per Flush Ratings For Urinal Flushes | 1.00 | GPF |
| Proposed Urinal | 0.125 GPF -Wall Mount | |
| GPF of Proposed Urinal Flush Valve** ***(1992 EpACT Energy Act Mandates 1.0GPF Max on Urinals)* | 0.125 | GPF |
| Estimated Annual Water Savings From Urinal | 45.58 | 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 | | 20 | |
| 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 | | 11.67 | kGal |
| Estimated Annual Water Savings From Female Users | | 71.28 | kGal |
| Total Water Savings From Water Closets | | 82.95 | kGal |

**Water & Cost Saving Calculations**

**Water Savings Calculation**

| | | |
|---|---|---|
| Water Savings By The Use of Low Flow Water Closet Flush Valves/Yr | 82.95 | kgal |
| Water Savings By The Use of Low Flow Urinal Flush Valves/ Yr | 45.58 | kgal |
| Total Annual Water Savings in kgal | 128.53 | kgal |

**Cost Savings Calculations**

| | | |
|---|---|---|
| Enter Water Tariff Rate ($/1000Gal) | $5.82 | $$ |
| Estimated Cost Savings From Water | $748 | $$ |

**Estimated Cost of Retrofit**

| | | |
|---|---|---|
| Cost For Replacing Existing Urinal Fixture With A Low Flow Fixture | $5,201 *(Includes Labor)* | $$ |
| Cost For Replacing Existing Flush Valves With Low Flow - Dual Flush Valves ($80 Per Unit) *(Up For Liquid Waste And Down For Solid Waste)* | $12,381 *(Includes Labor)* | $$ |
| Estimated Total Cost For Retrofit | $17,582 | $$ |
| Simple Pay Back Period | 23.50 | 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: | $17,582 | Simple Payback Period: | 23.50 Yrs |
| Annual Cost Savings: | $748 | | |

| UIC | Retrofit Apartment Tank Toilets to Dual Flush |
|---|---|
| EAP3 | Location: |

## EXISTING CONDITION

| | | |
|---|---|---|
| Total Occupants: | 10 | |
| Number of Water Closets To Be Replaced | 2 | |
| Number of Occupied Days Per Week (Max 7) | 5 | |
| Number of Occupied Weeks/Year (Max 52) | 37 | |
| **Estimated Restroom Usage/Individual/Day** *5.05 flushes/person/day@American Water Works Association (AWWA)* | 4 | (Select) |

## PROPOSED RETROFIT/REPLACEMENT

| | | |
|---|---|---|
| Existing Gallons Per Flush Ratings For Water Closet Flushes | 1.28 | GPF |
| Replace or Retrofit Toilets With Dual Flush Toilets | Retrofit | |
| **Replace** | | |
| Proposed Toilet | 0.8GPF -Floor Mount, 10" Rough-In | |
| GPF of Proposed New Low Flow Water Closet Fixture* | 0.80 | GPF |
| **Retrofit** | | |
| Dual Flush - Retrofit Setup Valve for Flush Tank Toilet — *Solid Waste(20%)* | 1.28 | GPF |
| **(Federal Law Requires All Flushes Not To Exceed 1.6 GPF)* — *Liquid Waste(80%)* | 1.02 | GPF |

## Water & Cost Saving Calculations

| | | |
|---|---|---|
| Water Savings By The Use of Low Flow Water Closet Flush Valves/Day | 8.19 | gal |
| Total Annual Water Savings in gallons | 1.52 | kgal |
| **Cost Savings Calculations** | | |
| Enter Water Tariff Rate ($/1000Gal) | $5.82 | $$ |
| Estimated Cost Savings From Water | $9 | $$ |
| **Estimated Cost of Retrofit** | | |
| Estimated Total Cost For Retrofit | $315 | $$ |
| Simple Pay Back Period | 35.67 | Yrs |
| *Type of Recommendation* | No/Low Cost ECM Recommendation | |



## ECM EXPLANATION:

The highest water utilization at any home/office occurs in the restrooms. It is estimated that on an average a normal human being uses the restroom at least four times a day. Keeping with the global water conservation objectives, federal law prohibits use of any new water closet flushes over 1.6 GPF.

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

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

**Summary:**

| | | | | |
|---|---|---|---|---|
| Initial Investment: | $315 | | | |
| | | Simple Payback: | 35.67 | Years |
| Annual Cost Savings: | $9 | | | |

| UIC | Replace External Windows |
|---|---|
| EAE2 | Location: Throughout building |

**ENTER EXISTING CONDITIONS**

## Existing and Proposed Window Properties

| | | |
|---|---|---|
| Total Sq.Ft window area: | 336 | sq.ft |
| Approximate number of windows: | 28 | |
| Total existing window area: | 336 | Sq.Ft |
| Select The Existing Window Type | Metal Frame & Double Glazing | *(Select)* |
| 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) | 0.35 | Btu/ft².°F·h |
| *AHRAE 90.1 Recommended Value* | | |

## Existing & Proposed Air Leakage Through Windows

| | | |
|---|---|---|
| Insert Existing Estimated Air Change Rate/Hr (ACH 1): | 0.75 | |
| *(Existing Air Changes Per Hour, 1.5 is very leaky and 0.35 ideal)* | | |
| Insert Proposed Estimated Air Change Rate/Hr (ACH 2): | 0.53 | |
| Estimated Space Volume Under Consideration | 10,000.00 | Cu. Ft |
| Is the Property Cooled ? | Yes | *(Select)* |

### WINTER

| | | |
|---|---|---|
| Select Type of Heating Fuel | Natural Gas | *(Select)* |
| Net heating plant & distribution system efficiency: | 74.18 | **%** |
| Annual Heating Hours: | 2,963 | HDD |
| Estimated Total Annual Input Heating Energy Savings By Replacing Windows | 1.67 | Therms |
| Estimated Total Annual Input Heating Energy Savings Achieved By Controlling Air Leakage Through Windows | 39 | Therms |
| Estimated Total Input Heating Fuel Savings From Replacing Windows | 40 | Therms |

### SUMMER

| | | |
|---|---|---|
| Select Type of Cooling Fuel: | Electric | *(Default)* |
| Cooling Plant Efficiency **(EER)**: | 7.44 | **EER** |
| Annual Cooling Hours: | 1,407 | CDD |
| Annual Total Input Cooling Fuel Savings During Summer Season By Replacing Windows | 793 | kWh |
| Estimated Total Annual Input Cooling Energy Savings Achieved By Controlling Air Leakage Through Windows | 184 | kWh |
| Estimated Total Input Cooling Fuel Savings From Replacing Windows | 977 | kWh |

**ENERGY & COST ANALYSIS**

| | | | | | |
|---|---|---|---|---|---|
| Insert Cost of Heating Fuel: | $1.31 | $/Therm | Annual Heating Cost Savings: | $52.89 | $$ |
| Insert Cost of Cooling Fuel: | $0.17 | $/kWh | Annual Cooling Cost Savings: | $168.97 | $$ |
| **Total Annual Cost Savings** | $224 | | Total Annual Cost Savings From Heating & Cooling: | $222 | $$ |
| **Cost of window upgrade:** | $22,986 | | Estimated Annual O&M Savings | $2 | $ |
| **Simple payback:** | 102.58 | **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: | $22,986 | Simple Payback | 102.58 Yrs |
| Annual Energy Cost Savings: | $224 | | |

# APPENDIX F:
# Solar PV

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

Select State: Northern California  **Electric Rate:** $0.17 $/KWH  Annual Electric Consumption: 198,969 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 | 20.20 | 20 | 64 | 31,115 | 31,115 | $5,290 | $70,700 | 13.4 | $0 | $21,210 | $685 | $0 | 8.1 |
| 2 | Building 2 | 1 | 13 | 13 | 1 | 20,179 | 20,179 | $3,430 | $45,850 | 13.4 | $0 | $13,755 | $444 | $0 | 8.1 |
| 3 | Building 3 | 1 | 21 | 21 | 1 | 32,348 | 32,348 | $5,499 | $73,500 | 13.4 | $0 | $22,050 | $712 | $0 | 8.1 |
| 4 | Building 4 | 1 | 22 | 22 | 1 | 33,118 | 33,118 | $5,630 | $75,250 | 13.4 | $0 | $22,575 | $729 | $0 | 8.1 |
| 5 | Building 5 | 1 | 34 | 34 | 1 | 52,526 | 52,526 | $8,929 | $119,350 | 13.4 | $0 | $35,805 | $1,156 | $0 | 8.1 |
| 6 | Building 7 | 1 | 14 | 14 | 1 | 22,027 | 22,027 | $3,745 | $50,050 | 13.4 | $0 | $15,015 | $485 | $0 | 8.1 |
| 7 | | | | | | | | | | | | | | | |
| 8 | | | | 0 | 0 | | 0 | $0 | $0 | | $0 | $0 | $0 | $0 | |
| 9 | | | | 0 | 0 | | 0 | $0 | $0 | | $0 | $0 | $0 | $0 | |
| 10 | | | | 0 | 0 | | 0 | $0 | $0 | | $0 | $0 | $0 | $0 | |
| | | **6** | | **124** | **69** | **191,313.0** | **191,313** | **$32,523** | **$434,700** | **13.37** | **$0** | **$130,410** | **$4,209** | **$0** | **8.06** |

| Solar Rooftop Photovoltaic Analysis | | |
|---|---|---|
| Total Number of Roofs | 6 | |
| Estimated Number of Panels | 69 | |
| Estimated KW Rating | 124 | KW |
| Potential Annual KWh Produced | 191,313 | KWh |
| % of Current Electricity Load | 96.2% | |

| Financial Analysis | | |
|---|---|---|
| Investment Cost | $434,700 | |
| Estimated Energy Cost Savings | $32,523 | |
| Potential Rebates | $130,410 | |
| Potential Annual Incentives | $4,209 | |
| Payback without Incentives | 13.4 | years |
| Incentive Payback but without SRECS | 8.1 | years |
| Payback with All Incentives | 8.1 | years |