ENERGY SERVICES PROPOSAL

Camas School District

Lacamas Elementary & J.D. Zellerbach

HVAC System and Controls Improvements

Presented by:

Abacus Resource Management Company

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TABLE OF CONTENTS

Page

Executive Summary 3

I. Facility Description 4

II. ESCO Equipment 8

III. ESCO Services 10

IV. Project Costs 14

V. Project Accounting 16

VI. Standards of Comfort Service 17

VII. Estimated Annual Savings Amount 17

VIII. Method of Calculating Energy and Energy Cost Savings 17

IX. Energy Cost Savings Guaranty 18

X. Financing 18

XI. Insurance and Bonding 18

XII. Modifications to Baseline by Owner 19

XIII. Project Schedule 19

APPENDIX A Investment Grade Energy Audits

APPENDIX B Financial Table

EXECUTIVE SUMMARY

Abacus Resource Management Company (Abacus) is pleased to present this proposal for the implementation of energy efficiency measures at the Camas School District – Lacamas Elementary & J.D. Zellerbach facilities.

This Proposal follows the outline contained in the Conditions of the Master Energy Services Agreement No. 2011-169 A(1). As such, it presents the contractual terms under which Abacus, Camas School District, and the State of Washington will work together over the term of the project. This agreement describes the services rendered, payment methods, guarantees, and other aspects of the project.

An estimated $91,371 in Clark Public Utility District and Northwest Natural incentives are expected for this project. In addition, Abacus will assist Camas School District in applying for the Washington State OSPI energy operational cost savings grant program. Single grants may be obtained up to $1,000,000 for school districts.

Description of the Project

Lacamas Elementary:

The overall project consists of refurbishing and improving the HVAC systems serving the POD areas, replacement or upgrade of most of the HVAC systems serving the main school building and offices, and control system additions and modifications to improve comfort and reduce energy usage throughout the school.

J.D. Zellerbach:

The overall project consists of reprogramming and recommissioning the direct digital controls and graphical user interface for the HVAC systems, installation of CO2 sensing and demand control ventilation for the main HVAC systems, repair and replacement of broken mechanical and control components associated with the main HVAC systems.

Scope of Services

The scope of services under this Proposal includes the design, construction, and commissioning of the proposed measures and the verification of savings.

Financial Benefits

The project will produce an estimated $23,713 annually in utility savings as described in the Investment Grade Audits (IGAs).

Guarantees

Abacus is providing three guarantees under this Proposal. First, we are guaranteeing the Maximum Project Cost as defined in Paragraph IV will not exceed $443,723. Second, Abacus is guaranteeing that Camas School District realizes actual energy/utility savings of not less than 481,371 kWh and 745 therms, which at the baseline utility rates (as defined in the Energy Audit), represents an annual cost savings of $23,713. Third, we are guaranteeing the energy equipment will perform at or above the levels of service defined in Paragraph VI.

In addition to these guarantees, we will provide the Camas School District an "open book" process regarding the actual construction costs. If the actual construction costs are less than we forecast, Camas School District will realize the financial savings. Camas School District representatives will be invited to review the quotes and/or bids from subcontractors and interview the subcontractors to be used on this project.

Project Summary

Total Estimated Project Cost (including all fees and taxes)	$513,996
Maximum Guaranteed Project Cost (total less DES fees and taxes)	$443,723
Guaranteed Energy Savings (at current rates)	$23,713
Annual total kWh guaranteed	481,371
Annual total Therms guaranteed	745
Estimated Northwest Natural incentive	$745
Estimated Clark PUD incentive	$90,626

I. FACILITY DESCRIPTION

Lacamas Elementary School

Facility Description: The school was built in the mid 1960's and is composed of five stand-alone masonry buildings and two portables. There are three individual classroom "pods", a multi-purpose building and an administration building. The table below summarizes the individual buildings on the campus. There are also two portable buildings at this school.

Building	Area (square feet)
Administration	2,485
Pod 100	8,750
Pod 200	8,750
Pod 300	8,750
Multi-Purpose Building	14,381
Portable A	1,800
Portable B	1,800
TOTAL	46,716

Energy Supply: The building receives electricity from Clark Public Utilities through three electric meters: One serves the main campus, one serves the portable A, and one serves the portable B. There is no natural gas used at this site.

Lighting: Lighting is predominantly standard efficiency T8 fluorescent lights with standard efficiency electronic ballasts. Compact fluorescent lights are used in recessed cans and some gymnasium fixtures. There are metal halide lights in the parking lot. There is a large single pane plastic skylight in the middle of each pod building, and there are some other single pane plastic skylights on the multi-purpose building that provide daylight.

Hot Water: Domestic hot water is generated by five stand-alone electric water heaters, located in mechanical rooms and closets. They each have a total input capacity of 3 kW and heat water to about 110°F for hand washing and kitchen use. Domestic hot water is circulated throughout each building through a small circulating pump.

HVAC (Heating, Ventilation and Air Conditioning):

Space Heating: It is an all electric facility, so all of the space heating is provided through either electric resistance heating elements, or through air source heat pumps.

Air Conditioning: The only areas that are equipped with air conditioning are the administration building, classroom Pod 1 building, the computer lab (in the multi-purpose building) and the two portable classrooms. The details of the HVAC systems are provided below, building by building.

Ventilation: Ventilation is provided to all spaces through fixed position automatic dampers inside multiple air handling systems. The only spaces equipped with CO2 sensors are the two gymnasiums, and it appears to us that some of these spaces are over-ventilated.

HVAC Controls: The majority of the buildings have been converted to Delta DDC Controls some years ago. The new gym is controlled by a third party control system that is not integrated into the Delta controls or the District main Host computer. The controls need some additions, upgrades, reprogramming and commissioning.

J.D. Zellerbach

Facility Description: The Camas School District J.D. Zellerbach Administration headquarters is comprised of four buildings. All of the buildings were studied for this audit. This campus was originally built and operated for 50 years as an elementary school. In 2010, the elementary school was remodeled and converted into the new headquarters for the Camas School District Administration. Buildings 1 and 2 were originally constructed in 1953 and now house the district administration and operations staff. These two buildings are connected by a lobby and are mirror images of each other; throughout this report, these buildings are analyzed as one building. Building 4 was added in 1966 and consists of a kitchen and cafeteria, a gym, and two classrooms used for Head Start classes. Building 3 was completed in 1973 and was remodeled in 2010; it now consists of the district print shop, information technologies center, and

classrooms used for preschool and daycare. The total building square footage on this campus is approximately 67,000 square feet.

Energy Supply: The buildings receive electricity from Clark Public Utilities, and natural gas from Northwest Natural Gas. There is a single electric meter, and a single natural gas meter.

Lighting: Lighting is predominantly T8 fluorescent lights with standard efficiency electronic ballasts. T5 fluorescent lights are found in some areas. The gym has 400 watt metal halide lamps as seen in the picture to the right.

The building also has many compact fluorescent lamps (CFL) in recessed cans and ceiling mounted bowl fixtures, and LED exit signs. Skylights were added during the remodel of 2010 and help to add natural light to Buildings 1 and 2.

Several spaces, specifically offices and storage rooms, have occupancy sensors controlling the overhead lighting. Photocells control the outdoor lighting.

Hot Water: Domestic hot water is generated by electric hot water heaters located throughout the buildings. Three of the water heaters are Appliance Building Company units with two heating elements that are 12,000 watts each; these units were installed in the late 1960s. There is also one Ruud unit which has an 80 gallon capacity with two heating elements that are 4,500 watts each. Domestic hot water is circulated throughout the buildings with several a small circulating pumps.

HVAC:

Building 1 and 2:

Heating Boilers:

There are two electric boilers located in the mechanical spaces that provide hot water for the air handling units. They are both Coates - CAM Industries Model 12CWB-1 electric hot water boilers that have a maximum kW of 72. Each boiler produces hot water for the main air handlers, AHU 1 and AHU 2. They maintain the heating water supply temperature between about 140°F and 150°F during occupied hours. These boilers have an outside air lockout temperature of 60 degF.

Each boiler has a dedicated 1/2 hp circulating pump that circulates the hot water through the boiler and its air handling unit.

Air Cooled Chiller:

Chilled water is provided to Building 1 and 2 by a Carrier air-cooled 55-ton chiller. The unit has four compressors, an energy efficiency ratio (EER) of 10.1, and an integrated part load value (IPLV) of 14.6. This chiller has an outside air lockout temperature of 65 degF. There is a 5 HP pump in a closet near the chiller that circulates the chilled water through the chiller and to all the air handlers. Currently, the chilled water pump operates 24/7.

Air Handlers:
There are four main air handling units (AHUs) in Buildings 1 and 2. AHU 1 and AHU 2 are large constant volume multizone units which supply conditioned air to the majority of each building, except the core area. These are triple deck units, meaning they have a hot deck, a cold deck and a bypass deck. Each zone has a damper which mixes hot air and bypass air or cold air and bypass air to meet the temperature needs of its zone. The hot deck is heated with hot water and cooling is provided by chilled water.

AHU 3 and AHU 4 are constant volume cooling-only units with electric duct heaters which reheat the supply air depending on the zonal demands. These two units serve the central areas of the buildings. See HVAC floor plans in the Investment Grade Audit.

There are also three rooftop units (RTUs) which serve areas that have undergone usage changes since the RTUs were installed. Currently, only RTU 3 operates regularly.

Building 3:

Heating Boilers:
In Building 3, the original 1973 electric boiler was replaced with a natural gas boiler in 2010. The new boiler is located in the mechanical space above the print shop and provides heating to the Supply Fans (SFs) and the reheat boxes throughout the building. This Thermal Solutions Model EVA075 hot water boiler has a maximum input of 75,000 BTU/h and an output of 66,000 BTU/h. It maintains the heating water supply temperature between about 140°F and 150°F during occupied hours. The boiler has an outside air lockout temperature of 60 degF.

This boiler has a dedicated 1/3 hp circulating pump that circulates the hot water through the boiler and the air handling units.

Air Conditioning:
Cooling is provided to this building by split system condensers on the roof. Each air handling unit, referred to in this building as Supply Fans, has a corresponding split system condensing unit which provides cooling to the zone.

Air Handlers:
Building 3 has four constant volume air handling units. Four of these units are cooling-only with hot water reheat coils in the ducts which reheat the air depending on zonal demand. One unit is single zone and has hot water heating in the unit.

Building 4:

Heating Boilers:
None. Heating in Building 4 is provided by electric heating coils.

Air Conditioning:
None. No cooling is provided in Building 4.

Air Handlers:
Building 4 has five constant volume air handling units. Four of these units are cooling-only with hot water reheat coils in the ducts which reheat the air depending on zonal demand. One unit is single zone and has hot water heating in the unit.

HVAC Controls: The building has Alerton DDC controls for the HVAC systems. Observations, trending and data logging have revealed that parts of the control system are broken and not functioning properly. The controls need some additions, upgrades, reprogramming and commissioning.

For more details about the existing buildings see the Detailed Investment Grade Audits presented in Appendix A.

II. ESCO EQUIPMENT

The overall scope of the work is the following:

Lacamas Elementary School

PODs:
Refurbish existing Pace AHU's including new bearings, belts, etc. Clean and repair cabinet and motorized dampers. Add demand control ventilation with CO2 control. Clean, test and repair all electric duct heaters. Reprogram controls to optimize economizer, schedule and usage of heat pump on pod 1.

New and old Gyms:
Integrate new gym AHU into Delta controls system and reprogram operation and schedule. Add demand control ventilation with CO2 control to both gym units.

Main Building:
Replace U6 and U7 electric resistance heating with heat pumps. Install new packaged units or split system & refurbish existing fans, cabinets and dampers. Reprogram and replace DDC controls to optimize usage of the new heat pump systems.

Library:
Demo and patch unit ventilator UV-1 and replace with new roof top packaged heat pump. Includes new ductwork and DDC controls.

Computer Lab:
Replace existing roof top packaged heat pump with new. New unit to be high efficiency and have low ambient controls to allow proper heat pump operation in winter.

Office area:
Replace 7 packaged roof top units with 5 units to combine zones, reduce over-aired condition, improve comfort and reduce energy usage. 2 Ton units to be high efficiency.

Specific tasks will include:

1. Provide all required permits and inspections.
2. Remove and recycle demolished units.
3. Refurbish pod air handling units and electric duct heaters.
4. Modify the roof curb and structure as required to accept the new rooftop units.
5. Install new roof top units and controls.
6. Connect required duct smoke detectors to shutdown unit and fire alarm system.
7. Connect to existing low pressure ductwork, or run new ductwork as required.
8. Coordinate with re-roof project as required.
9. Upgrade and add to existing Delta DDC control system to accomplish the described EEM sequences. Integrate new gym unit, repair broken control panels and components.
10. Clean work areas and remove all construction debris on a regular basis.
11. Test and adjust all HVAC systems.
12. Commission all HVAC systems and controls to establish optimum operational performance.
13. Provide operator training on all systems.
14. Supply Operation & Maintenance Manuals.

J.D. Zellerbach

This measure proposes to make adjustments, repairs and additions to the existing DDC HVAC control system which will provide both improved comfort and reduce the energy usage. Demand control ventilation with CO2 sensors will be added. Some mechanical components will also be upgraded as necessary to provide a complete, properly functioning system.

Specific tasks will include:

1. Provide all required permits and inspections.
2. Repair broken control system and HVAC system components including damper actuators, belts, sheaves, boiler elements, etc.
3. Reprogram system to include the following control strategies:
   Discharge air temperature reset
   Optimal Start/Stop programming
   Demand control ventilation with CO2 sensors
   Free-Cooling airside economizer
   Controlled morning warm-up
4. Commission controls to establish optimum operational performance.
5. Provide Owner training on modifications.
6. Supply Operation & Maintenance manuals, as applicable.

III. ESCO SERVICES

ESCO will provide the following services:

A. CONSTRUCTION SERVICES

1. Construction: Provide, or cause to be provided, all material, labor, and equipment, including paying for permits, fees, bonds, and insurance, required for the complete and working installation of the ESCO equipment. The ESCO intends to solicit construction costs from selected mechanical subcontractors and equipment suppliers who will competitively acquire all material, labor and subcontractors, except the following tasks will be completed by ESCO's own staff:

   a) Field Superintendent: Daily supervision of the work.
   b) Control System Programmer: Abacus has an employee that has factory certified training on the programming, tuning and commissioning of DDC control systems. On occasion, we encounter control vendors that do not have sufficient expertise to properly implement some of our recommended control strategies. As such, Abacus may provide programming labor as part of the direct construction costs of the project.

When ESCO has completed the installation of the Equipment, including start-up and operation verification and training in accordance with the Proposal, ESCO shall provide to Owner a "Notice of Commencement of Energy Savings" and Owner shall have 14 days within which to accept or challenge the Notice.

2. Performance Verification: Complete the M&V protocols outlined in the Energy Audit and work with Clark PUD, Northwest Natural Gas / Energy Trust of Oregon, and the Owner to document the savings upon which the utility incentives will be based.

3. Performance Maintenance: The ESCO will monitor system performance and will review expected performance and actual performance with the Owner on a quarterly basis during the first year following the commencement of energy savings. The Owner may elect to continue performance maintenance and monitoring beyond the first year by executing a separate performance maintenance agreement.

4. Equipment Maintenance: The ESCO will provide no equipment maintenance other than warranty services. Following the completion of the installation and Owner acceptance of the Equipment, Owner shall provide all necessary service, repairs, and adjustments to the Equipment so that the Equipment will perform in the manner and to the extent set forth in the Proposal. ESCO shall have no obligation to service or maintain the Equipment after Completion and Acceptance unless ESCO and Owner have entered into a separate maintenance agreement. ESCO shall coordinate manufacturer's standard warranty on equipment and materials.

5. Hazardous Waste: ESCO intends to notify the Owner of all locations where the work may encounter hazardous materials and request the Owner abate the hazard prior to the work. However, upon the request of Owner, ESCO may, without assuming the ownership thereof and acting in the name and on behalf of the Owner, have the hazardous material or substances removed and disposed of or contained and the cost of such work is not included in the project. Owner agrees and acknowledges that it has not relied on or employed ESCO to analyze or identify the presence of any hazardous substance on the Owner's premises.

6. Operation and Maintenance Measures: None.

7. Warranty: ESCO will respond to and correct all warranty claims initiated by the Owner for a period of one year following the "Notice of Commencement of Energy Savings."

B. PROFESSIONAL SERVICES

1. Project Management: Overall development and management of the project throughout the term of the agreement. Specific tasks include project development, management of Owner/Designer issues, Management of Owner/Constructor issues, and management of warranty issues. Also includes coordination with District architect for the (separate) re-roof project. ESCO will keep Owner informed on project status via regular emails and project meetings. ESCO will issue formal meeting minutes of all meetings.

2. Energy Audit: Detailed engineering analysis to establish scope and feasibility of conservation measures.

3. Design Services: Provide sketches, material lists, drawings, specifications, and other documentation which may be required for Owner's review and to obtain permits and negotiate or receive competitive prices for construction of the ESCO equipment. Design services include all mechanical, electrical, structural, and architectural design required for the project. Specific tasks will include:
   a. Collect record drawings and conduct site surveys.
   b. Meet with Owner to determine design standards.
   c. Preliminary design submittal and review.
   d. Final design submittal and review.
   e. Negotiating & Bidding (including document reproduction and distribution).
   f. Contractor interviews and selection.
   g. Submittal/shop drawing review.
   h. As-built drawing preparation as applicable.
   i. Six month and one year warranty inspections.

4. Construction Management: Provide construction management services to coordinate and supervise the work. Specific tasks will include:
   a. Execute all subcontracts.
   b. Secure all required bonds, permits, and insurance coverage.
   c. Coordinate and control the construction schedule.
   d. Maintain complete and accurate project accounting records including invoicing.
   e. Coordinate and control all construction activities.
   f. Execute project closeout.
   g. Resolve all warranty claims.

   The owner is expected to coordinate day-to-day communications with staff and any scheduling of staff relocations in and around the work.

5. Start-Up, Testing and Operation Training: The ESCO will provide:
   a. Complete start-up, testing, balancing, and commissioning of ESCO equipment.
   b. Training of building staff to perform basic adjustments and scheduling of the affected equipment.

6. Ongoing Services: For a period one year following the "Notice of Commencement of Energy Savings" the ESCO will provide:
    a. Remote monitoring, quarterly reporting, and meetings as needed to address concerns related to actual performance of the ESCO equipment.
    b. Coordination with subcontractors and suppliers as required to resolve warranty claims made by Owner.

    For an additional two year period, the ESCO will provide:

    c. Remote monitoring, annual reporting, and meetings as needed to address concerns related to actual performance of the ESCO equipment.

IV. PROJECT COSTS

A. ESCO guarantees that the Maximum Project Cost for scope items listed in paragraph II will not exceed $443,723 (all costs are **not** including sales tax). In addition to these costs which are included in the agreement, there are costs budgeted outside the agreement for sales tax and General Administration project management fee ($70,273 total) bringing the total project budget to $513,996.

B. Maximum Project Cost includes:
   1. Construction Services ..... $ 313,032
   2. Professional Services (ESCO Fees)..... $ 109,561
   3. Other Costs (Contingency)… ..... $ 21,130

C. Construction Services: Will be charged at actual costs not to exceed the guaranteed maximum price of $313,032. These costs are estimated as follows:

A. CONSTRUCTION COSTS			Proposed Cost	
	Labor and Material:			
L-1	HVAC Controls / Refurbish Pod HVAC		$	87,840
L-3	Replace Computer Room RTHP		$	11,200
L-4	New HP's for U6, U7, UV1		$	73,576
L-5	Office new HP's & combine zones		$	43,200
JDZ-1	Controls & Repairs		$	90,627
Subtotal Labor and Materials Cost			$	306,444
	Permits	0.15%	$	460
	Construction Bond	2.00%	$	6,129
TOTAL CONSTRUCTION COST			$	313,032

Invoicing for the construction services will be on a monthly basis based on percentage of work completed. Invoicing backup data will be provided including schedule of values and corresponding subcontractor invoices or other source of costs.

The ESCO shall provide a Schedule of Values at the end of construction bidding. At a minimum, the schedule shall identify the costs of subcontractors, Abacus direct purchased material, bonds, permits, and direct project expenses.

D. Professional Services: Will be lump sum fees and will be billed as a percentage of completion. The total fee for all professional services is $109,561 which breaks down as follows:

B. PROFESSIONAL SERVICES FEES			
Audit Fee (Paid by Utility)	0.0%	$	-
Design M,E,C,S	7.0%	$	21,912
Construction Management	6.0%	$	18,782
Commissioning	3.0%	$	9,391
ESCO M and V Cost	2.0%	$	6,261
Ongoing M&V (Years 2 and 3)	2.0%	$	6,261
Overhead and Profit	15.0%	$	46,955
TOTAL ESCO FEES		$	109,561

E. Energy Performance Monitoring and Verification Fee: Is included in Professional Services Fees above and will be billed at the end of the first year of energy savings (one year after commencement of energy savings). The ongoing M&V fee for years 2 and 3 will be billed at the end of those years as applicable ($3,130.50 per year)

F. Contingency: Within the Guaranteed Maximum Price, a contingency of $21,130 is available to the ESCO to cover unanticipated costs associated with the work. These additional costs can be added to the agreement via a Change Order request from ESCO. Any unspent contingency will revert to the Owner at project closeout.

G. Other Costs: The following costs are not guaranteed by the ESCO and are listed here for budgetary or funding authorization purposes only:

1. DES Project Management Fee:

   $29,000 + $4,000 for 2 years M&V fee = $33,000 total

2. Sales Tax: sales tax will be charged at the prevailing rate (currently 8.4%) to yield the following estimated tax amounts:

Sales Tax - Construction Portion	$26,295
Sales Tax - Professional Services Portion	$ 9,203
Sales Tax - Contingency Portion	$ 1,775
TOTAL SALES TAX	$37,273

V. PROJECT ACCOUNTING

A. Accounting Records

The ESCO shall check all material, equipment and labor entering into the Work and shall keep such full and detailed accounts as may be necessary for proper financial management under this Agreement. The accounting system shall be satisfactory to the Owner. The Owner shall be afforded access to all the ESCO's records, books, correspondence, instructions, drawings, receipts, vouchers, memoranda and similar data relating to this Contract, and the ESCO shall preserve all such records for a period of three years, or for such longer period as may be required by law, after the final payment.

B. Construction Services

Project accounting records will be used for the sole purpose of documenting actual cost of the Construction Services.

C. Reconciliation of Actual Project Costs

1. The guaranteed maximum project cost is based on an estimate of construction services costs. In recognition that actual costs may vary from the estimate, the following procedures are established to reconcile this difference:

    a. When actual costs exceed the estimate, the additional expense will be borne by the ESCO.
    b. When actual costs are less than the estimate, the remaining funds will be returned to the Owner by executing a deductive change order at project completion.

VI. STANDARDS OF COMFORT SERVICE

A. Heating: 70-74F occupied/55F unoccupied.

B. Cooling: 73-77F occupied/85F unoccupied.

C. Ventilation: Washington Ventilation Code minimum occupied/infiltration only unoccupied.

VII. ESTIMATED ANNUAL SAVINGS AMOUNT

A. The ESCO estimates that annual utility savings will be 481,371 kWh and 745 Therms.

B. The ESCO estimates that annual utility cost savings will be $23,713.

VIII. METHOD OF CALCULATING ENERGY AND ENERGY COST SAVINGS (M&V PLAN)

We will measure and verify the energy savings resulting from this project using the 2012 IPMVP (International Performance Measurement and Verification Protocol) Option C method – Whole Facility. This is the most appropriate method to use for the reasons listed below. Savings will be guaranteed at the utility rates currently in effect at the time of this proposal and as documented in the IGA's listed in Appendix A.

a. This will determine the whole facility energy performance, not just the performance of individual systems, which is what the owner is interested in.
b. The total projected energy savings are relatively large (greater than 10%) of the existing (baseline) energy use.
c. There are multiple systems that are affected by the proposed upgrades, so conducting retrofit isolation and metering all the systems would be prohibitively expensive.
d. There are significant interactive effects between the EEMs that are going to be implemented.
e. Major future changes to the facilities are not expected during the next three years.
f. Reasonable correlations exist between the existing energy use and the weather.

This will allow us to utilize the existing utility meters to define the existing (baseline) energy use, and the proposed (after upgrade) energy use. It will not require the addition of any other metering devices to complete the M&V.

IX. ENERGY COST SAVINGS GUARANTY

The ESCO guarantees that the actual energy/utility savings will not be less than 481,371 kWh and 745 Therms, which at the baseline utility rates (as defined in the Energy Audit), represents an annual cost savings of $23,713.

In the event that actual energy cost savings, pursuant to Section VIII Method of Calculating Energy and Energy Cost Savings, are less than this guaranteed minimum, the ESCO shall pay the Owner the difference between the actual cost savings and the guaranteed amount. This savings guarantee will be in effect only for the first 3 years after the commencement of savings unless the Owner executes a separate performance maintenance agreement for additional year(s) of Performance Monitoring and Verification Services.

X. FINANCING

Project financing will be provided by the Owner. The ESCO agrees to waive any finance fees related to the financing of project costs (as described in Section IV) provided the Owner agrees to make monthly progress payments to the ESCO based on the percentage of completion of each task. Progress payments will be less 5% for retention. Retention amounts will be due after project completion per the ESCO Agreement.

XI. INSURANCE AND BONDING

A. The ESCO shall provide a payment and performance bond in the amount of 100% of the Construction Services cost plus applicable sales tax on that cost. The Bond shall be in the form of AIA Document A312. The "Sum Amount of Bond" shall specifically exclude coverage for those portions of the Energy Services Agreement and/or Energy Services Agreement Addendum pertaining to design services, energy cost savings guarantee, maintenance guarantee, utility incentives, efficiency guarantees, and any other clauses which do not relate specifically to construction management and supervision of work for purchasing and installing of ESCO Equipment, or for work to be accomplished by the Owner. The Bond must be with a Surety or Bonding Company that is registered with the State of Washington Insurance Commissioner's Office.

B. For the purposes of this Agreement, the "Sum Amount of Bond" shall be $339,327 ($313,032 construction services plus $26,295 sales tax).

C. Certificates of General Liability insurance will be provided prior to contract signing. The State of Washington shall be named as an additional insured on all insurance certificates.

XII. MODIFICATIONS TO BASELINE BY OWNER

A. The Owner shall maintain all existing facilities and installed ESCO equipment during the term of this contract at or above current maintenance levels. Owner agrees to maintain the energy efficiency of the systems installed.

B. The energy savings are based on operating the energy systems in a similar manner that was represented and logged during our analysis period. In the event the Owner elects to operate the energy systems differently, thereby increasing the energy usage of the system or load in the spaces served, the ESCO will prepare a calculation of the additional energy used for such additional usage and be allowed to adjust the baseline use and savings accordingly.

XIII. PROJECT SCHEDULE

ESCO proposes the following schedule for completion of design and construction activities:

Camas School District acceptance of ESP	March 1, 2013
ESCO Notice to Proceed	March 15, 2013
Schematic design complete	April 8, 2013
Subcontractor walk-through(s)	April 15, 2013
Subcontractor Bids Awarded	April 24, 2013
Equipment ordered	May 3, 2013
Construction Begins	July 15, 2013
Construction Substantially Complete	August 23, 2013
Commencement of Energy Savings	September 20, 2013

These dates are preliminary. A more definitive schedule will be produced upon execution of contract documents, equipment selection for lead time, and coordination with re-roofing project work.

APPENDICES

The following documents are attached to this proposal and included as part intended to be a part of the proposal:

The Investment Grade Energy Audits for the Lacamas Elementary and J.D. Zellerbach are included in this proposal as Appendix A.

The Project Financial Tables are included as Appendix B.

APPENDIX A – INVESTMENT GRADE AUDITS

Investment Grade Energy Audit for the Camas School District

Lacamas Heights Elementary School

Located at 625 NE 4th Avenue
Camas, Washington

Prepared by:

ABACUS

February 4, 2013

Contacts

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Clark Public Utilities Contact Samuel Walker 360-992-3354
Energy Trust of Oregon Contact Lisa Bush 503-333-6741
Energy Consultant Contact Abacus Resource Management Company 12655 SW Center Street, Suite 250 Beaverton, OR 97005 503-277-5251 Steve Rubbert, President Phone: 503-936-6526 (stever@abacusrm.com) Rich Davis, Energy Engineer, C.E.M. Phone: (503) 936-7163 (richd@abacusrm.com)

Utility Rate Assumptions

Utility Rates used in analysis

$0.0469	Average Cost / kWh (Clark Public Utilities Schedule 134)
$6.770	Cost / kW / Month (Clark Public Utilities Schedule 134)

Table of Contents

Executive Summary *4*
Introduction and Background **4**
Incentives available for Energy Efficiency Projects **4**
Grants available for Energy Efficiency Projects **4**
Brief Description of Facility and Energy Using Systems **4**
Next Steps for the Owner **9**
Other Energy Saving Opportunities not included in Summary Table **9**
EEM 1: HVAC Controls Optimization *10*
EEM 2 Replace Computer Room Heat Pump with High Efficiency Heat Pump *22*
EEM 3: Replace U-6, U-7 and U-9 with (3) New High Efficiecy Heat Pumps *23*
EEM 4: Install High Efficiency Heat Pumps for Main Office *24*
Existing (Baseline) Energy Bills *25*
Existing (Baseline) Energy End Use Analysis *27*
Project Cost Estimates *29*
Measurement and Verification Plan *30*

EXECUTIVE SUMMARY

Introduction and Background

The Camas School District is interested in pursuing opportunities to lower the utility use of their facilities. This report presents detailed findings of an investment grade level analysis of energy savings and implementation costs for several specific energy efficiency measures (EEMs) identified at the Lacamas Heights Elementary School.

Incentives available for Energy Efficiency Projects

Clark Public Utilities offers incentives for owners to implement electric-saving measures. If the owner is interested in pursuing any of these opportunities they should discuss them with Clark Public Utilities prior to purchasing equipment or issuing contracts for construction. Some projects will require inspections and verifications of savings before and/or after they are installed in order to qualify for incentives. All measures will require submitting official forms to the sponsoring agency prior to purchasing any equipment.

Grants available for Energy Efficiency Projects

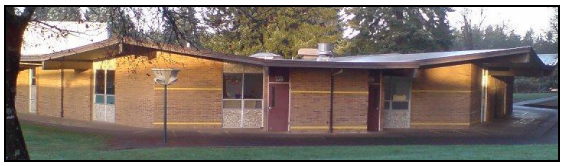
The State of Washington is currently accepting applications for grants from municipal governments for projects that result in energy conservation at municipal owned facilities. If the owner is interested in pursuing this latest grant opportunity they should work with an ESCO (Energy Services Company) to complete an Investment Grade Energy Audit, decide what projects they want to implement, and then apply for the grant.

Brief Description of Facility and Energy Using Systems

Facility Description: The school was built in the mid 1960's and is composed of five stand-alone masonry buildings and two portables. There are three individual classroom "pods", a multi-purpose building and an administration building. The table below summarizes the individual buildings on the campus. There are also two portable buildings at this school.

Building	Area (square feet)
Administration	2,485
Pod 100	8,750
Pod 200	8,750
Pod 300	8,750
Multi-Purpose Building	14,381
Portable A	1,800
Portable B	1,800
TOTAL	46,716

Administration Building



Typical Classroom Pod Building

Envelope Details: The buildings are constructed with double brick masonry construction, approximately 8" thick with no insulation. Adding insulation to the walls could be accomplished by furring out the inside or exterior, but this has a high payback, so it is not included in this report. There are small single pane windows with aluminum frames. These could be replaced with double pane insulated windows, but this also has a high payback, so it is not included in this report. There are infill panels installed above and below some of the windows, with an estimated R-value of 4. Adding insulation to these infill panels has a high payback, so it is not included in this report. There are flat roofs composed of 4" roof decking and a single ply roofing membrane, and the original design drawings indicate there is 2" of rigid insulation on the roof. Adding additional insulation to the ceiling has a high payback so it is not included in this report.

Typical Occupancy: The K-5 school has about 416 students in school for 180 days a year. The occupancy patterns of the school vary significantly between the school year and the summer, and are described below.

School Year and Summer Schedule: In the 2012/2013 School Year classes began on September 4, 2012 and the last day of class is scheduled for June 19, 2013.

School Year (Sep through June): School is in session from 9:00 am to 3:30 pm Monday, Tuesday, Thursday and Friday, and from 9:00 am to 1:10 pm on Wednesday. The busses drop children off at 8:45 am on school days. Teachers are required to be in their classes from 8:10 am to 3:40 pm Monday through Friday. Office Staff are there from 7:30 am to 4:30 pm. There are one or two custodians in the building from 6:30 am to 11:30 pm Monday through Friday. There are no regularly scheduled after-school programs in the school after school ends, but the school is used after hours for various programs, such as basketball and volleyball.

Summer (July & August): The office is open for about two weeks after school gets out, and opens about two weeks before school starts. Two custodians work in various parts of the buildings all summer long from 6:30 am to 3 pm Mondays through Fridays. Teachers are in the office or their classroom only sporadically.

Energy Supply: The building receives electricity from Clark Public Utilities through three electric meters: One serves the main campus, one serves the portable A, and one serves the portable B. There is no natural gas used at this site.

Lighting: Lighting is predominantly standard efficiency T8 fluorescent lights with standard efficiency electronic ballasts. Compact fluorescent lights are used in recessed cans and some gymnasium fixtures. There are metal halide lights in the parking lot. There is a large single pane plastic skylight in the middle of each pod building, and there are some other single pane plastic skylights on the multi-purpose building that provide daylight.

Hot Water: Domestic hot water is generated by five stand-alone electric water heaters, located in mechanical rooms and closets. They each have a total input capacity of 3 kW and heat water to about 110°F for hand washing and kitchen use. Domestic hot water is circulated throughout each building through a small circulating pump.

HVAC (Heating, Ventilation and Air Conditioning):

Space Heating: It is an all electric facility, so all of the space heating is provided through either electric resistance heating elements, or through air source heat pumps.

Air Conditioning: The only areas that are equipped with air conditioning are the administration building, classroom Pod 1 building, the computer lab (in the multi-purpose building) and the two portable classrooms. The details of the HVAC systems are provided below, building by building.

Ventilation: Ventilation is provided to all spaces through fixed position automatic dampers inside multiple air handling systems. The only spaces equipped with CO2 sensors are the two gymnasiums, and it appears to us that some of these spaces are over-ventilated.

Administration Building: There are six packaged rooftop heat pumps and one packaged rooftop air conditioner on the main office building that provides air conditioning. The units are about ten years old, and were standard efficiency units at the time of their installation. Replacing these units with high efficiency heat pumps / air conditioners would have a high payback, but in the future when they fail and need to be replaced they should consider installing high efficiency units. The packaged heat pumps also provide space heating, and they are equipped with electric resistance heating elements for low temperature operation. There are also electric baseboard heaters in the main lobby, and in the teachers' lounge.

Classroom Pod 1 Building: There is a single packaged rooftop heat pump that provides airflow throughout the classroom pod 1 building. During the summer it is capable of providing air conditioning, though it is rarely needed in this climate when the school is vacant in the summer months. During the winter it is capable of providing warm air using the heat pump mode. There are 11 electric duct heaters totaling 95 kW that also operate to trim the amount of heating needed by each zone, and they also provide heating when the rooftop unit switches out of heat pump mode. Our data logging indicates that the rooftop unit operates in the heat pump mode for 30 minutes to an hour on average during a winter morning, before switching out of heat pump mode and switching to ventilation only mode. There are also 13 ceiling mounted electric space heaters totaling 28 kW located near the perimeter of the classrooms that provide supplemental space heating to the spaces.

Classroom Pod 2 & 3 Buildings: Each of these classroom pod buildings has a single constant speed indoor air handler that provides airflow throughout the classroom pod 2 & 3 buildings. Each is equipped with automatic dampers to provide economizer cooling, and morning warm-up. Each has a central electric resistance heating panel that has been abandoned in place and no longer used. Each classroom pod building has 11 electric duct heaters totaling 95 kW (per building) that operate to provide space heating needed by each zone. Each classroom pod building also has 13 ceiling mounted electric space heaters totaling 28 kW (per building) located near the perimeter of the classrooms that provide supplemental space heating to the spaces.

Multi-Purpose Building: This building has five different HVAC systems, that each serve distinct areas in the building, and are described below by area.

Computer Lab: There is a single packaged rooftop heat pump that provides heating and cooling as needed to the computer lab, which is located in the multi-purpose building.

Music Room: There is a single constant speed indoor air handler with a central electric resistance heater that serves the music room. It is equipped with automatic dampers for ventilation air, and is capable of providing economizer cooling.

Library and Miscellaneous Offices: There is a single constant speed indoor air handler with a central electric resistance heater that serves ½ the library and about five small offices. It is equipped with automatic dampers for ventilation air, and is capable of providing economizer cooling. Each zone also has an electric resistance duct heater to provide the trim heating needed for each zone. There is also a unit ventilator on the exterior library wall that is used in the colder parts of the winter to provide space heating. This unit has an electric resistance heating element, but the unit is so noisy that it negatively affects the learning environment, so it is often turned off during the day which ends up compromising the thermal environment.

Old Gymnasium: There is a single constant speed indoor air handler with a central electric resistance heater that serves the old gymnasium. It is equipped with automatic dampers for ventilation air, and is capable of providing economizer cooling. It is also equipped with CO2 sensors for demand controlled ventilation.

New Gymnasium: There is a single constant speed indoor air handler with a central electric resistance heater that serves the new gymnasium. It is equipped with automatic dampers for ventilation air, and is capable of providing economizer cooling. It is also equipped with CO2 sensors for demand controlled ventilation, but it appears that the unit still brings in more ventilation air that is required.

Portable Classrooms: There is a total of four wall-mounted HVAC units on the two portable buildings. We could not confirm if they are air source heat pump units, or if they are air conditioning units with electric resistance heating elements. They are controlled by an Alerton DDC system.

Summary Table of EEMs

The table on the next page lists the EEMs recommended in this report.

Lacamas Heights Elementary School - Recommended EEMs

EEM #	EEM Description	Electricity Saved / Year (kWh)	Electric Demand Saved / Month (kW)	Natural Gas Saved / Year (Therms)	Total Owner Saved / Year ($)	Burdened Costs ($)	8.4% Taxes ($)	Initial Cost to Owner ($)	Estimated Clark PUD Incentives ($)	Possible WA State Grant	Net Cost to Owner ($)	Net Payback (Years)
1	HVAC Controls Optimization (Retro-Commission All DDC, Minimize Operating Hours, Add CO2 to Pods 2&3, Add Exhaust Dampers to 3 Pods, Re-furbish AHUs on Pods 2&3)	88,511	0	0	$4,150	$127,191	$10,684	$137,875	$17,702	$34,469	$85,704	20.6
3	Replace Computer Room RTU with High Efficiency Rooftop Heat Pump	3,314	0.0	0	$155	$16,217	$1,362	$17,579	$400	$4,395	$12,784	82.3
4	Install (3) New Heat Pumps, and Remove U6, U7 and Library Unit Ventilator	19,796	5.0	0	$1,334	$106,536	$8,949	$115,485	$1,000	$28,871	$85,614	64.2
5	Install (5) New Rooftop HVAC Units in Office Building, and Remove (7) Rooftop HVAC Units	11,397	0.5	0	$575	$62,553	$5,254	$67,807	$400	$16,952	$50,456	87.7
TOTAL		**123,017**	**5.5**	**0**	**$6,215**	**$312,497**	**$26,250**	**$338,747**	**$19,502**	**$84,687**	**$234,558**	**37.7**

EEM 1 incentive has been estimated at $0.20 per measured kWh saved / year, capped at 50% of the project costs. We assumed that EEMs 2 & 4 would qualify for standard incentives of $100/ton by Clark PUD, and EEM 3 would qualify for $250/ton for the library rooftop heat pump. All of these incentives are estimates by Abacus in the table above. Clark PUD will determine the actual incentives based upon the measured energy savings after the projects are completely installed.

The table to the right illustrates the existing energy use on a per square foot basis and the proposed energy use after the recommended EEMs above are installed.

Lacamas Heights Elementary School EUI Summary				
Building	43,116	sq ft		
	Existing	Proposed	Saved	Saved
Electric EUI	46,846	37,108	9,738	21%
Gas EUI	0	0	0	0%
Total EUI	**46,846**	**37,108**	**9,738**	**21%**

Next Steps for the Owner

Review this Report and Decide which EEMs to Implement. The EEMs identified in this report affect different systems and have different budgets. If the owner has potential funding and commitment to implement any of these measures in the next year or two then notify the serving utility companies which measures would be considered. Indicate the timeframe you are considering and the potential budget.

Clark Public Utilities will notify you of the next steps to participate in their incentive program. The particular EEMs that you are interested in implementing will determine what the next steps are, in order to qualify for incentives from Clark Public. Normally you will be required to sign official paperwork from Clark PUD prior to issuing contracts to implement the EEMs, in order to qualify for the incentives.

Grant Applications must be submitted no later than February 15, 2013.

Other Energy Saving Opportunities not included in Summary Table

The following energy saving opportunities are not included in the summary table of this report. They are briefly described here, along with the reason why they are not included.

Install new heat pumps in the classroom pods: Even with available incentives and tax credits this project would have a payback well over 40 years.

Install new variable refrigerant flow heat pumps in the classroom pod and offices: Even with available incentives and tax credits this project would have a payback well over 40 years.

Install new variable air volume multizone units in the classroom pods and offices: Even with available incentives and tax credits this project would have a payback well over 40 years.

Install new LED parking lot lights: Even with available incentives and tax credits this project would have a payback well over 25 years.

Install new instantaneous water heaters: Even with available incentives and tax credits this project would have a payback well over 15 years.

Solar Electric Generation: Even with available incentives and tax credits solar photovoltaic would have a payback well over 40 years.

Solar Water Heating of Domestic Hot Water: Glazed solar collectors could be mounted on the roof and used to heat or pre-heat the domestic hot water. These systems also have a payback over 25 years.

New Double Pane Windows: Insulated double pane windows would reduce the heat loss in the winter and the heat gain in the summer. This upgrade would have a payback over 25 years.

Lighting Upgrade: There is opportunity to reduce the lighting energy use through installing LED and high efficiency T8 systems, but the payback for these upgrades is over 15 years.

EEM 1: HVAC CONTROLS OPTIMIZATION

This measure proposes to retro-commission the existing HVAC controls, implement optimized control strategies, and expand the controls to add CO2 sensors for demand controlled ventilation, and expand the Delta controls to the new gym air handler so that all of the systems are on a single control system. This measure will also install automatic dampers on the three pod exhaust hoods, to minimize warm air leaving through this and cold air entering through this. This measure will also refurbish the two air handlers that serve pods 2 and 3 by replacing filters, making sure the automatic dampers are working, and replacing any fan bearings that are needed. The new units will save energy in the following ways:

Minimize Operating Hours – the school is normally occupied by students from 8:45 am until 3:35 pm, and by teachers from 8:00 am to 3:40 pm. Currently many air handlers start at 5 or 6 am and don't turn off until 7 pm, even thought the building may only be occupied by one or two custodians for many of the hours. We plan on reducing the operating hours so that the building only reaches setpoint when the students are in the school, and we will ensure that the over-ride buttons are working so that if the space temperatures start to drift after-hours while still occupied by staff they can temporarily over-ride the HVAC unit in their area on for an hour at a time.

Maximize Heat Pump Operation on Pod 1 – the school installed a rooftop heat pump on pod 1 several years ago, and left the electric resistance duct heaters in place. We recorded the operation of the heat pump, and found that it only operates in heat pump mode during morning warm-up, and this only lasts for 20 to 50 minutes each day during the winter. The electric duct heaters continue to operate for an hour or so as the building is brought up to temperature before the students arrive. We propose to modify the control sequences to leave the heat pump in warm-up mode for a longer period, which will reduce the amount of electric resistance heating required. One possible way to do this is to allow several rooms to be slightly over-heated (by one to three degrees) in the morning.

CO2 Sensors for minimizing outside air – CO2 sensors will be installed on the return air of each of the pod 2 and 3 air handlers to monitor the CO2 levels in the spaces. When the CO2 levels are low, then the outside air can be reduced, and when the CO2 levels get too high then the outside air dampers will automatically open up to provide the required amount of outside air. This is generally expected to reduce the amount of outside air used in these units throughout the year, especially when the spaces are lightly occupied, which is at least several hours each day. We will also recalibrate and retro-commission the existing CO2 sensors and damper operation of the gym units which are also lightly occupied all day long.

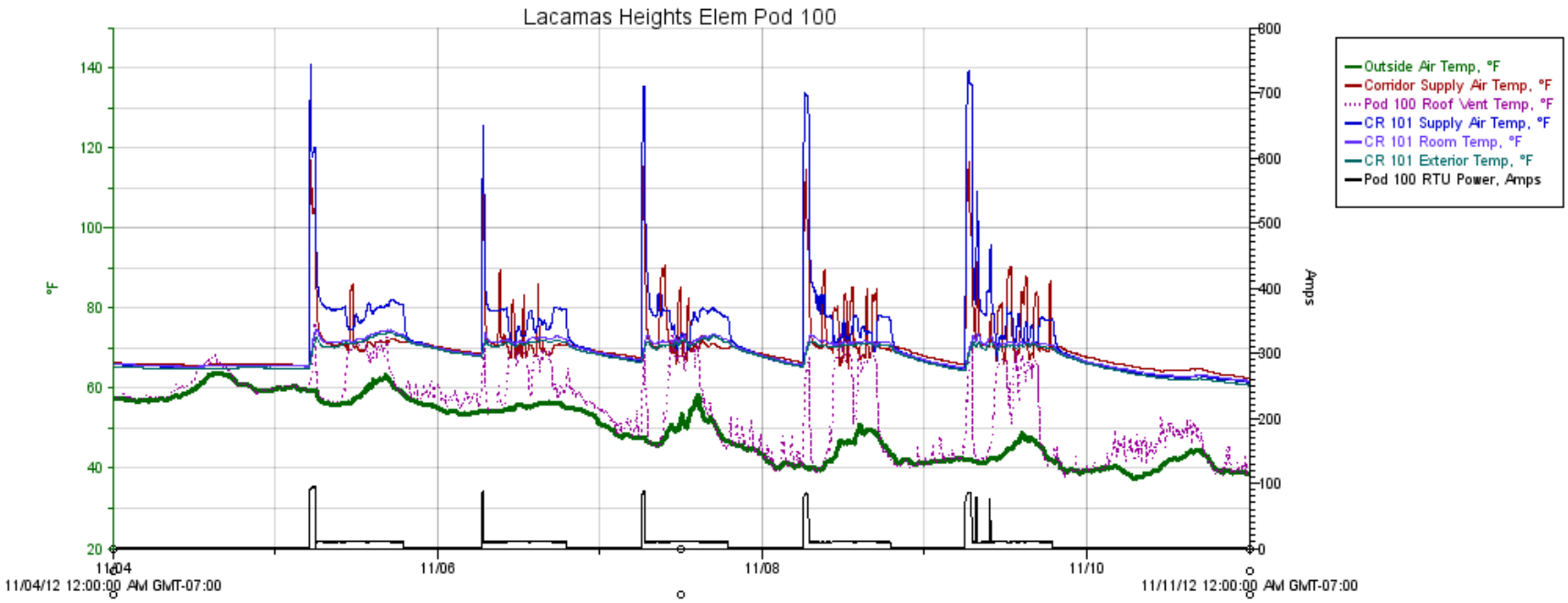
Optimal Start/Stop on all units – the units we trended were operating until 7 pm, although the students leave at 3:30 pm and the teachers leave at 3:40 pm. We propose to change the schedule to match the actual occupancy. We will also ensure that the units will start as late as possible in order to make the spaces comfortable by the time the building is occupied by students. Existing over-ride thermostats will be checked to be sure that they work, and will be replaced if they are not operational, so that when these spaces are occupied outside of normal business hours the control system can automatically turn the appropriate HVAC system on for approximately one hour at a time.

Coordinate Old and New Gym Air Handler Operation – our data recording indicates that there are times when the old gym has warmed up quickly, and then it overheats and switches in to free-cooling economizer operation, while the new gymnasium is continuing to try to heat the space. We will expand the Delta controls so that it controls both the new gym and the old gym air handlers, and coordinates their operation so that one air handler is not adding heat to both spaces, while the other air handler is trying to remove heat and cool the space.

Impact on maintenance: This project is not expected to have any impact on maintenance costs.

The following pages illustrate the existing operation of the units that we recorded during our energy audit.

EXISTING POD 1 HVAC: ONE WEEK

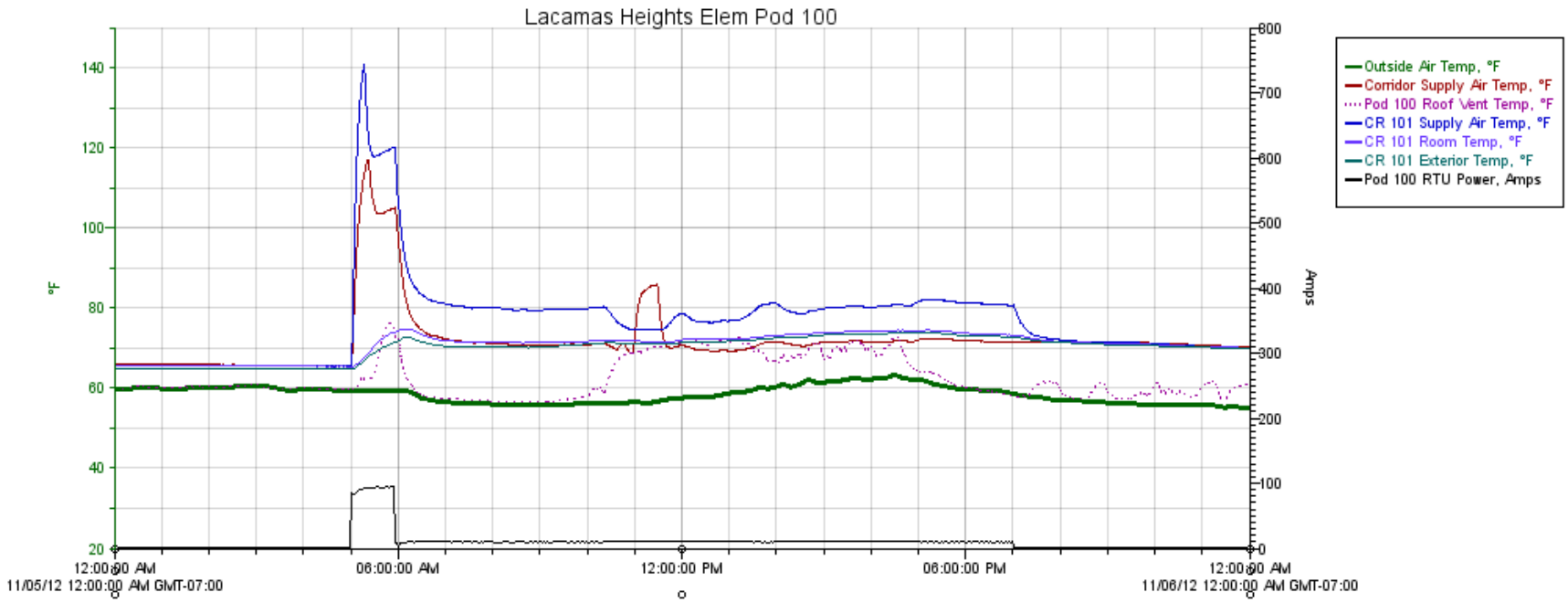


This graph shows the outdoor air temperature (thick green line near the bottom), the heat pump power (black line), some room temperatures and supply air temperautre, and the temperature of the air just outside the exhaust vent on the roof, over a one week perid.

This illustrates that the heat pump mode is only for a short time each day.

This also illustrates that warm air exhausts the roof vent at many times during the day, when it should not be.

EXISTING POD 1 HVAC: ONE DAY



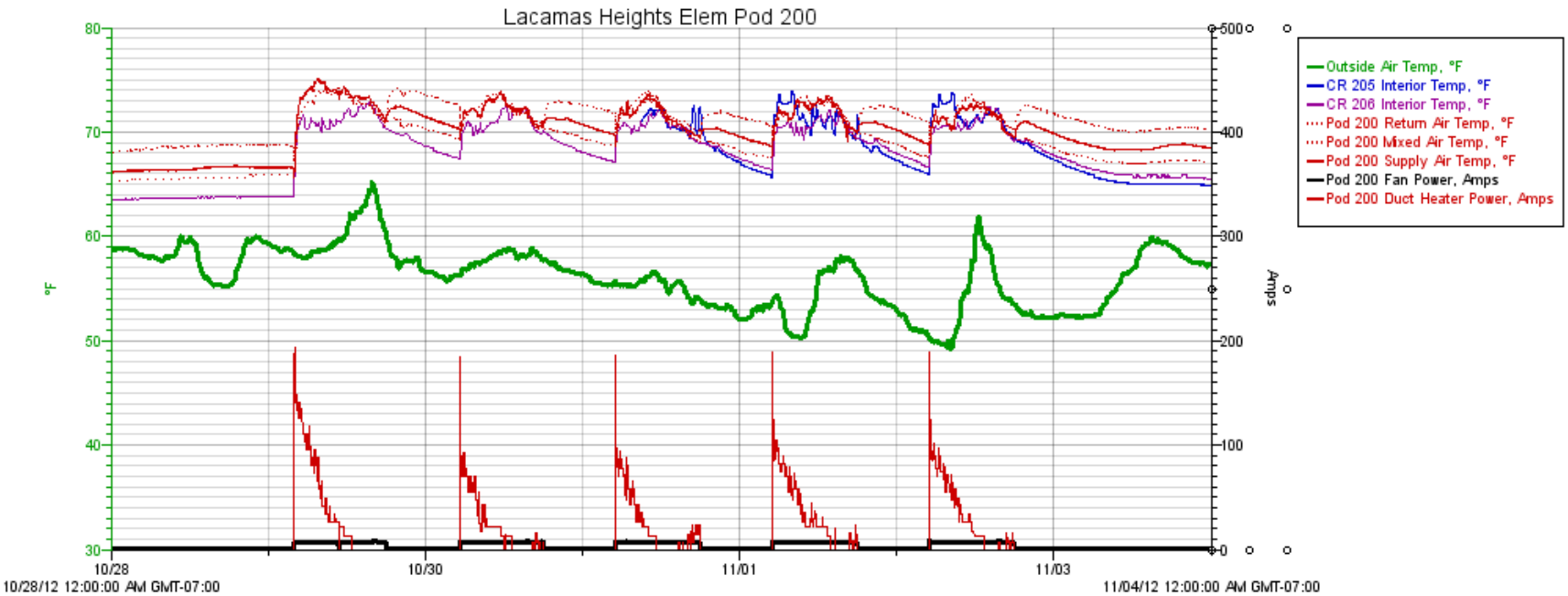
This graph shows the outdoor air temperature (thick green line near the bottom), the heat pump power (black line), some room temperatures and supply air temperautre, and the temperature of the air just outside the exhaust vent on the roof, over a one day perid.

This illustrates that the heat pump mode is only for one hour this day, and the unit started at 5 am – which is very early for a night when the outside air was 60 F – indicating optimal start routine is not working properly.

This illustrates that the HVAC operated until 7 pm this day, which is typical.

This also illustrates that warm air exhausts the roof vent at many times during the day, when it should not be.

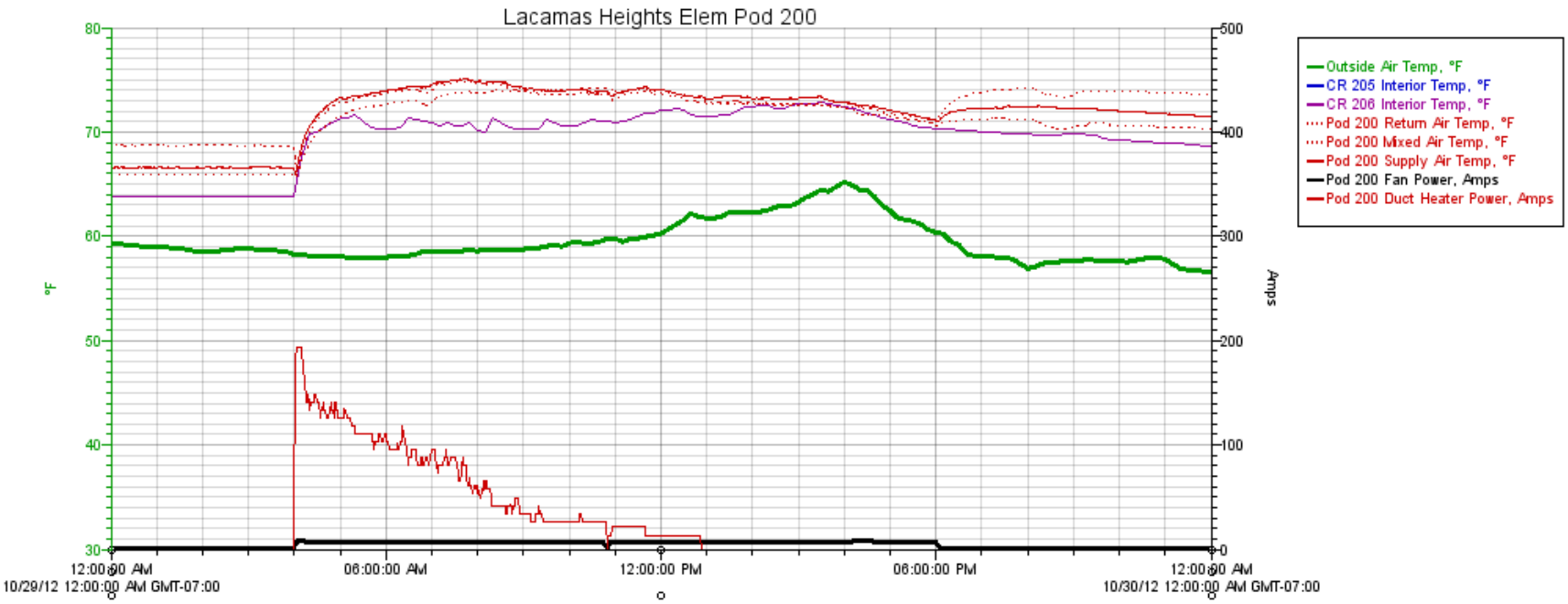
EXISTING POD 2 HVAC: ONE WEEK



This graph shows the outdoor air temperature (thick green line near the middle), the fan power (black line), the electric duct heater power (red line), some room temperatures and supply air temperature and return air temperature, over a one week perid.

This illustrates that the spaces never drift below 63 F even after the HVAC has been off all weekend.

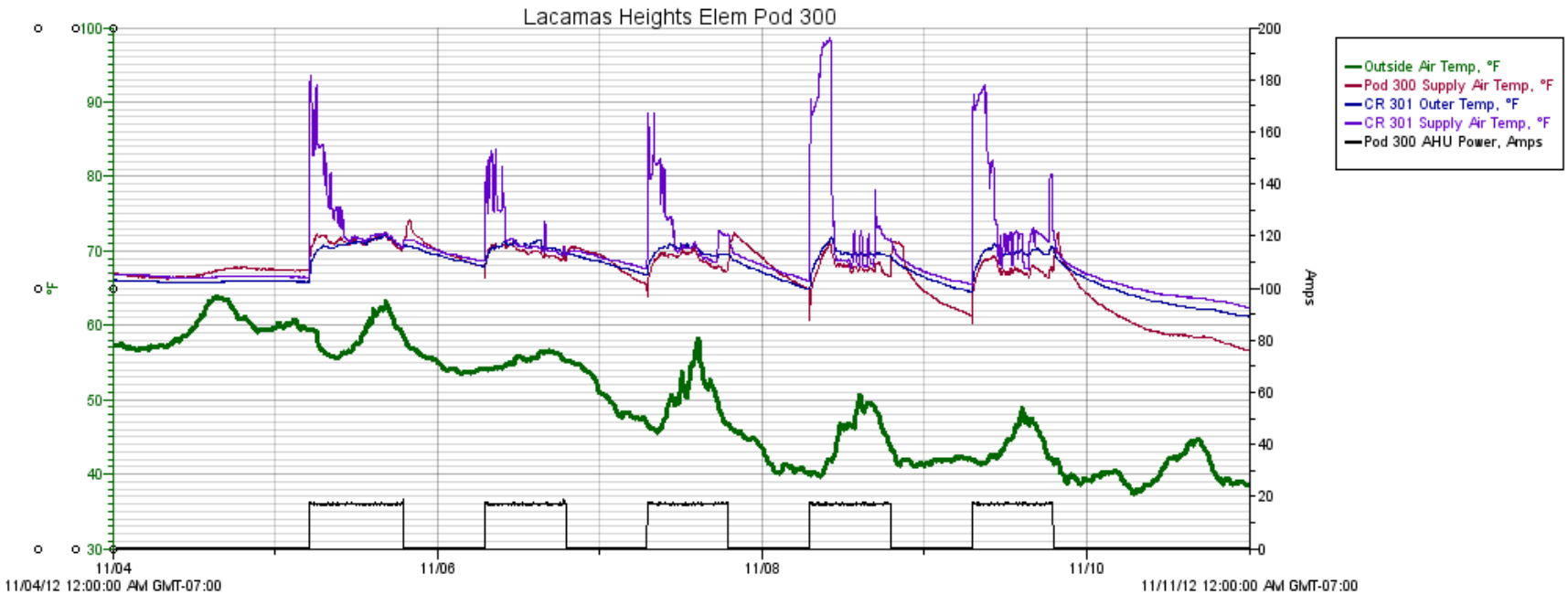
EXISTING POD 2 HVAC: ONE DAY



This graph shows the outdoor air temperature (thick green line near the middle), the fan power (black line), the electric duct heater power (red line), some room temperatures and supply air temperature and return air temperature, over a one week perid.

This illustrates that the unit started at 4 am this day – which is very early for a night when the outside air was 58 F – indicating optimal start routine is not working properly. It also shows that room 206 was heated to 70 F within about 20 minutes of startup, which seems like it is working properly, but it is starting much too early when the students don't arrive until 8:45 am this day.

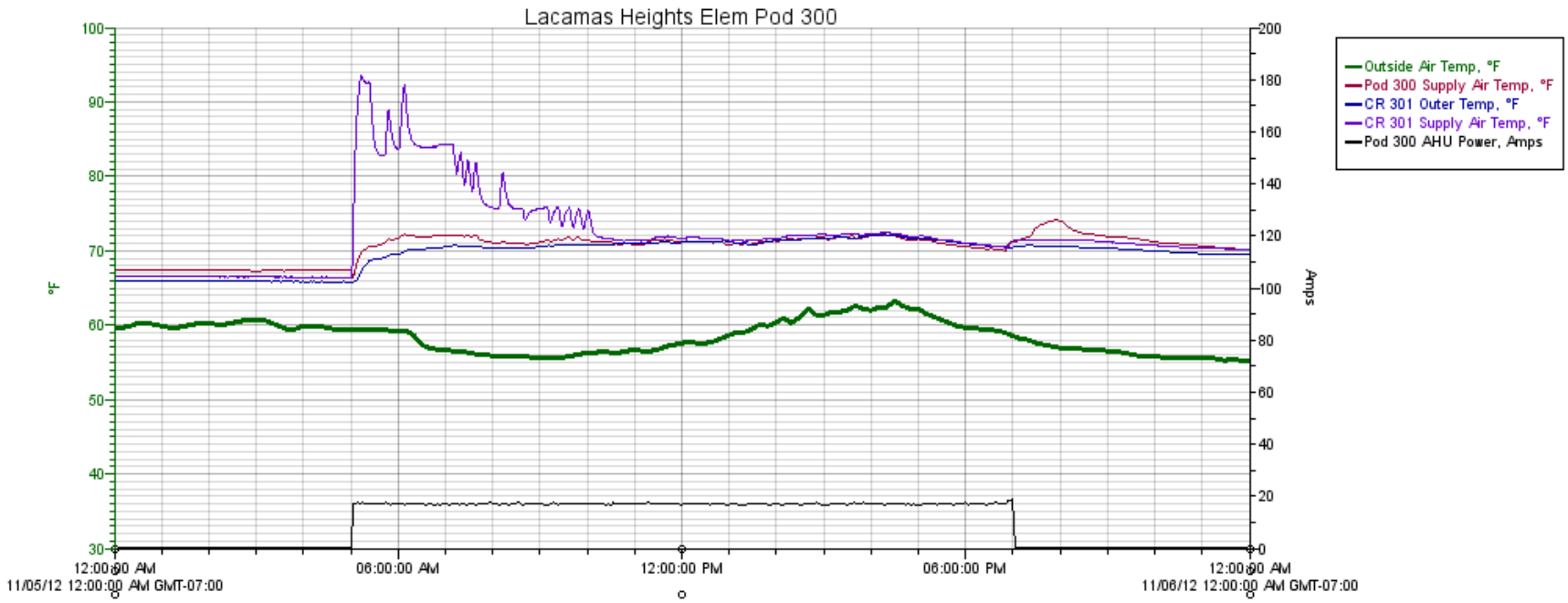
EXISTING POD 3 HVAC: ONE WEEK



This graph shows the outdoor air temperature (thick green line near the middle), the fan power (black line), one room temperatures and supply air temperature, over a one week perid.

This illustrates that the spaces never drift below 63 F even after the HVAC has been off an entire day (Saturday) and the outside air was down in the 40's.

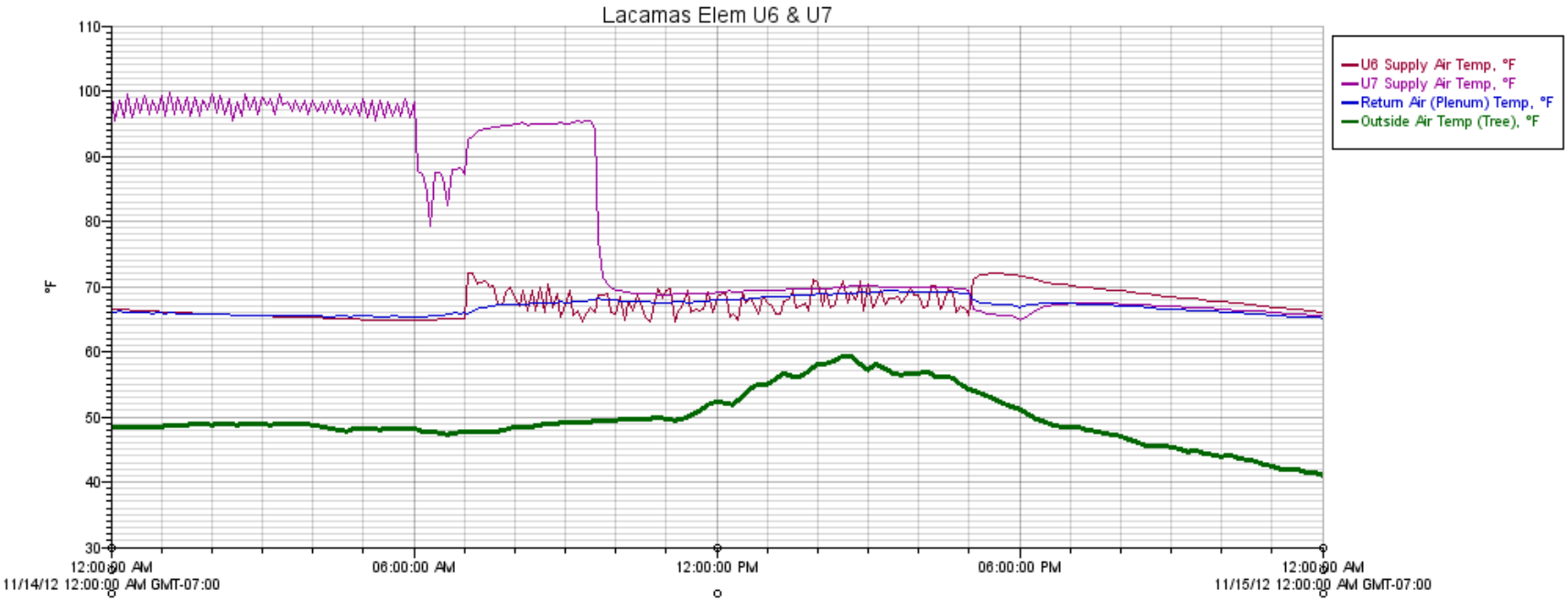
EXISTING POD 3 HVAC: ONE DAY



This graph shows the outdoor air temperature (thick green line near the middle), the fan power (black line), one room temperatures and supply air temperature, over a one day perid.

This illustrates that the unit started at 5 am this day – which is very early for a night when the outside air was 60 F – indicating optimal start routine is not working properly. It also shows that room 301 was heated to 70 F within about 60 minutes of startup, which seems like it is taking too long, but it is starting much too early when the students don't arrive until 8:45 am this day.

EXISTING U6 & U7 HVAC: ONE DAY

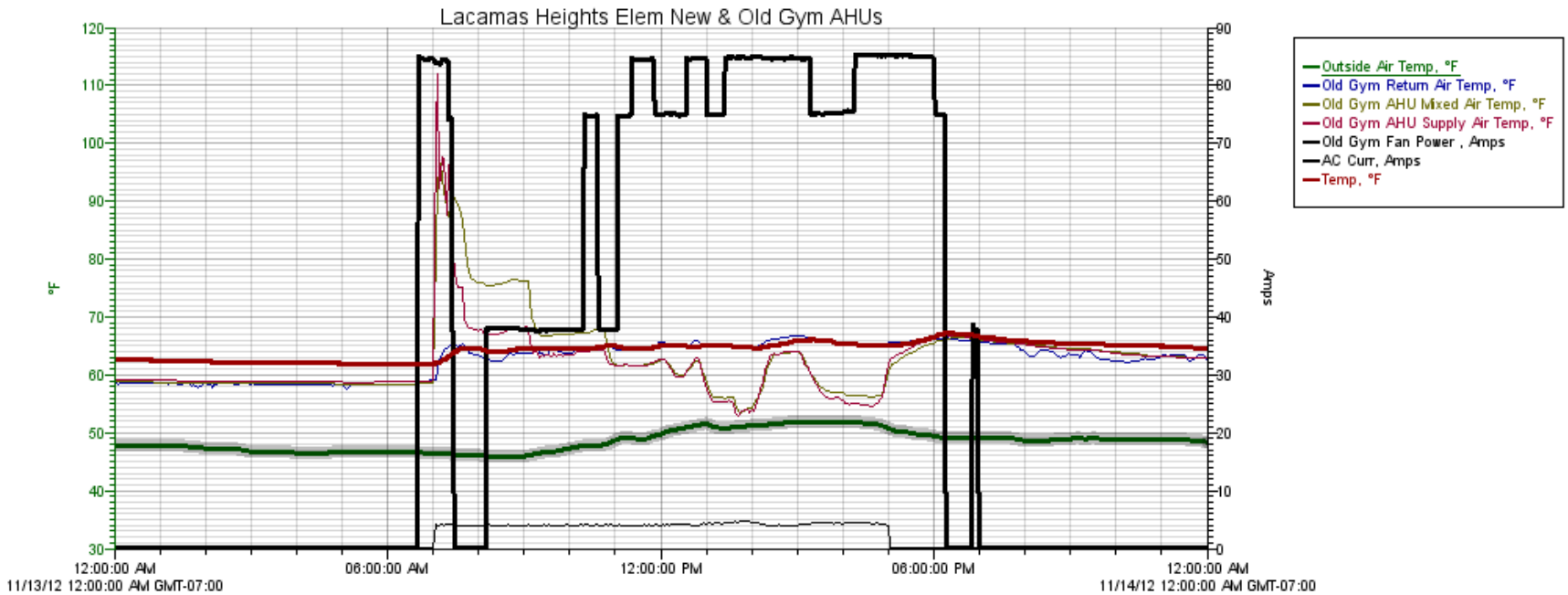


This graph shows the outdoor air temperature (thick green line near the bottom), the supply air temperature of U6 (red line near middle) and U7 (purple line near top), and the combined return air temperature of these zones, over a one day perid.

This illustrates that U7 was operating all night long supplying 95 F degree air to the zones, which is an indication that the unit is not working or being controlled properly.

This also illustrates that U6 started to operate at 6 am and did not shut off until 5 pm. This is longer than needed on a day when students arrive at 8:45 am and leave by 3:30 pm.

EXISTING NEW & OLD GYM HVAC: ONE DAY



This graph shows the outdoor air temperature (thick green line near the bottom), the supply air temperature of the old gym AHU (thin red line near the middle), the new gym space temp (thick red line near the middle), and the power of the new gym duct heater (black line), over a one day perid.

This illustrates that the new gym unit operated from 6:30 am to 6 pm this day, and the old guym unit operated from 7 am to 5 pm this day.

This also illustrates that the old gym started in heating mode in the morning, then by 1 pm is was going into economizer mode even though the outisde air was around 50F and the new gym unit was still in full heating mode. This indicates a control issue where the two units may be fighting one another, or there are other issues causing increased energy use, that will be addressed and resolved as part of the retro-commissioning process.

Summary Table of the existing energy use, the proposed energy use, and the saved energy from this EEM. The detailed calculations are provided in a separate excel spreadsheet file.

Existing Energy Use Summary

	Total HVAC Energy (kWh	Annual Fan Energy (kWh)	Annual AC Energy (kWh)	Total Annual Electric Heat Energy (kWh)	AHU Annual Electric Heat Energy (kWh)	Duct Heater Annual Electric Heat Energy (kWh)	Ceiling Heater Annual Electric Heat Energy (kWh)
Pod-1	67,999	8,669	425	58,904	6,847	36,873	15,184
Pod-2	78,125	11,231	0	66,894	0	51,821	15,074
Pod-3	78,125	11,231	0	66,894	0	51,821	15,074
U6 & U7	34,509	4,705	0	29,805	26,621	3,184	0
UV Library	3,971	137	0	3,834	3,834	0	0
U9 (Old Gym)	57,243	4,269	0	52,974	52,974	0	0
New Gym AHU	81,972	10,109	0	71,863	71,863	0	0
Offices RTUs	20,385	4,854	1,871	13,660	11,547	0	2,113
Computer Rm HP	6,627	606	1,333	4,688	4,688		
TOTAL	428,958	55,812	3,630	369,517	178,374	143,698	47,445
% of Bill	72%	9%	1%	62%	30%	24%	8%

Proposed Energy Use & Savings Summary

	Total HVAC Energy (kWh	Annual Fan Energy (kWh)	Annual AC Energy (kWh)	Total Annual Electric Heat Energy (kWh)	AHU Annual Electric Heat Energy (kWh)	Duct Heater Annual Electric Heat Energy (kWh)	Ceiling Heater Annual Electric Heat Energy (kWh)
Pod-1	43,768	5,559	146	38,063	6,872	18,537	12,655
Pod-2	55,877	7,201	0	48,676	0	36,124	12,553
Pod-3	55,877	7,201	0	48,676	0	36,124	12,553
U6 & U7	26,869	3,243	0	23,626	21,089	2,537	0
UV Library	3,971	137	0	3,834	3,834	0	0
U9 (Old Gym)	57,243	4,269	0	52,974	52,974	0	0
New Gym AHU	72,545	10,109	0	62,436	62,436	0	0
Offices RTUs	18,995	4,127	1,666	13,202	11,006	0	2,196
Computer Rm HP	5,302	485	1,067	3,750	3,750		
TOTAL	340,448	42,330	2,879	295,239	161,961	93,321	39,956
SAVED	**88,511**	**13,481**	**751**	**74,278**	**16,413**	**50,377**	**7,488**
% of Baseline	**21%**	**24%**	**21%**	**20%**	**9%**	**35%**	**16%**

EEM 2 REPLACE COMPUTER ROOM HEAT PUMP WITH HIGH EFFICIENCY HEAT PUMP

This measure proposes to replace the standard efficiency rooftop heat pump serving the computer lab with a high efficiency heat pump. The increased efficiency will result in electric savings throughout the year.

Impact on maintenance: This project is not expected to have any impact on maintenance costs.

EEM 3: REPLACE U-6, U-7 AND U-9 WITH (3) NEW HIGH EFFICIECY HEAT PUMPS

This measure proposes to replace the electric resistance heat used in U-6, U-7 and U-9 and replace it with air source heat pumps.

The U-9 library unit ventilator will be decommissioned and a new rooftop heat pump will be installed on the roof and ducted into the sidewalls to provide conditioning for that half of the library.

The U-6 and U-7 electric resistance heaters will be removed, and new split system heat pumps will be installed to provide space heating to the other half of the library, the music room, and the miscellaneous offices.

Impact on maintenance: This project is not expected to have any impact on maintenance costs.

EEM 4: INSTALL HIGH EFFICIENCY HEAT PUMPS FOR MAIN OFFICE

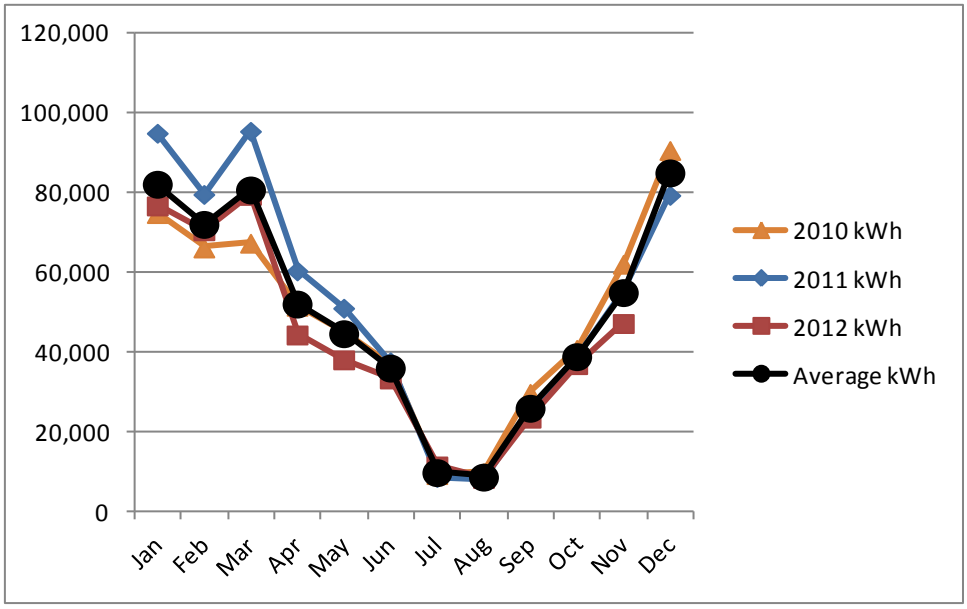
This measure proposes to remove six standard efficiency heat pumps from the office building, and install four high efficiency heat pumps to serve those areas. In two instances, two existing heat pumps can be replaced by a single heat pump and provide adequate heating and cooling to the zones. This will result in less total airflow, but still adequate airflow, which will result in some fan energy savings.

This measure will also replace one rooftop air conditioning unit (with electric resistance heat) with a new high efficiency heat pump. This will result in heating energy savings throughout the heating season.

Impact on maintenance: This project is not expected to have any impact on maintenance costs.

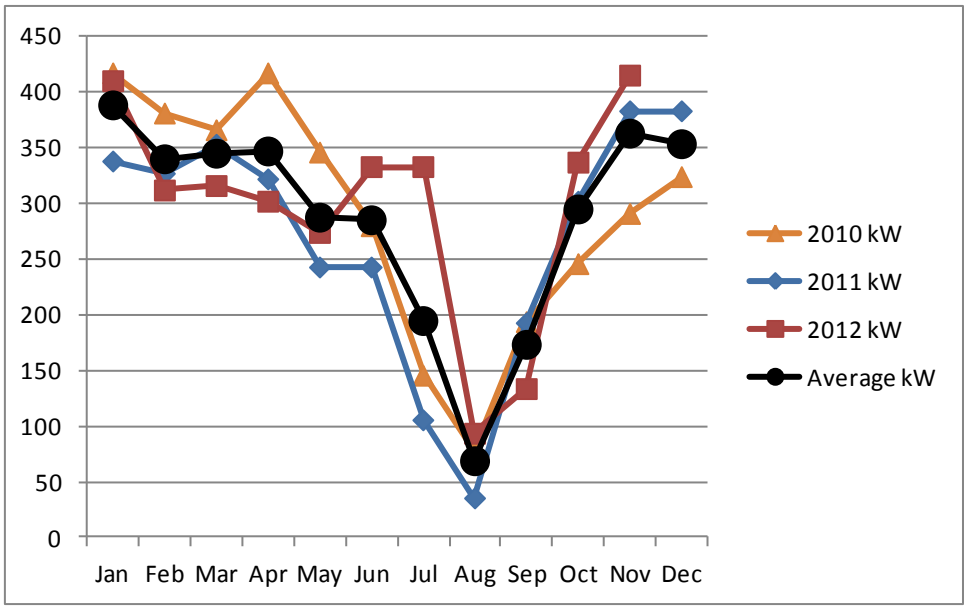
EXISTING (BASELINE) ENERGY BILLS

The recent historical electrical energy use (kWh) is illustrated below, and in the table that follows. There is one electric meter serving the entire facility, and usage has been fairly consistent over the years. The usage is higher in the summer due to air conditioning.



	2010 kWh	2011 kWh	2012 kWh	Average kWh	Average 2011-2012
Jan	74,880	95,040	76,800	82,240	85,920
Feb	66,240	79,680	70,560	72,160	75,120
Mar	67,440	95,520	79,440	80,800	87,480
Apr	51,600	60,480	44,400	52,160	52,440
May	44,880	51,120	38,160	44,720	44,640
Jun	37,200	37,680	33,360	36,080	35,520
Jul	9,360	8,640	11,520	9,840	10,080
Aug	9,840	7,920	8,400	8,720	8,160
Sep	29,760	24,720	23,520	26,000	24,120
Oct	40,800	39,120	36,960	38,960	38,040
Nov	62,160	55,680	47,280	55,040	51,480
Dec	90,720	79,440		85,080	79,440
Total	584,880	635,040	470,400	591,800	592,440

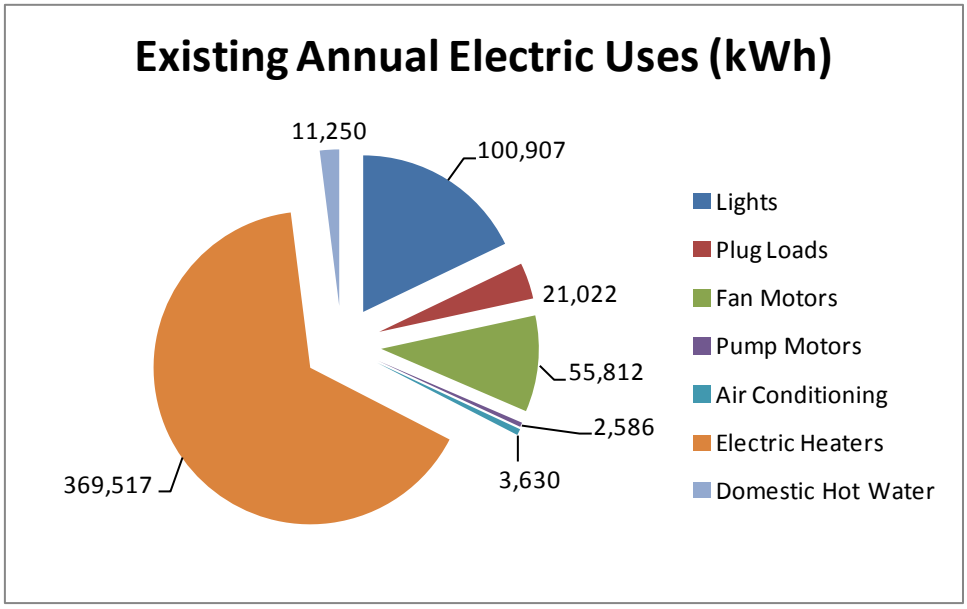
The recent historical electrical energy demand (kW) is illustrated below, and in the table that follows. There is one electric meter serving the main facility.



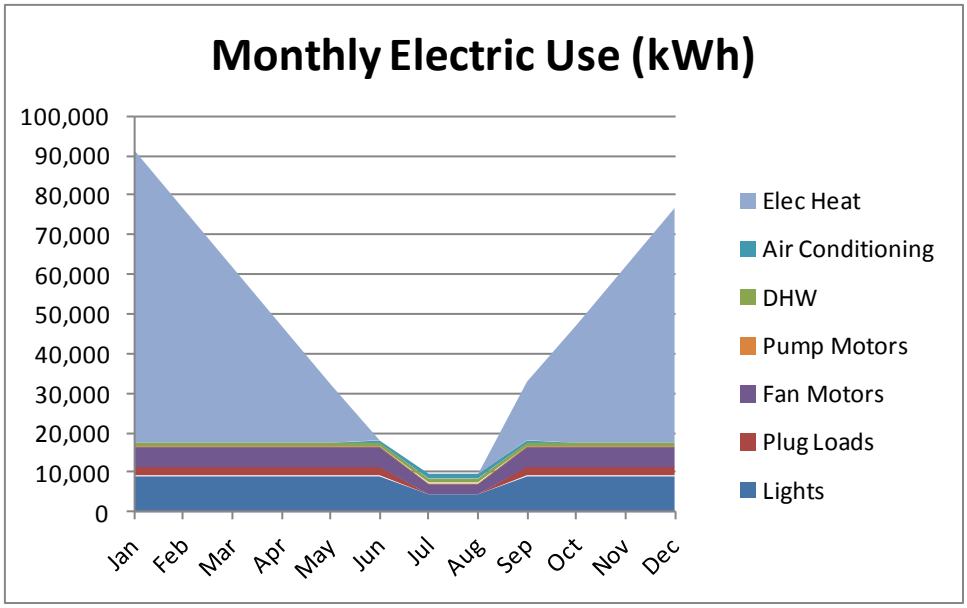
	2010 kW	2011 kW	2012 kW	Average kW
Jan	416	337	409	387
Feb	380	326	311	339
Mar	365	352	315	344
Apr	416	321	301	346
May	345	242	273	287
Jun	279	242	332	284
Jul	145	105	332	194
Aug	77	35	93	68
Sep	193	192	133	173
Oct	245	301	336	294
Nov	290	382	414	362
Dec	323	382		353
Total	3,474	3,217	3,249	3,431

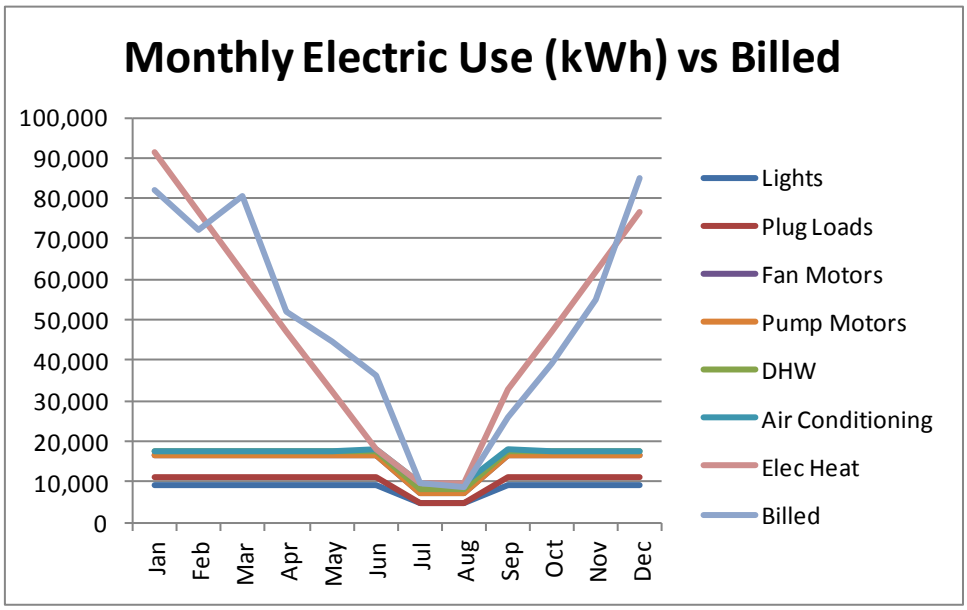
EXISTING (BASELINE) ENERGY END USE ANALYSIS

As the first step in our investment grade energy audit, we first determine where the existing energy in the facility is being used. This step is essential to take in order to accurately determine what the potential energy savings can be. The results of this analysis are presented here.



	Watts / Square Foot	Peak Possible kW	Equivelant Full Load Hours / Year	Annual kWh	kWh % of Bill
Lights	1.20	56.1	1,800	100,907	17%
Plug Loads	0.25	11.7	1,800	21,022	4%
Fan Motors		18	3,163	55,812	9%
Pump Motors		0.6	4,000	2,586	0.4%
Air Conditioning		50.0	73	3,630	0.6%
Electric Heaters		490.3	754	369,517	62.4%
Domestic Hot Water		22.5	500	11,250	1.9%
Miscellaneous				27,077	4.6%


Monthly Electric Use (kWh)
100,000
90,000
80,000
70,000
60,000
50,000
40,000
30,000
20,000
10,000
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Elec Heat
Air Conditioning
DHW
Pump Motors
Fan Motors
Plug Loads
Lights


Monthly Electric Use (kWh) vs Billed
100,000
90,000
80,000
70,000
60,000
50,000
40,000
30,000
20,000
10,000
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Lights
Plug Loads
Fan Motors
Pump Motors
DHW
Air Conditioning
Elec Heat
Billed

MEASUREMENT AND VERIFICATION PLAN

Proposed M&V Methodology.

We propose to measure and verify the energy savings resulting from this project using the 2012 IPMVP (International Performance Measurement and Verification Protocol) Option C method – Whole Facility. This is the most appropriate method to use because:

a) This will determine the whole facility energy performance, not just the performance of individual systems, which is what the owner is interested in.
b) The total projected energy savings are relatively large (greater than 10%) of the existing (baseline) energy use.
c) There are multiple systems that are affected by the proposed upgrades (numerous fans, electric duct heaters, electric ceiling heaters, and heat pumps) – so conducting retrofit isolation and metering all the systems would be prohibitively expensive.
d) There are significant interactive effects between the sequencing strategies that are going to be implemented.
e) Major future changes to the facilities are not expected during the next three years.
f) Reasonable correlations exist between the existing energy use and the weather.

This will allow us to utilize the existing main electric utility meter to define the existing (baseline) energy use, and the proposed (after upgrade) energy use. It will not require the addition of any other metering devices to complete the M&V.

Note about potential change of usage: If after the upgrade the school significantly increases their operating hours then we would reserve the right to adjust the baseline (existing) energy use to take this into account. For instance, if the school changes its summer schedule and remains open during the summer for summer school, then the existing energy use will be modified to reflect how much energy the building would have used before the upgrade if it had been operating during the summer. We would propose to do this using our existing energy end use analysis – by modifying the operating hours appropriately.

Note about significant change in weather: If there is significantly different weather experienced after the upgrade (much hotter than normal in the summer or much colder in the winter than normal) then we reserve the right to adjust the baseline (existing) energy use to determine how much the older systems would have used if they were operated with the current weather. We would propose to do this with linear regression models that depict the energy use based on monthly heating degree days for natural gas use, and monthly cooling degree days for electric use. Then the after-upgrade energy use would be compared to the adjusted baseline energy use to determine the actual energy savings.

Investment Grade Energy Audit for the Camas School District

J.D. Zellerbach Administration Center

Located at 841 NE 22nd Avenue
Camas, Washington

Prepared by:

ABACUS

February 4, 2013

Contacts

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Utility Rate Assumptions

Utility Rates used in analysis

$0.93197	Cost / Therm (NWN Schedule 03C)
$0.0469	Average Cost / kWh (Clark Public Utilities Schedule 134)
$6.770	Cost / kW / Month (Clark Public Utilities Schedule 134)

Table of Contents

Executive Summary *4*
Introduction and Background **4**
Incentives available for Energy Efficiency Projects **4**
Grants available for Energy Efficiency Projects **4**
Brief Description of Facility and Energy Using Systems **4**
Summary Table of EEMs **20**
Next Steps for the Owner **22**
Other Energy Saving Opportunities not included in Summary Table **22**
EEM 1: Optimize Existing HVAC and DDC Systems *23*
Existing (Baseline) Energy Bills *55*
Existing (Baseline) Energy End Use Analysis *58*
Project Cost Estimates *61*
Measurement and Verification Plan *62*

EXECUTIVE SUMMARY

Introduction and Background

The Camas School District in Camas, Washington is interested in pursuing opportunities to lower the utility use of their facilities. This report presents detailed findings of an investment grade level analysis of energy savings and implementation costs for several specific energy efficiency measures (EEMs) identified.

Incentives available for Energy Efficiency Projects

Clark Public Utilities offers incentives for owners to implement electric-saving measures. If the owner is interested in pursuing any of these opportunities they should discuss them with Clark Public Utilities prior to purchasing equipment or issuing contracts for construction. Some projects will require inspections and verifications of savings before and/or after they are installed in order to qualify for incentives. All measures will require submitting official forms to the sponsoring agency prior to purchasing any equipment.

The Energy Trust of Oregon offers incentives for owners to implement natural gas-saving measures. If the owner is interested in pursuing any of these opportunities they should discuss them with the Energy Trust of Oregon prior to purchasing equipment or issuing contracts for construction. Some projects will require inspections and verifications of savings before and/or after they are installed in order to qualify for incentives. All measures will require submitting official forms to the sponsoring agency prior to purchasing any equipment.

Grants available for Energy Efficiency Projects

The State of Washington is currently accepting applications for grants from municipal governments for projects that result in energy conservation at municipal owned facilities. If the owner is interested in pursuing this latest grant opportunity they should work with an ESCO (Energy Services Company) to complete an Investment Grade Energy Audit, decide what projects they want to implement, and then apply for the grant.

Brief Description of Facility and Energy Using Systems

Facility Description: The Camas School District J.D. Zellerbach Administration headquarters is comprised of four buildings. All of the buildings were studied for this audit. This campus was originally built and operated for 50 years as an elementary school. In 2010, the elementary school was remodeled and converted into the new headquarters for the Camas School District Administration. Buildings 1 and 2 were originally constructed in 1953 and now house the district administration and operations staff. These two buildings are connected by a lobby and are mirror images of each other; throughout this report, these buildings are analyzed as one building. Building 4 was added in 1966 and consists of a kitchen and cafeteria, a gym, and two classrooms used for Head Start classes. Building 3 was completed in 1973 and was remodeled in 2010; it now consists of the district print shop, information technologies center, and classrooms used for preschool and daycare. The total building square footage on this campus is approximately 67,000 square feet.

Envelope Details: The buildings are constructed of 9" of concrete with 4" brick veneer finish, and gypsum board on the interior. There are a variety of windows, including both double pane and single pane glazing which have aluminum or hollow metal frames. The buildings have acoustic drop ceilings with 4" to 6" of batt insulation above the ceiling. The roof is mostly a flat roof comprised of roofing membrane, 1/2" plywood sheathing, and glulam joists. The envelope is typical for the construction of the day and transfers a fair amount of heat across the envelope, especially across the single pane windows. Upgrading the single pane windows however would have a payback well over 30 years, so it is not included in this report.

Typical Occupancy:

Building 1: Building 1 has approximately 24 employees, not including custodians. Custodians usually work in the building from 4:00 pm to 6:00 pm. This building is occupied by staff between the hours of 7 am to 5 pm and is used in the evenings several hours each week for meetings.

Building 2: Building 2 has about 18 employees. This building is occupied between the hours of 7 am and 5 pm is used in the evenings several hours each week for meetings.

Building 3: Building 3 has two distinct areas which were separated in the remodel of 2010 and are now accessed by separate outside doors.

Print Shop and IT Center: These areas have 7 employees who are present between 7 am and 5 pm.

Preschool/Daycare Area: The school area has approximately 25 students and 3 adults present between the hours of 6 am and 6 pm.

Building 4: Building 4 has two distinct areas which operate differently.

Cafeteria/Kitchen and Gym: These areas area used by the Preschool/Daycare for breakfast, lunch or a snack and the gym is rented out by community groups who use it for meetings, church, or exercise. This building is occupied by varying numbers of occupants between the hours of 8 am and 8 pm.

Head Start Rooms: There are two classrooms in the back of this building which are used by 20-25 students and 3 adults between the hours of 7 am and 5 pm.

Energy Supply: The building receives electricity from Clark Public Utilities, and natural gas from Northwest Natural Gas. There is a single electric meter, and a single natural gas meter.

Lighting: Lighting is predominantly T8 fluorescent lights with standard efficiency electronic ballasts. T5 fluorescent lights are found in some areas. The gym has 400 watt metal halide lamps as seen in the picture to the right.

The building also has many compact fluorescent (CFL) lamps in recessed cans and ceiling mounted bowl fixtures, and LED exit signs. Skylights were added during the remodel of 2010 and help to add natural light to Buildings 1 and 2.

The buildings are sparsely occupied and the staff is diligent about leaving lights off in areas that are not being used. During several site visits the board room, conference room, gym, cafeteria and print shop lighting was observed to be off when the spaces were unoccupied.

Examples of Lighting Turned Off during Occupied Hours

Lighting Controls: Several spaces, specifically offices and storage rooms, have occupancy sensors controlling the overhead lighting. Photocells control the outdoor lighting.

Hot Water: Domestic hot water is generated by electric hot water heaters located throughout the buildings. Three of the water heaters are Appliance Building Company units with two heating elements that are 12,000 watts each; these units were installed in the late 1960s. There is also one Ruud unit which has an 80 gallon capacity with two heating elements that are 4,500 watts each. Domestic hot water is circulated throughout the buildings with several a small circulating pumps.

Domestic Hot Water Heaters

DHW Circulation Pump

PROJECT COST ESTIMATES

The Total Project Costs for the Recommended EEMs are based on quotes provided by Abacus.

HVAC:

The following pages contain a description of the HVAC system (boilers, air handling units, etc) in each building.

Building 1 and 2:

Heating Boilers:

There are two electric boilers located in the mechanical spaces that provide hot water for the air handling units. They are both Coates - CAM Industries Model 12CWB-1 electric hot water boilers that have a maximum kW of 72. Each boiler produces hot water for the main air handlers, AHU 1 and AHU 2. They maintain the heating water supply temperature between about 140°F and 150°F during occupied hours. These boilers have an outside air lockout temperature of 60 degF.

Each boiler has a dedicated 1/2 hp circulating pump that circulates the hot water through the boiler and its air handling unit.

Electric Boiler

Hot Water Pump

Air Cooled Chiller:

Chilled water is provided to Building 1 and 2 by a Carrier air-cooled 55-ton chiller. The unit has four compressors, an energy efficiency ratio (EER) of 10.1, and an integrated part load value (IPLV) of 14.6. This chiller has an outside air lockout temperature of 65 degF. There is a 5 HP pump in a closet near the chiller that circulates the chilled water through the chiller and to all the air handlers. Currently, the chilled water pump operates 24/7.

Air Cooled Chiller

Chilled Water Pump

Air Handlers:

There are four main air handling units (AHUs) in Buildings 1 and 2. AHU 1 and AHU 2 are large constant volume multizone units which supply conditioned air to the majority of each building, except the core area. These are triple deck units, meaning they have a hot deck, a cold deck and a bypass deck. Each zone has a damper which mixes hot air and bypass air or cold air and bypass air to meet the temperature needs of its zone. The hot deck is heated with hot water and cooling is provided by chilled water.

AHU 3 and AHU 4 are constant volume cooling-only units with electric duct heaters which reheat the supply air depending on the zonal demands. These two units serve the central areas of the buildings. See HVAC floor plans on following pages.

There are also three rooftop units (RTUs) which serve areas that have undergone usage changes since the RTUs were installed. Currently, only RTU 3 operates regularly.

The following table provides additional details about each unit in Buildings 1 and 2:

Multizone Constant Air Volume (MZU) Air Handlers Assumptions

	Maximum Airflow (cfm)	Design Minimum Outside Air (cfm)	(%)	Supply Fan (hp)	Return Fan (hp)	Total Fan (hp)
AHU-1	9,800	1,960	20%	10	5	15
AHU-2	9,800	1,960	20%	10	5	15
TOTAL	19,600	3,920	20%	20	10	30

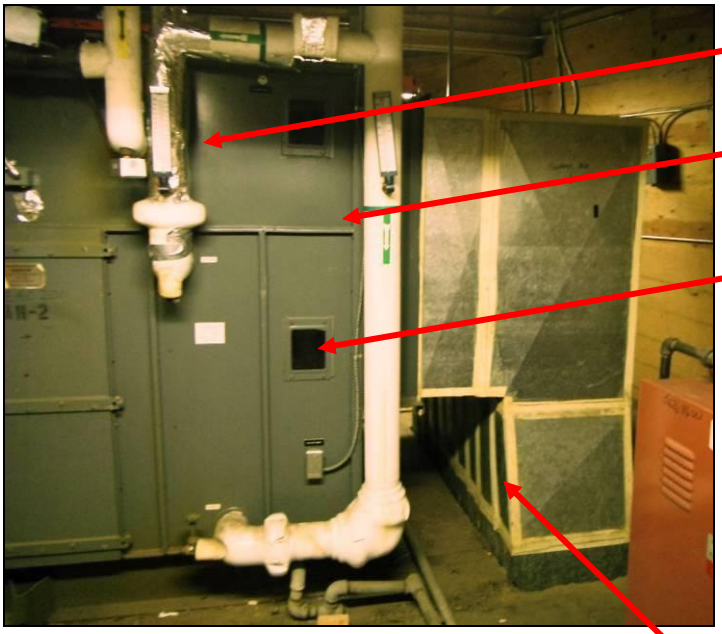
Constant Air Volume (CAV) Air Handlers Assumptions

	Maximum Airflow (cfm)	Design Minimum Outside Air (cfm)	(%)	Supply Fan (hp)	Return Fan (hp)	Total Fan (hp)
AHU-3	3,600	309	9%	3	1 1/2	4 1/2
AHU-4	3,000	309	10%	3	1 1/2	4 1/2
TOTAL	6,600	617	9%	6	3	9

Roof Top Unit (RTU) Air Handler Assumptions

	Maximum Airflow (cfm)	Design Minimum Outside Air (cfm)	(%)	Supply Fan (hp)	Return Fan (hp)	Total Fan (hp)	
ACU 2	1,600	240	15%	1	0	1	*Unit does not operate.
ACU 3	1,600	240	15%	1	0	1	
ACU 4	1,600	240	15%	1	0	1	*Unit does not operate.
TOTAL	4,800	720	15%	3	0	3	

AHU 1 and **AHU 2**



AHU 3

AHU 4

Building 3:

Heating Boilers:

In Building 3, the original 1973 electric boiler was replaced with a natural gas boiler in 2010. The new boiler is located in the mechanical space above the print shop and provides heating to the Supply Fans (SFs) and the reheat boxes throughout the building. This Thermal Solutions Model EVA075 hot water boiler has a maximum input of 75,000 BTU/h and an output of 66,000 BTU/h. It maintains the heating water supply temperature between about 140°F and 150°F during occupied hours. The boiler has an outside air lockout temperature of 60 degF.

This boiler has a dedicated 1/3 hp circulating pump that circulates the hot water through the boiler and the air handling units.

Air Conditioning:

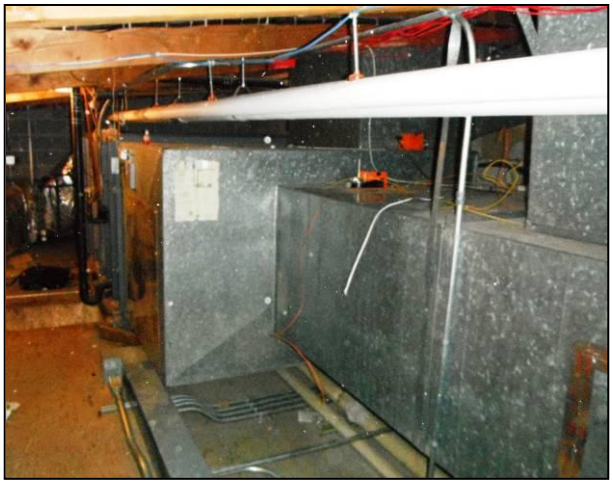
Cooling is provided to this building by split system condensers on the roof. Each air handling unit, referred to in this building as Supply Fans, has a corresponding split system condensing unit which provides cooling to the zone.

Air Handlers:

Building 3 has four constant volume air handling units. Four of these units are cooling-only with hot water reheat coils in the ducts which reheat the air depending on zonal demand. One unit is single zone and has hot water heating in the unit.

Constant Air Volume (CAV) Air Handler Assumptions

	Maximum Airflow (cfm)	Design Minimum Outside Air (cfm)	(%)	Supply Fan (hp)	Return Fan (hp)	Total Fan (hp)
SF 1	9,850	1,500	15%	5	3	8
SF 2	5,200	800	15%	3	2	5
SF 3	4,110	600	15%	3	2	5
SF 4	4,000	600	15%	2	0	2
TOTAL	23,160	3,500	15%	13	7	20



SF 1

SF 4

Building 4:

Heating Boilers:

None. Heating in Building 4 is provided by electric heating coils.

Air Conditioning:

None. No cooling is provided in Building 4.

Air Handlers:

Building 4 has five constant volume air handling units. Four of these units are cooling-only with hot water reheat coils in the ducts which reheat the air depending on zonal demand. One unit is single zone and has hot water heating in the unit.

Constant Air Volume (CAV) Air Handlers Assumptions

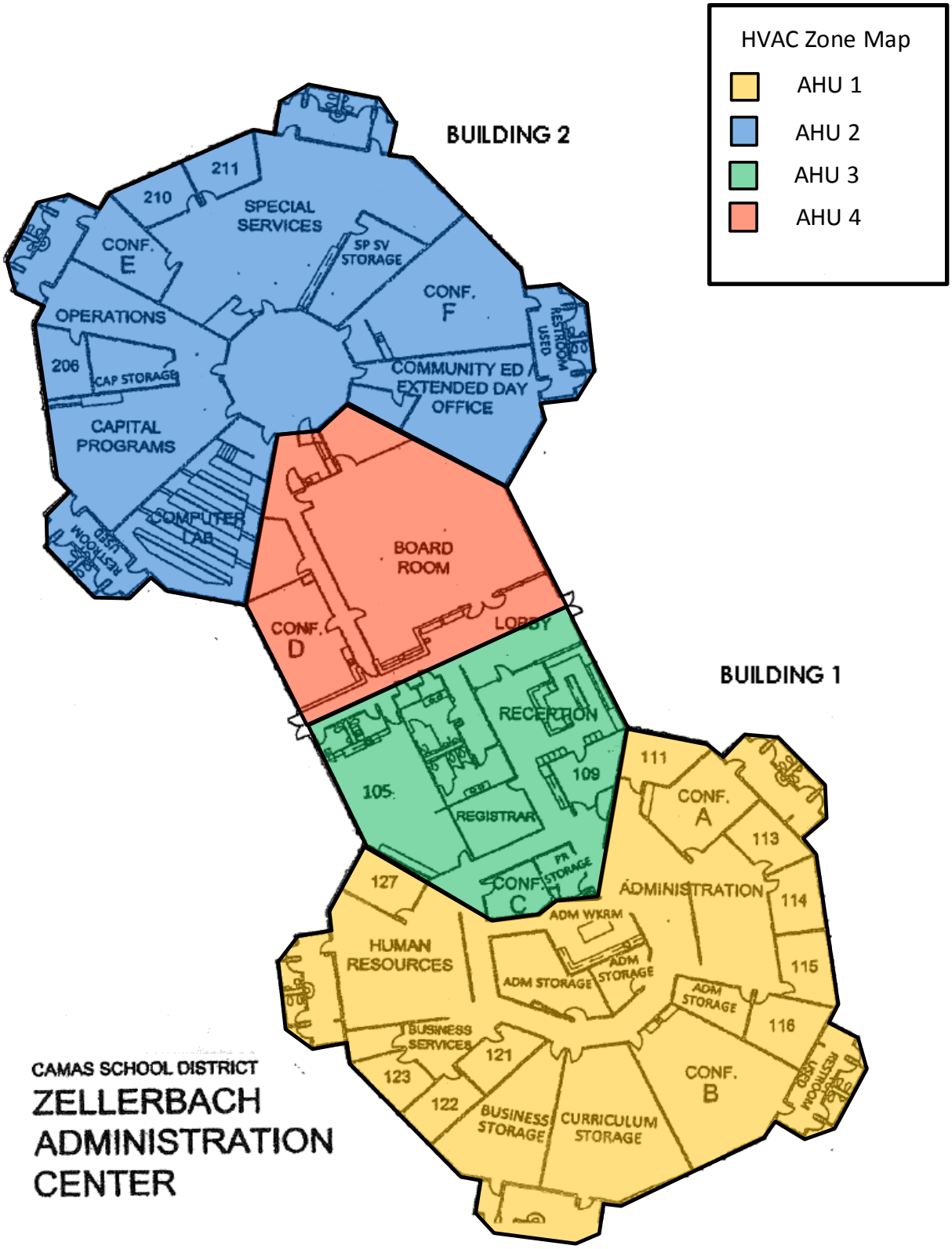
	Maximum Airflow (cfm)	Design Minimum Outside Air (cfm)	(%)	Supply Fan (hp)	Return Fan (hp)	Total Fan (hp)
SF 1	2,600	148	6%	1	0	1
SF 2	2,600	148	6%	1	0	1
SF 3	2,500	148	6%	1	0	1
SF 4	2,000	148	7%	1	0	1
SF 5	1,200	148	12%	1/2	0	1/2
TOTAL	10,900	740	7%	4 1/2	0	4 1/2

SF 2

SF 5 (ceiling mounted)

HVAC Zone Map/Simplified Floor Plan

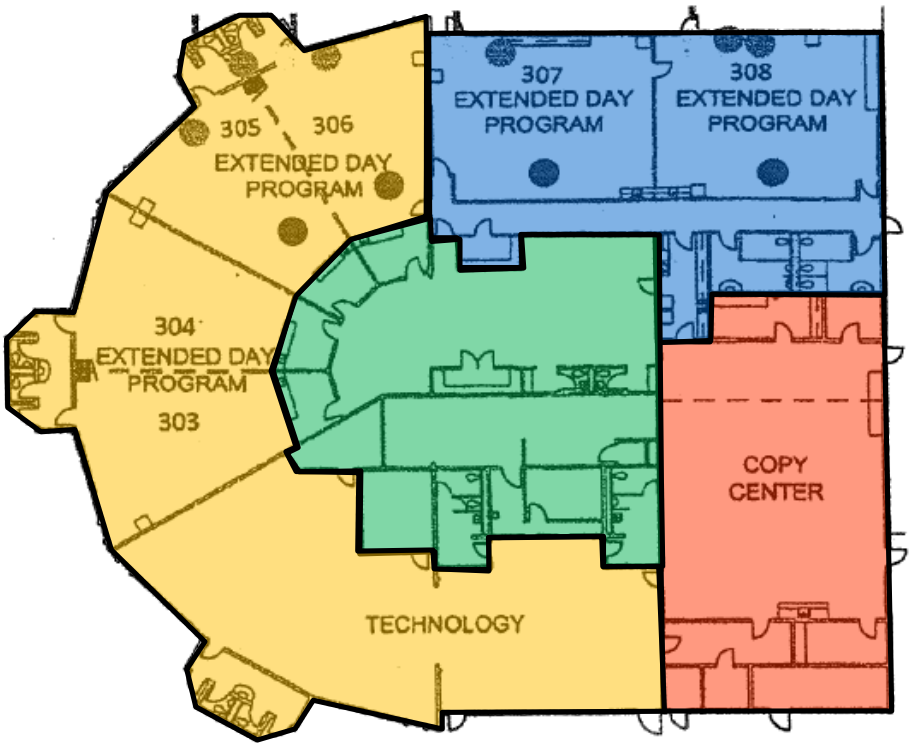
The maps on the following pages show the different HVAC zones for the air handlers at the Administration Center.



HVAC Zone Map

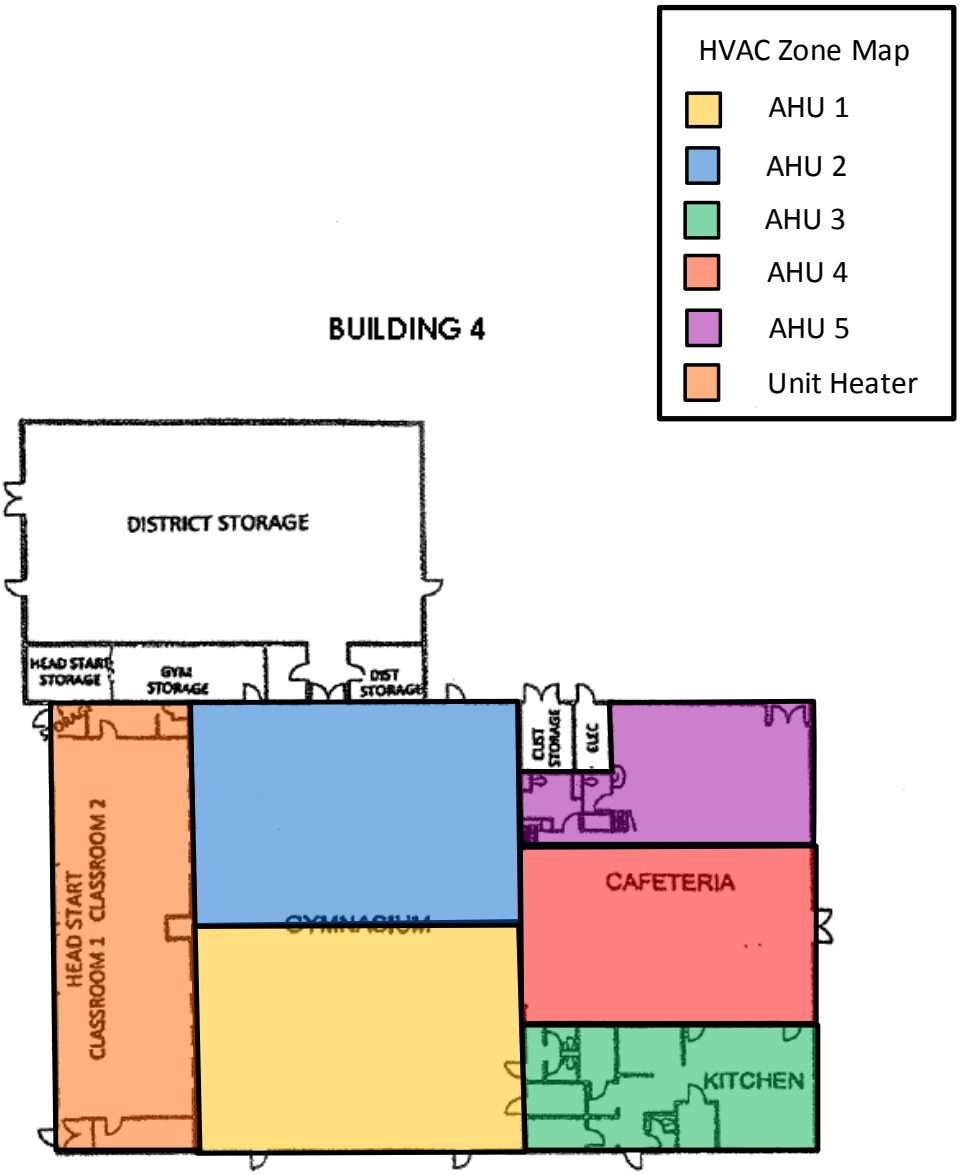
- SF 1
- SF 2
- SF 3
- SF 4

BUILDING 3



CAMAS SCHOOL DISTRICT

ZELLERBACH ADMINISTRATION CENTER



CAMAS SCHOOL DISTRICT

ZELLERBACH ADMINISTRATION CENTER

Summary Table of EEMs

The table on the next page lists the EEMs recommended in this report.

Camas SD JDZ Admin Center - Recommended EEMs

EEM #	EEM Description	Electricity Saved / Year (kWh)	Electric Demand Saved / Month (kW)	Natural Gas Saved / Year (Therms)	Annual Utility Costs Saved / Year ($)	Net EEM Burdened Costs ($)	8.4% Taxes ($)	Initial Cost to Owner ($)	Estimated Clark PUD Incentives ($)	Estimated ETO Incentives ($)	Net Cost to Owner ($)	Net Payback (Years)
1	New HVAC and Controls	358,354	0	745	$17,498	$131,226	$11,023	$142,249	$76,636	$745	$64,868	3.7
TOTAL		**358,354**	**0.0**	**745**	**$17,498**	**$131,226**	**$11,023**	**$142,249**	**$76,636**	**$745**	**$64,868**	**3.7**

All incentives will be determined by the appropriate utility; the figures listed above are estimates only.

The table below illustrates the existing energy use on a per square foot basis and the proposed energy use after the recommended EEMs above are installed.

Camas SD Admin Building EUI Summary				
Building	66,337	sq ft		
	Existing	Proposed	Saved	Saved
Electric EUI	58,021	39,583	18,437	32%
Gas EUI	9,652	8,529	1,124	12%
Total EUI	**67,673**	**48,112**	**19,561**	**29%**

Next Steps for the Owner

Review this Report and Decide which EEMs to Implement. The EEMs identified in this report affect different systems and have different budgets. If the owner has potential funding and commitment to implement any of these measures in the next year or two then notify the serving utility companies which measures would be considered. Indicate the timeframe you are considering and the potential budget.

Clark Public Utilities and the Energy Trust of Oregon will notify you of the next steps to participate in their incentive program. The particular EEMs that you are interested in implementing will determine what the next steps are, in order to qualify for incentives from Clark Public Utilities and/or Northwest Natural.

Grant Applications must be submitted no later than February 25, 2013.

Other Energy Saving Opportunities not included in Summary Table

The following energy saving opportunities were not included in the summary table of this report. They are briefly described here, along with the reason why they are not included.

Solar Electric Generation: Even with available incentives and tax credits solar photovoltaic would have a payback well over 40 years.

Solar Water Heating of Domestic Hot Water: Glazed solar collectors could be mounted on the roof and used to heat or pre-heat the domestic hot water. These systems also have a payback over 25 years.

EEM 1: OPTIMIZE EXISTING HVAC AND DDC SYSTEMS

This measure proposes to make adjustments to the existing DDC system to provide both improved comfort and reduced energy use. Additionally, some equipment like dampers, actuators and valves will need to be repaired or replaced. After conducting several site visits, recording the operation of the HVAC systems over time and analyzing the data, we have identified ways which the existing system is not operating optimally and can be improved for both comfort and energy savings. The new units will save energy in the following ways:

Minimize Hours of Operation – many of the air handling units were found to be operating excessively, often operating for several hours per day outside of occupied hours of the buildings. In the case of Building 1 and Building 2, data logging showed that all four air handlers were operating 24 hours per day, 7 days per week, even though the building is only occupied from 7 am to 5 pm on weekdays. We assume that this is typical of the operation of the units during the winter months. This EEM proposes to change the schedule to match the actual occupancy and ensure that the units will start as late as possible in order to make the spaces comfortable by the time the building opens to staff. This building already has over-ride thermostats which can be used to reactivate the AHUs when the spaces are occupied outside of normal business hours. Building operators are unsure as to whether the after-hours override buttons currently work properly; this EEM will correct any issues and provide training to the staff about the proper usage of the afterhours override buttons.

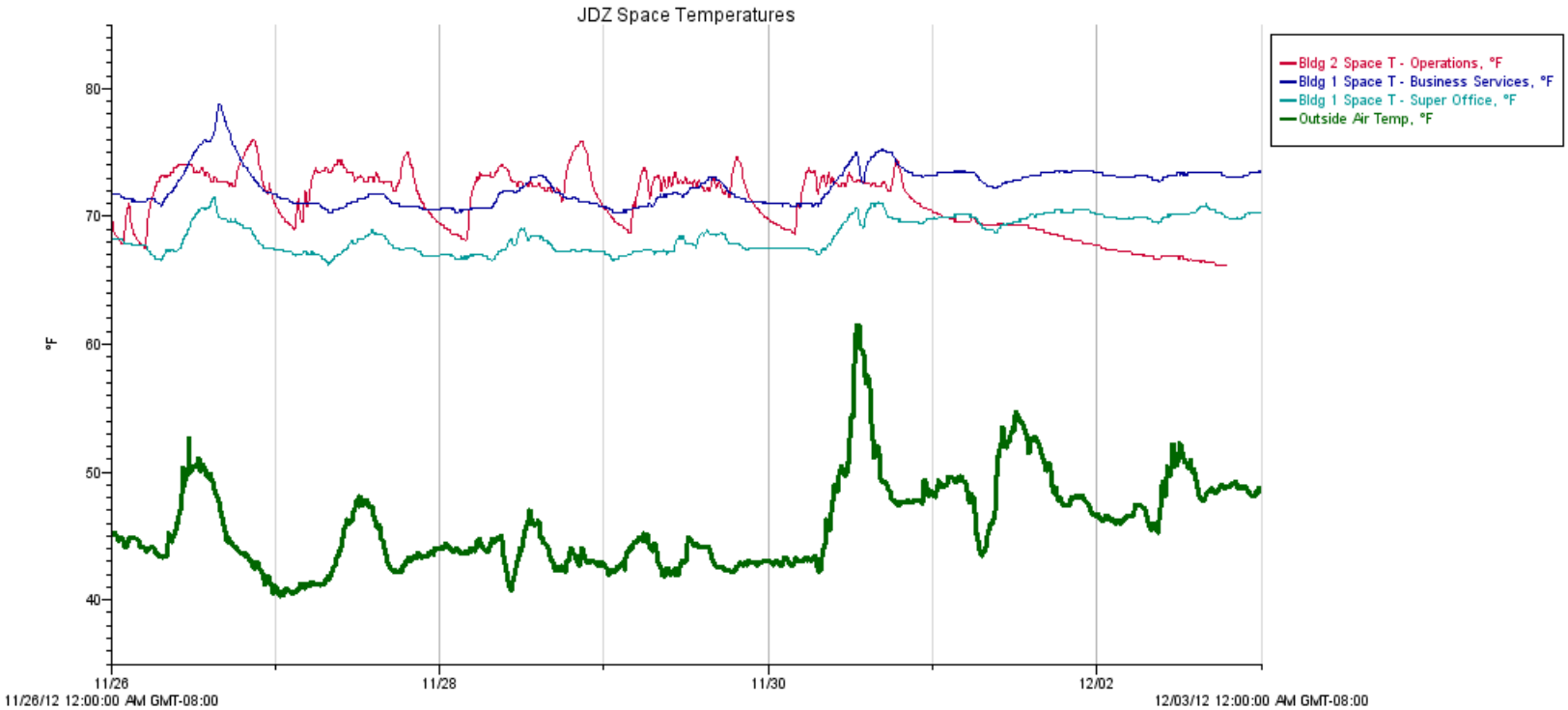
CO2 Sensors for minimizing outside air – CO2 sensors will be installed on the return air of each of the six air handlers to monitor the CO2 levels in the spaces. When the CO2 levels are low, then the outside air can be reduced, and when the CO2 levels get too high then the outside air dampers will automatically open up to provide the required amount of outside air. This is generally expected to reduce the amount of outside air used in these units throughout the year, especially when the spaces are lightly occupied, which is most of the day.

Optimize Outside Air Damper Control and Free-Cooling Airside Economizer – Data logging showed that the outside air economizers are not always working properly. There are times when the outside air dampers stay open when outside temperatures are low and the AHUs are in heating mode. Our audit was conducted in December and we did not capture any operation of the chiller, however we suspect that there are times when the air handlers should be bringing in cool outside air (55 F or 60 F) instead of running the chiller, but instead the units are only bringing in a small amount of outside air and mixing it with warmer return air (70F) and then running the chiller to cool the mixed air down to 55 F. This EEM will include reviewing the controls programming and physically inspecting the equipment to correct these issues.

Impact on maintenance: Included in this project is the replacement of some of the actuator and dampers in the existing AHUs. These upgrades will postpone maintenance costs for this equipment. Otherwise, this project will not affect maintenance costs.

The following pages illustrate the existing operation of the units that we recorded during our energy audit. The detailed energy savings calculations follow.

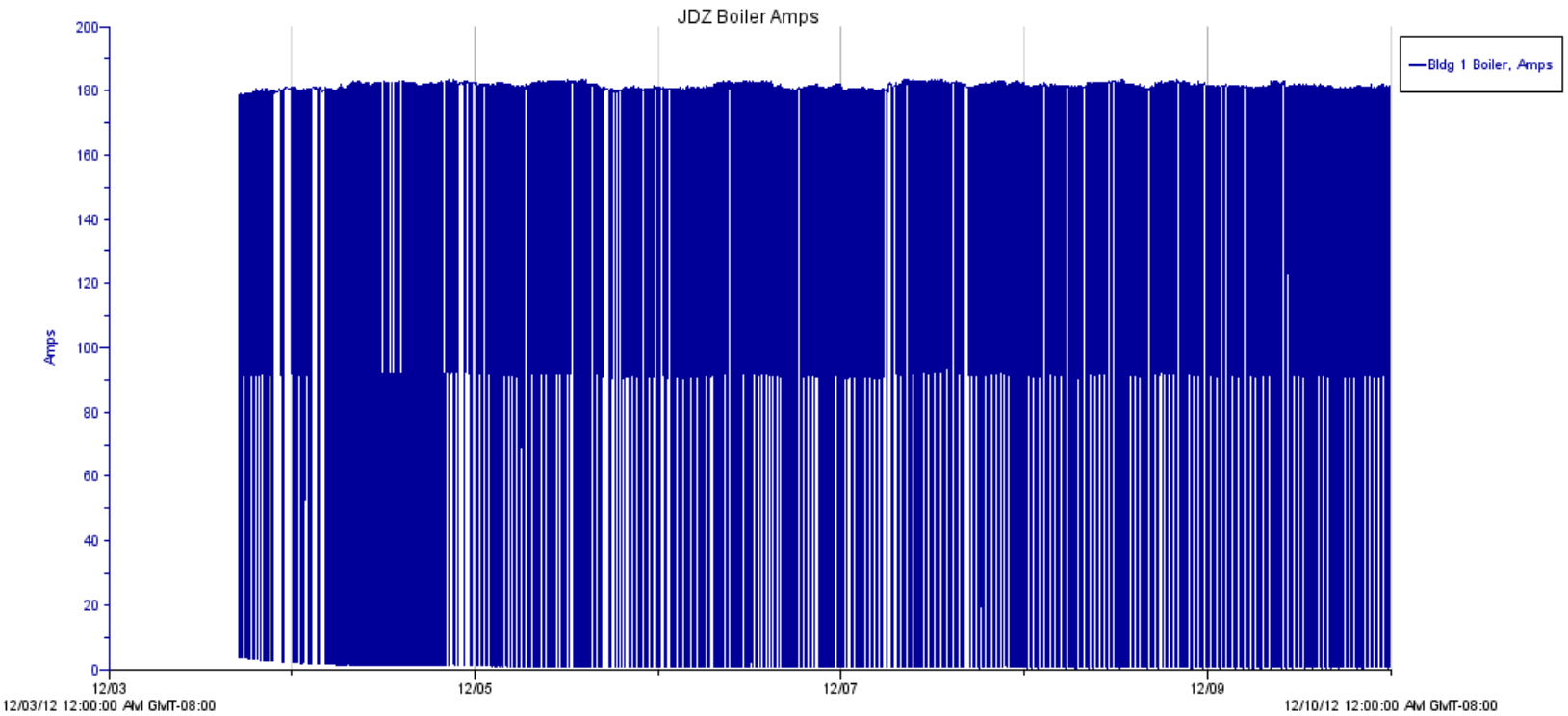
EXISTING INDOOR TEMPERATURES: ONE WEEK



This graph shows the outdoor air temperature (thick green line near the bottom) and the indoor temperatures of the spaces in Building 1 and Building 2 over a one week period.

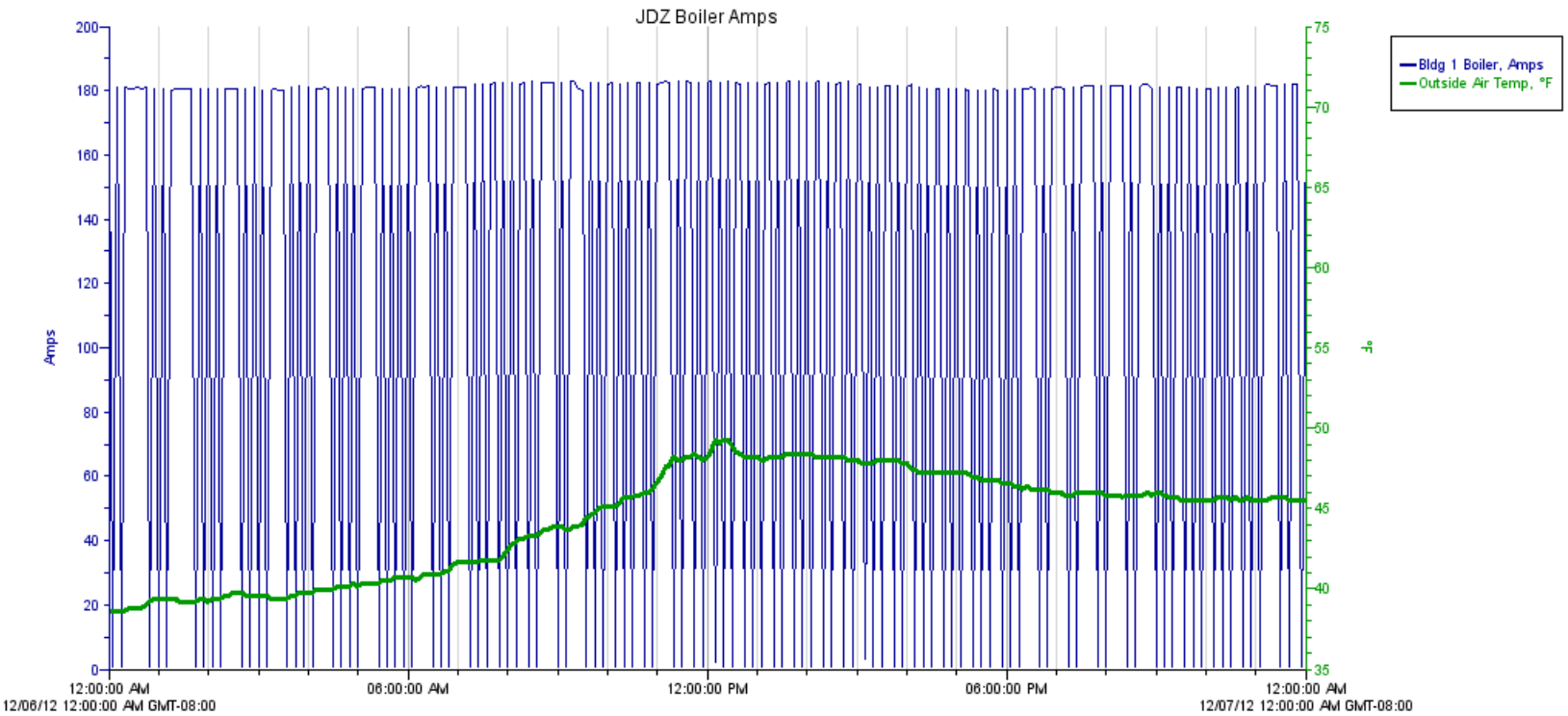
This illustrates that overnight and on weekends, the indoor air temperatures never drop below 67 deg F. This also illustrates that the boiler, boiler pumps and air handling unit fans never shut off.

EXISTING BOILER OPERATION: ONE WEEK



This graph shows the boiler Amps for the electric hot water boiler in Building 1. The boiler cycles on and off continuously, 24/7.

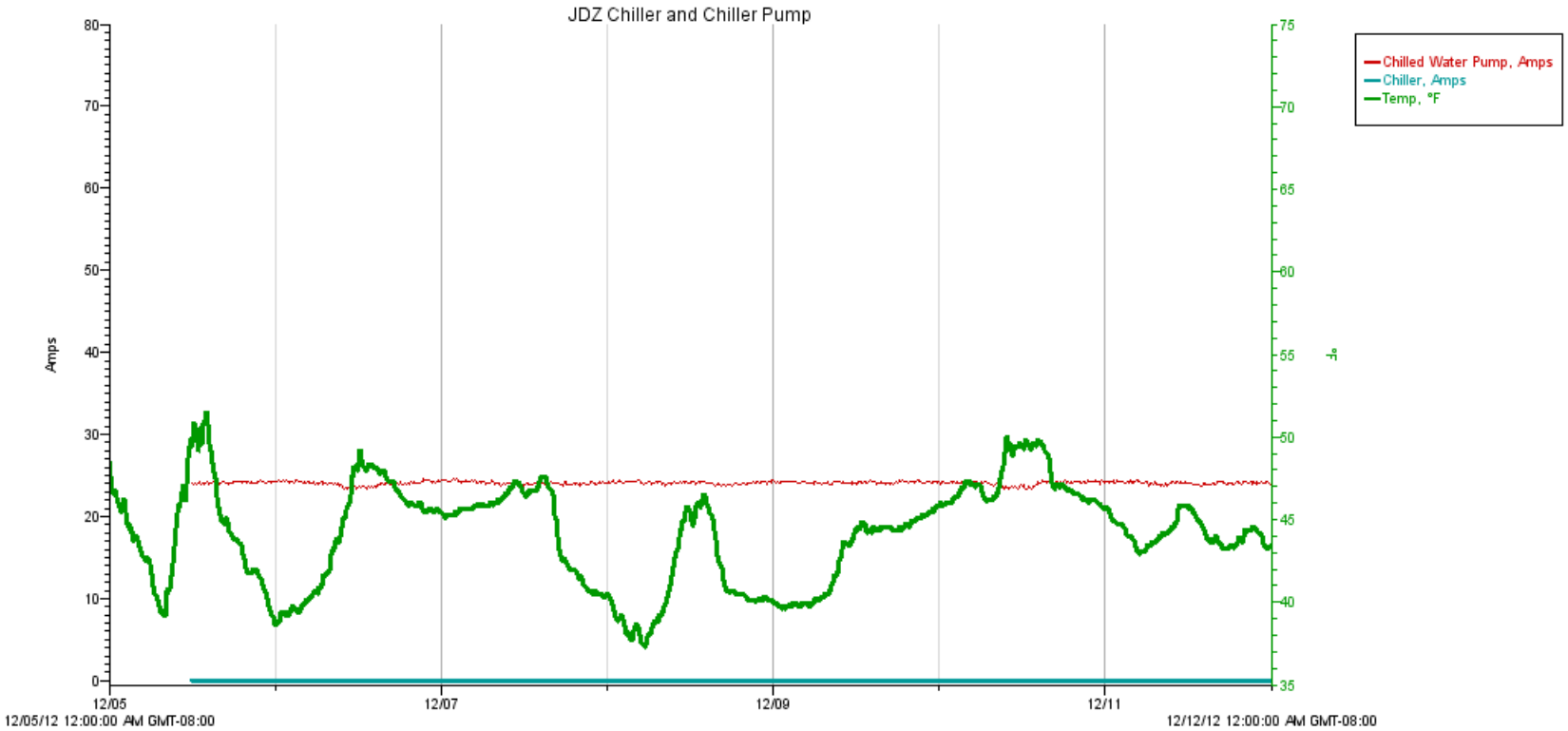
EXISTING BOILER OPERATION: ONE DAY



This graph shows the boiler Amp draw over a single day in December. The outside air is the thick green line near the bottom.

The graph shows that the boiler operates more frequently (cycles on for longer) when outside air temperatures are lower.

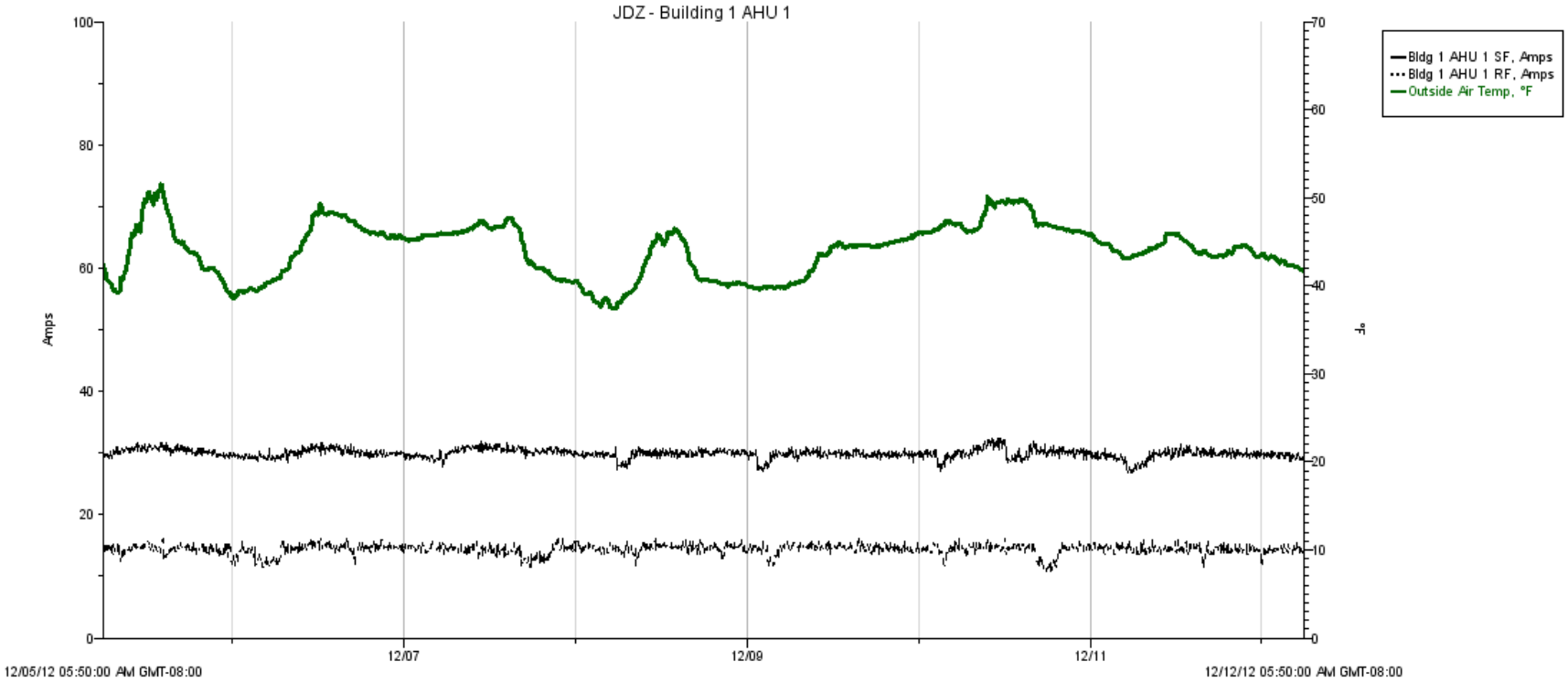
EXISTING CHILLER OPERATION: ONE WEEK



This graph shows the chiller power (teal), chilled water pump (red) and outside air (green) temperature one week in December.

This illustrates that the chiller never operated, however the chilled water pump operated continuously.

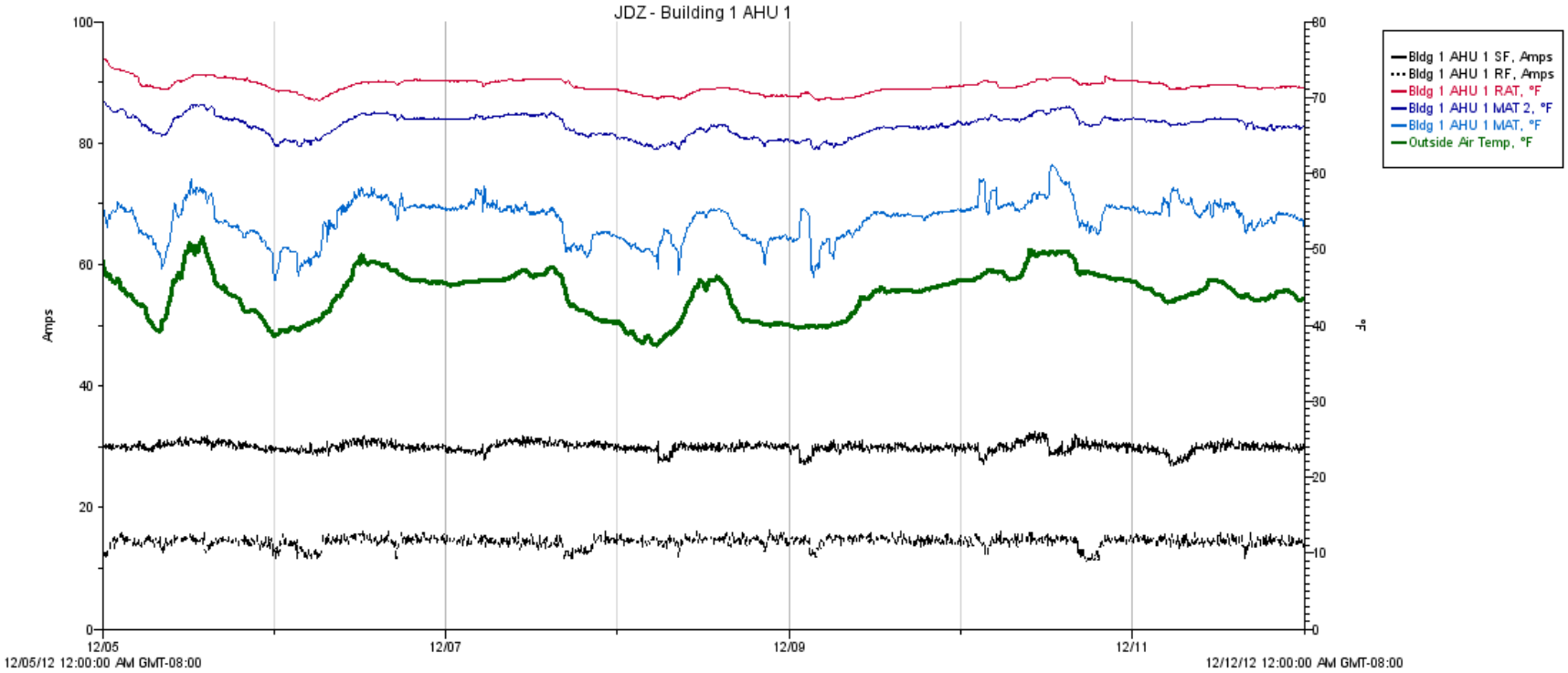
EXISTING BUILDING 1 AHU-1 OPERATION: ONE WEEK



This graph shows the AHU-1 supply and return fan power (black lines near bottom) and outside air (green) temperature one week in December.

This illustrates that AHU-1 operated continuously every day, even though occupants are present in the building only from 7am to 5pm.

EXISTING BUILDING 1 AHU-1 DETAILED OPERATION: ONE WEEK



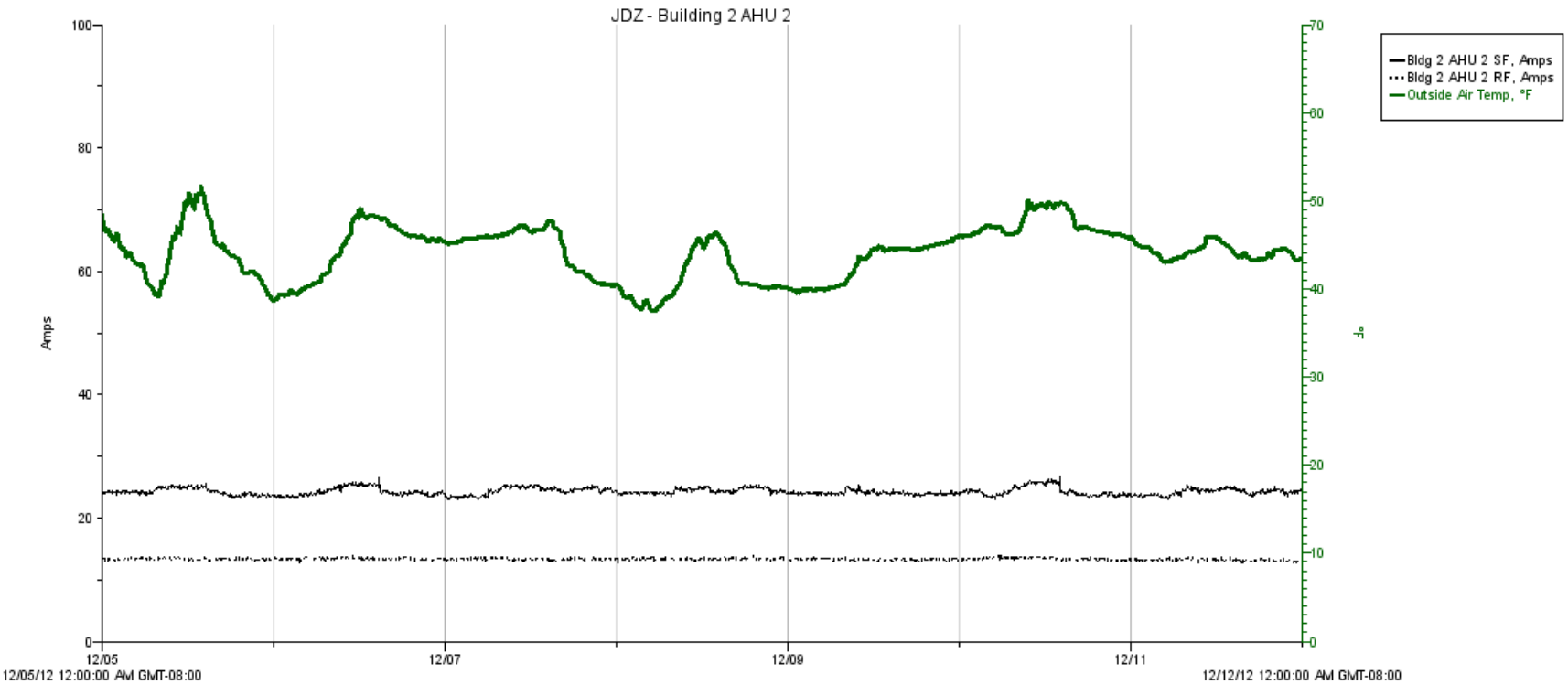
This graph shows the deatiled AHU-1 operation: supply and return fan power (black lines near bottom), outside air (green), return air (red line near the top), and the mixed air (blue lines) over a week in December.

The two black lines illustrate the fans operate continuously.

The blue lines (mixed air temperature) were averaged when used in the EEM calculations.

The red line (return air temperautre) illustrates that the return air is around 70 F to 72 F at all times.

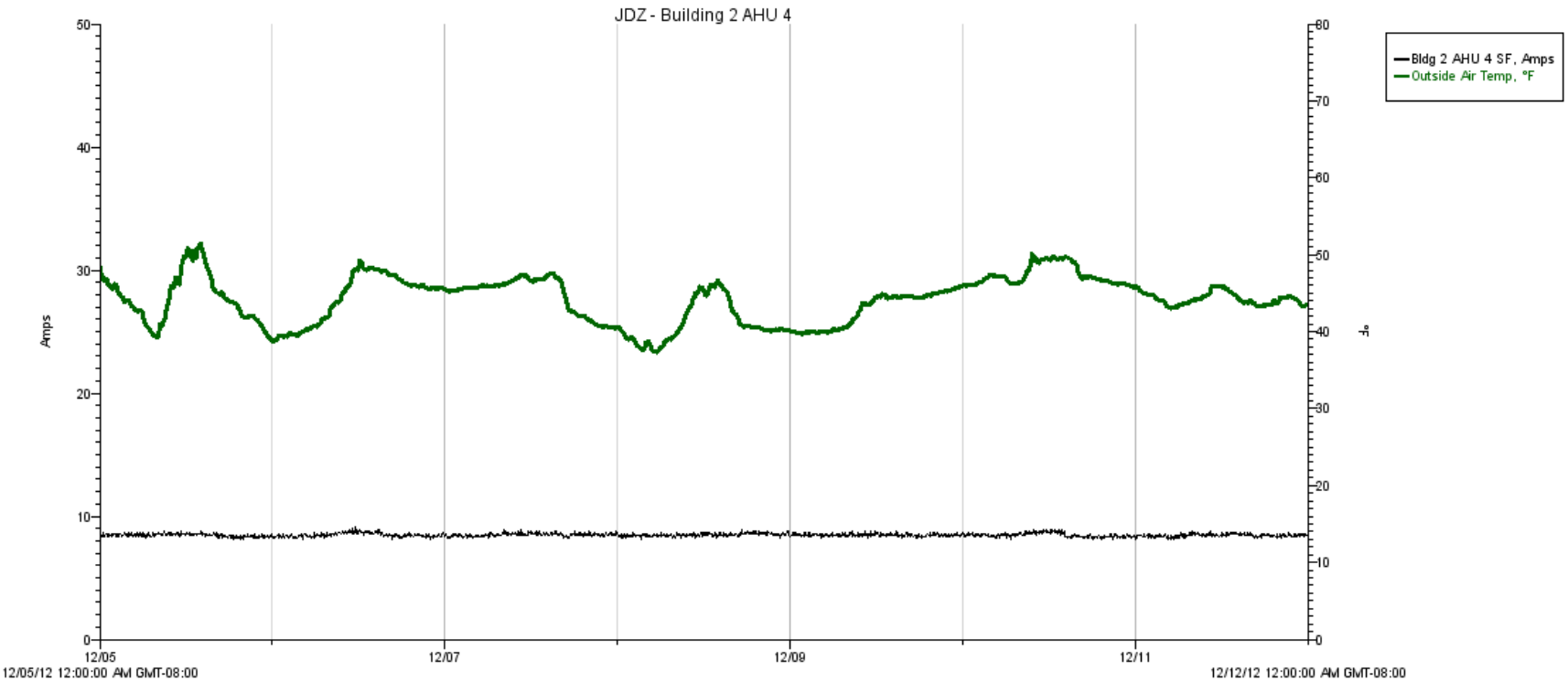
EXISTING BUILDING 2 AHU-2 OPERATION: ONE WEEK



This graph shows the AHU-2 supply and return fan power (black lines near bottom) and outside air (green) temperature one week in December.

This illustrates that AHU-2 operated continuously every day, even though occupants are present in the building only from 7am to 5pm.

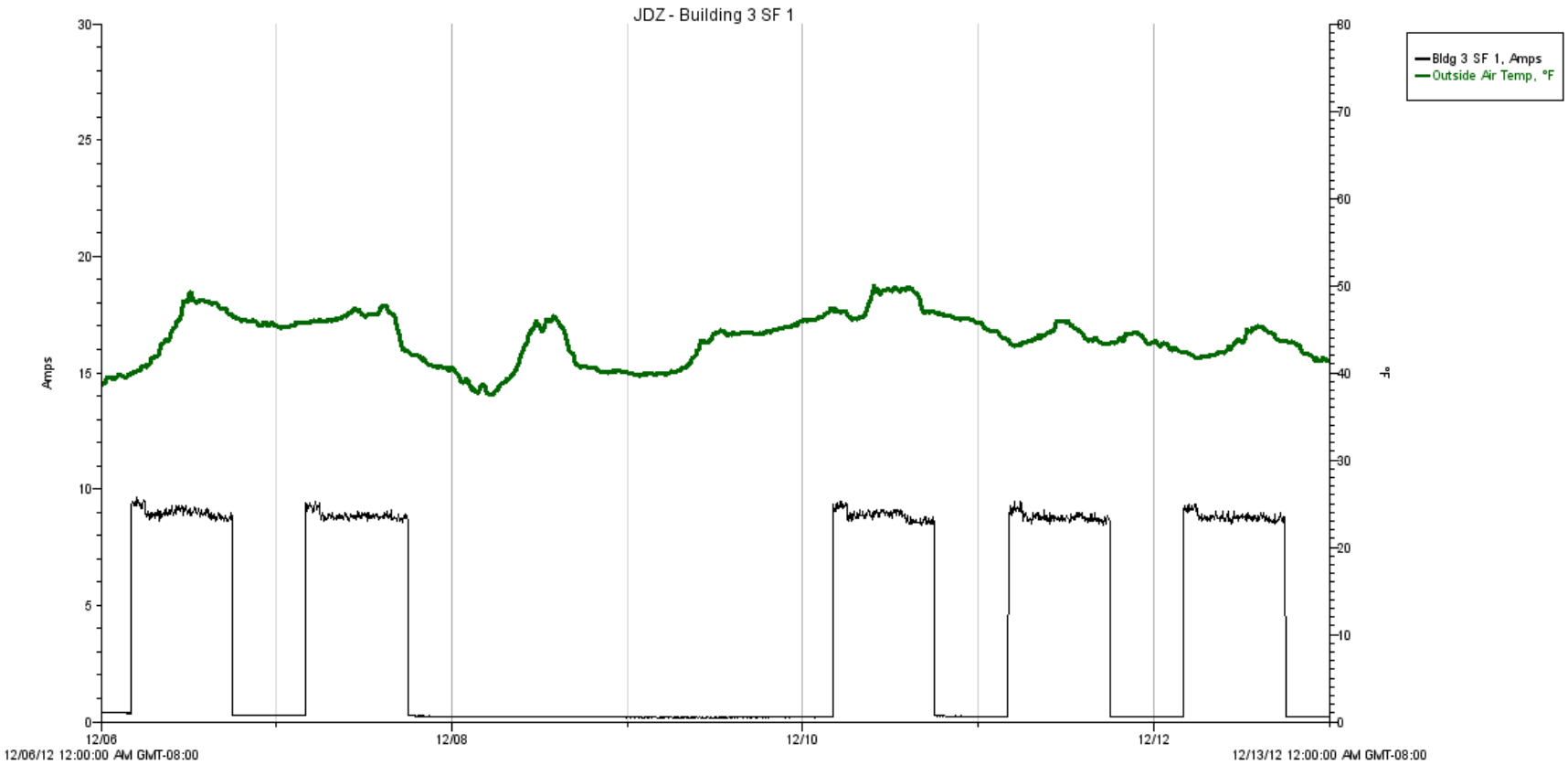
EXISTING BUILDING 2 AHU-4 OPERATION: ONE WEEK



This graph shows the AHU-4 supply and return fan power (black lines near bottom) and outside air (green) temperature one week in December.

This illustrates that AHU-4 operated continuously every day, even though occupants are present in the building only from 7am to 5pm.

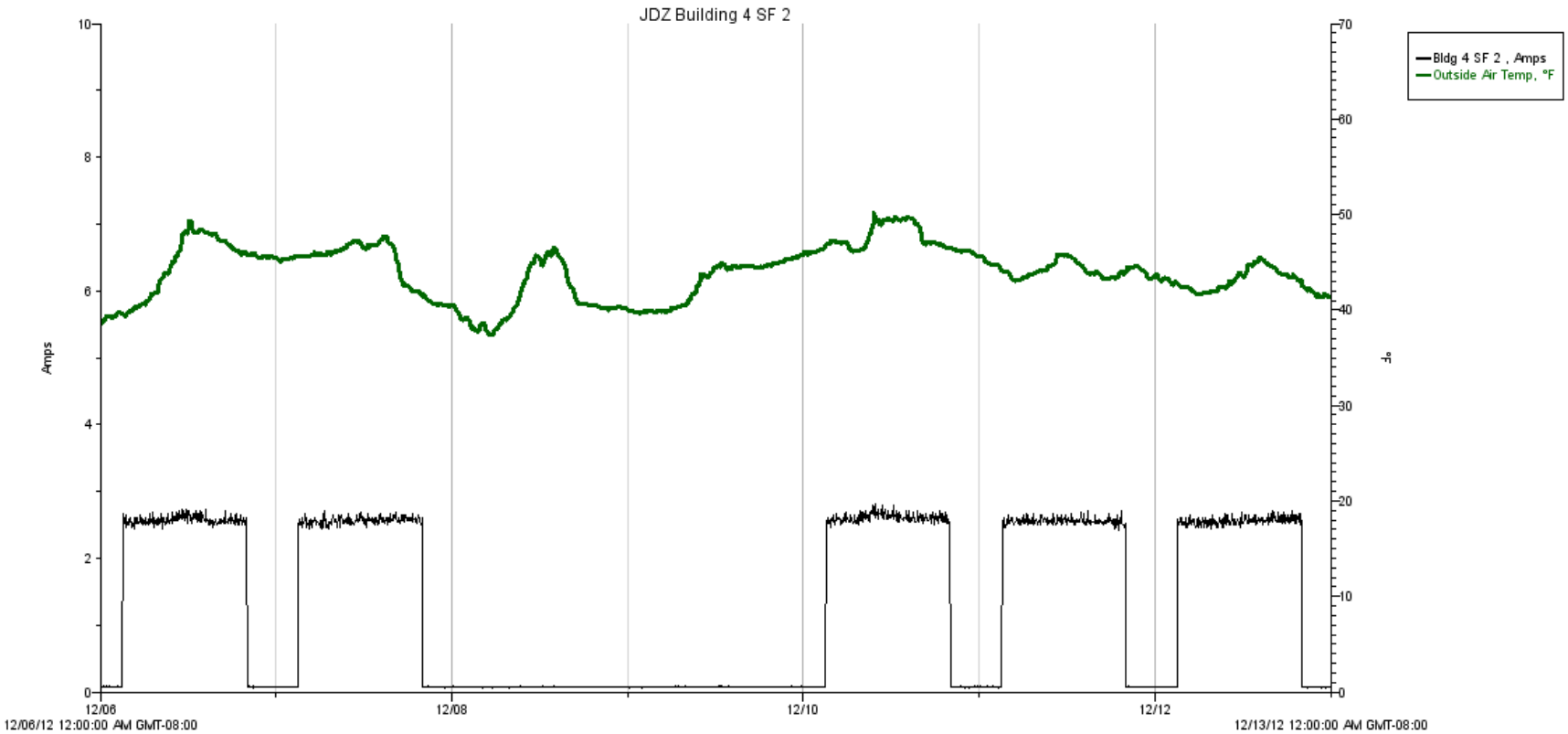
EXISTING BUILDING 3 SF-1 OPERATION: ONE WEEK



This graph shows the SF-4 supply fan power (black line near bottom) and outside air (green) temperature one week in December.

This illustrates that SF-4 operated from 4am to 6pm.

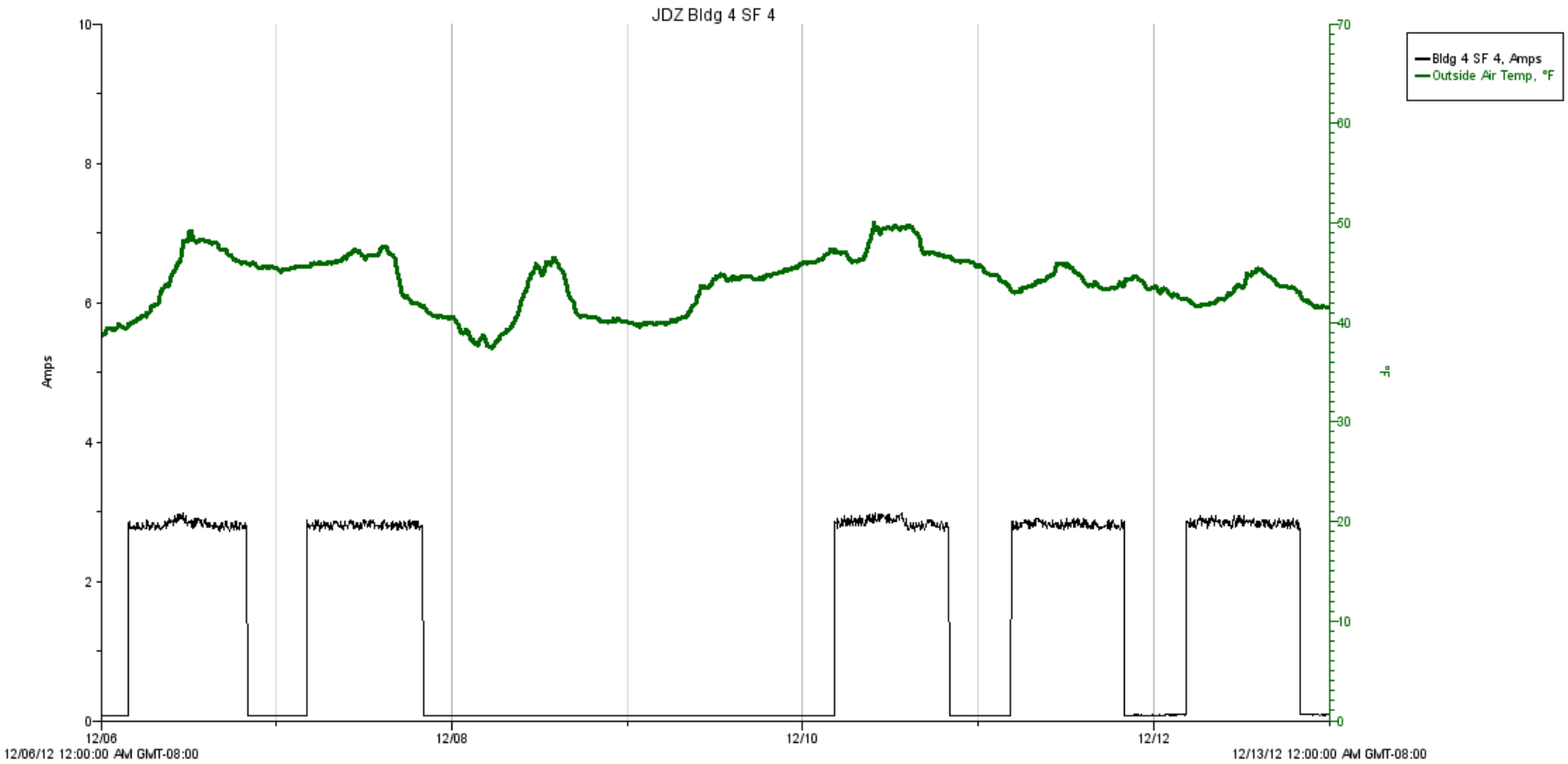
EXISTING BUILDING 4 SF-2 OPERATION: ONE WEEK



This graph shows the SF-2 supply fan power (black line near bottom) and outside air (green) temperature one week in December.

This illustrates that SF-2 operated from 3am to 8pm.

EXISTING BUILDING 4 SF-4 OPERATION: ONE WEEK



This graph shows the SF-2 supply fan power (black line near bottom) and outside air (green) temperature one week in December.

This illustrates that SF-2 operated from 3am to 8pm.

Assumptions used in detailed energy savings analysis:

Central Plant Efficiency Assumptions

Heating Efficiency	100%	
Chiller Efficiency	14.6	EER
Chiller Efficiency	0.82	kW/ton

Multizone Constant Air Volume (MZU) Air Handlers Assumptions

	Maximum Airflow (cfm)	Design Minimum Outside Air (cfm)	(%)	Supply Fan (hp)	Return Fan (hp)	Total Fan (hp)
AHU-1	9,800	1,960	20%	10	5	15
AHU-2	9,800	1,960	20%	10	5	15
TOTAL	19,600	3,920	20%	20	10	30

Constant Air Volume (CAV) Air Handlers Assumptions

	Maximum Airflow (cfm)	Design Minimum Outside Air (cfm)	(%)	Supply Fan (hp)	Return Fan (hp)	Total Fan (hp)
AHU-3	3,600	495	14%	3	1 1/2	4 1/2
AHU-4	3,000	495	17%	3	1 1/2	4 1/2
TOTAL	6,600	990	15%	6	3	9

Roof Top Unit (RTU) Air Handler Assumptions

	Maximum Airflow (cfm)	Design Minimum Outside Air (cfm)	(%)	Supply Fan (hp)	Return Fan (hp)	Total Fan (hp)	
ACU 2	1,600	240	15%	1	0	1	*Unit does not operate.
ACU 3	1,600	240	15%	1	0	1	
ACU 4	1,600	240	15%	1	0	1	*Unit does not operate.
TOTAL	4,800	720	15%	3	0	3	

The following pages will contain the detailed calculations for the existing and proposed systems in each building.

Building 1 and 2

AHU 1 and 2 - Winter – Baseline

	Assumptions		
	High Bin	Mid Bin	Low Bin
Total Airflow (%)	100%	-	100%
Outside Airflow (%)	20%	Econo	20%
RAT (F)	72	-	70
Cold Deck	55	-	59
Hot Deck	76	-	105

AHU 1 and AHU 2 Multizone with hot deck, cold deck and bypass
Operates 24/7 during the months of October - May

OAT (F)	Hours / Year	Total Airflow (%)	Total Airflow (cfm)	Fan Power (kW)	Fan Energy (kWh)	Outside Airflow (%)	Outside Airflow (cfm)	Return Air Temp (F)	Mixed Air Temp (F)	Cold Deck Temp (F)	Hot Deck Temp (F)	Supply Air Percent Cooling	Supply Air Percent Bypass	Supply Air Percent Heating	CFM of Cooling	Cooling Tons	Cooling kW	Cooling kWh	CFM of Heating	Heating (kW)	Heating (kWh)
92	0	**100%**	19,600	23	0	**20%**	3,920	**72**	76	**55**	**76**	100%	0%	0%	19,600	37	30	0	0	0	0
87	1	100%	19,600	23	23	20%	3,920	72	75	57	75	100%	0%	0%	19,600	32	26	26	0	0	0
82	10	100%	19,600	23	234	20%	3,920	72	74	59	74	80%	20%	0%	15,680	22	18	179	0	0	0
77	31	100%	19,600	23	725	20%	3,920	72	73	60	73	60%	40%	0%	11,760	13	11	342	0	0	0
72	85	100%	19,600	23	1,988	100%	19,600	72	72	62	72	40%	60%	0%	7,840	7	6	489	0	0	0
67	124	100%	19,600	23	2,900	100%	19,600	72	67	64	67	20%	80%	0%	3,920	1	1	113	0	0	0
62	279	100%	19,600	23	6,524	100%	19,600	72	62	62	62	0%	100%	0%	0	0	0	0	0	0	0
57	570	100%	19,600	23	13,329	20%	3,920	70	67	67	71	0%	93%	7%	0	0	0	0	1400	1	808
52	1,034	100%	19,600	23	24,180	20%	3,920	70	66	66	79	0%	86%	14%	0	0	0	0	2800	11	11,730
47	1,399	100%	19,600	23	32,715	20%	3,920	70	65	65	88	0%	79%	21%	0	0	0	0	4200	30	41,661
42	1,115	100%	19,600	23	26,074	20%	3,920	70	64	64	96	0%	71%	29%	0	0	0	0	5600	57	63,245
37	796	100%	19,600	23	18,614	20%	3,920	70	63	63	105	0%	64%	36%	0	0	0	0	7000	92	73,370
32	253	100%	19,600	23	5,916	20%	3,920	70	62	62	105	0%	57%	43%	0	0	0	0	8400	113	28,657
27	61	100%	19,600	23	1,426	20%	3,920	70	61	61	105	0%	50%	50%	0	0	0	0	9800	135	8,250
22	60	100%	19,600	23	1,403	20%	3,920	70	60	60	105	0%	50%	50%	0	0	0	0	9800	138	8,301
17	14	**100%**	19,600	23	327	**20%**	3,920	**70**	59	**59**	**105**	0%	50%	50%	0	0	0	0	9800	141	1,980
Total	5,832				136,381													1,150			238,003

AHU 1 and 2 - Summer – Baseline

	Assumptions		
	High Bin	Mid Bin	Low Bin
Total Airflow (%)	100%	-	100%
Outside Airflow (%)	20%	Econo	20%
RAT (F)	72	-	70
Cold Deck	55	-	59
Hot Deck	76	-	105

AHU 1 and AHU 2

Multizone with hot deck, cold deck and bypass
Operates from 5am to 9pm during the months of June - September

OAT (F)	Hours / Year	Total Airflow (%)	Total Airflow (cfm)	Fan Power (kW)	Fan Energy (kWh)	Outside Airflow (%)	Outside Airflow (cfm)	Return Air Temp (F)	Mixed Air Temp (F)	Cold Deck Temp (F)	Hot Deck Temp (F)	Supply Air Percent Cooling	Supply Air Percent Bypass	Supply Air Percent Heating	CFM of Cooling	Cooling Tons	Cooling kW	Cooling kWh	CFM of Heating	Heating (kW)	Heating (kWh)
92	13	**100%**	19,600	23	304	**20%**	3,920	**72**	76	**55**	**76**	100%	0%	0%	19,600	37	30	396	0	0	0
87	29	100%	19,600	23	678	20%	3,920	72	75	57	75	100%	0%	0%	19,600	32	26	766	0	0	0
82	80	100%	19,600	23	1,871	20%	3,920	72	74	59	74	80%	20%	0%	15,680	22	18	1,434	0	0	0
77	147	100%	19,600	23	3,438	20%	3,920	72	73	60	73	60%	40%	0%	11,760	13	11	1,622	0	0	0
72	254	100%	19,600	23	5,940	100%	19,600	72	72	62	72	40%	60%	0%	7,840	7	6	1,460	0	0	0
67	226	100%	19,600	23	5,285	100%	19,600	72	67	64	67	20%	80%	0%	3,920	1	1	206	0	0	0
62	334	100%	19,600	23	7,811	100%	19,600	72	62	62	62	0%	100%	0%	0	0	0	0	0	0	0
57	246	100%	19,600	23	5,753	20%	3,920	70	67	67	71	0%	93%	7%	0	0	0	0	1400	1	349
52	58	100%	19,600	23	1,356	20%	3,920	70	66	66	79	0%	86%	14%	0	0	0	0	2800	11	658
47	5	100%	19,600	23	117	20%	3,920	70	65	65	88	0%	79%	21%	0	0	0	0	4200	30	149
42	0	100%	19,600	23	0	20%	3,920	70	64	64	96	0%	71%	29%	0	0	0	0	5600	57	0
37	0	100%	19,600	23	0	20%	3,920	70	63	63	105	0%	64%	36%	0	0	0	0	7000	92	0
32	0	100%	19,600	23	0	20%	3,920	70	62	62	105	0%	57%	43%	0	0	0	0	8400	113	0
27	0	100%	19,600	23	0	20%	3,920	70	61	61	105	0%	50%	50%	0	0	0	0	9800	135	0
22	0	100%	19,600	23	0	20%	3,920	70	60	60	105	0%	50%	50%	0	0	0	0	9800	138	0
17	0	**100%**	19,600	23	0	**20%**	3,920	**70**	59	**59**	**105**	0%	50%	50%	0	0	0	0	9800	141	0
Total	1,392				32,552													5,885			1,156

AHU 1 and 2 - Winter – Proposed

	Assumptions		
	High Bin	Mid Bin	Low Bin
Total Airflow (%)	100%	-	100%
Outside Airflow (%)	20%	Econo	20%
RAT (F)	72	-	70
Cold Deck	55	-	59
Hot Deck	76	-	105

AHU 1 and AHU 2 Multizone with hot deck, cold deck and bypass

Schedule units to operate during occupied period from 7am to 9pm (assume unit actually run 5am to 9pm for morning warm up)

OAT (F)	Hours / Year	Total Airflow (%)	Total Airflow (cfm)	Fan Power (kW)	Fan Energy (kWh)	Outside Airflow (%)	Outside Airflow (cfm)	Return Air Temp (F)	Mixed Air Temp (F)	Cold Deck Temp (F)	Hot Deck Temp (F)	Supply Air Percent Cooling	Supply Air Percent Bypass	Supply Air Percent Heating	CFM of Cooling	Cooling Tons	Cooling kW	Cooling kWh	CFM of Heating	Heating (kW)	Heating (kWh)
92	0	**100%**	19,600	23	0	**20%**	3,920	**72**	76	**55**	**76**	100%	0%	0%	19,600	37	30	0	0	0	0
87	0	100%	19,600	23	0	20%	3,920	72	75	57	75	100%	0%	0%	19,600	32	26	0	0	0	0
82	6	100%	19,600	23	140	20%	3,920	72	74	59	74	80%	20%	0%	15,680	22	18	108	0	0	0
77	20	100%	19,600	23	468	20%	3,920	72	73	60	73	60%	40%	0%	11,760	13	11	221	0	0	0
72	61	100%	19,600	23	1,421	100%	19,600	72	72	62	72	40%	60%	0%	7,840	7	6	349	0	0	0
67	71	100%	19,600	23	1,649	100%	19,600	72	67	64	67	20%	80%	0%	3,920	1	1	64	0	0	0
62	146	100%	19,600	23	3,414	100%	19,600	72	62	62	62	0%	100%	0%	0	0	0	0	0	0	0
57	237	100%	19,600	23	5,542	20%	3,920	70	67	67	71	0%	93%	7%	0	0	0	0	1400	1	336
52	465	100%	19,600	23	10,874	20%	3,920	70	66	66	79	0%	86%	14%	0	0	0	0	2800	11	5,275
47	486	100%	19,600	23	11,359	20%	3,920	70	65	65	88	0%	79%	21%	0	0	0	0	4200	30	14,465
42	394	100%	19,600	23	9,220	20%	3,920	70	64	64	96	0%	71%	29%	0	0	0	0	5600	57	22,363
37	239	100%	19,600	23	5,595	20%	3,920	70	63	63	105	0%	64%	36%	0	0	0	0	7000	92	22,053
32	76	100%	19,600	23	1,777	20%	3,920	70	62	62	105	0%	57%	43%	0	0	0	0	8400	113	8,608
27	21	100%	19,600	23	497	20%	3,920	70	61	61	105	0%	50%	50%	0	0	0	0	9800	135	2,874
22	25	100%	19,600	23	573	20%	3,920	70	60	60	105	0%	50%	50%	0	0	0	0	9800	138	3,390
17	3	**100%**	19,600	23	64	**20%**	3,920	**70**	59	**59**	**105**	0%	50%	50%	0	0	0	0	9800	141	389
Total	2,249				52,593												0	742		0	79,753
				Saved	83,788												Saved	408		Saved	158,250

AHU 1 and 2 - Summer - Baseline

	Assumptions		
	High Bin	Mid Bin	Low Bin
Total Airflow (%)	100%	-	100%
Outside Airflow (%)	20%	Econo	20%
RAT (F)	72	-	70
Cold Deck	55	-	59
Hot Deck	76	-	105

AHU 1 and AHU 2 Multizone with hot deck, cold deck and bypass

Schedule units to operate during occupied period from 7am to 9pm (assume unit actually run 5am to 9pm for morning warm up)

OAT (F)	Hours / Year	Total Airflow (%)	Total Airflow (cfm)	Fan Power (kW)	Fan Energy (kWh)	Outside Airflow (%)	Outside Airflow (cfm)	Return Air Temp (F)	Mixed Air Temp (F)	Cold Deck Temp (F)	Hot Deck Temp (F)	Supply Air Percent Cooling	Supply Air Percent Bypass	Supply Air Percent Heating	CFM of Cooling	Cooling Tons	Cooling kW	Cooling kWh	CFM of Heating	Heating (kW)	Heating (kWh)
92	13	**100%**	19,600	23	304	**20%**	3,920	**72**	76	**55**	**76**	100%	0%	0%	19,600	37	30	396	0	0	0
87	25	100%	19,600	23	590	20%	3,920	72	75	57	75	100%	0%	0%	19,600	32	26	667	0	0	0
82	70	100%	19,600	23	1,625	20%	3,920	72	74	59	74	80%	20%	0%	15,680	22	18	1,246	0	0	0
77	118	100%	19,600	23	2,754	20%	3,920	72	73	60	73	60%	40%	0%	11,760	13	11	1,299	0	0	0
72	194	100%	19,600	23	4,537	100%	19,600	72	72	62	72	40%	60%	0%	7,840	7	6	1,115	0	0	0
67	167	100%	19,600	23	3,899	100%	19,600	72	67	64	67	20%	80%	0%	3,920	1	1	152	0	0	0
62	273	100%	19,600	23	6,372	100%	19,600	72	62	62	62	0%	100%	0%	0	0	0	0	0	0	0
57	213	100%	19,600	23	4,981	20%	3,920	70	67	67	71	0%	93%	7%	0	0	0	0	1400	1	302
52	54	100%	19,600	23	1,269	20%	3,920	70	66	66	79	0%	86%	14%	0	0	0	0	2800	11	615
47	5	100%	19,600	23	117	20%	3,920	70	65	65	88	0%	79%	21%	0	0	0	0	4200	30	149
42	0	100%	19,600	23	0	20%	3,920	70	64	64	96	0%	71%	29%	0	0	0	0	5600	57	0
37	0	100%	19,600	23	0	20%	3,920	70	63	63	105	0%	64%	36%	0	0	0	0	7000	92	0
32	0	100%	19,600	23	0	20%	3,920	70	62	62	105	0%	57%	43%	0	0	0	0	8400	113	0
27	0	100%	19,600	23	0	20%	3,920	70	61	61	105	0%	50%	50%	0	0	0	0	9800	135	0
22	0	100%	19,600	23	0	20%	3,920	70	60	60	105	0%	50%	50%	0	0	0	0	9800	138	0
17	0	**100%**	19,600	23	0	**20%**	3,920	**70**	59	**59**	**105**	0%	50%	50%	0	0	0	0	9800	141	0
Total	1,131				26,448												0	4,876		0	1,066
				Saved	6,103												Saved	1,009		Saved	89

AHU 3 and 4 – Winter – Baseline

	Assumptions		
	High Bin	Mid Bin	Low Bin
Total Airflow	100%	-	100%
Outside Airflow (%)	15%	Econo	15%
RAT (F)	72	-	70
SAT (F)	55	-	65
Air Re-heated (%)	0%	-	50%
Air Re-heated Temp (F)	55	-	80

AHU 3 and AHU 4

Constant volume with cooling only at unit and electric duct reheat
Operates 24/7 during the months of October - June

OAT (F)	Hours / Year	Total Airflow (%)	Total Airflow (cfm)	Fan Power (kW)	Fan Energy (kWh)	Outside Airflow (%)	Outside Airflow (cfm)	Return Air Temp (F)	Mixed Air Temp (F)	AHU Supply Air Temp (F)	Cooling (Btus/hr)	Cooling (Tons)	Cooling Power (kW)	Cooling Energy (kWh)	Air Reheated (%)	Air Reheated (cfm)	Air Reheated Temp (F)	Reheat Energy (kW)	Reheat Energy (kWh)
92	0	**100%**	6,600	7	0	**15%**	990	**72**	75	**55**	142,560	12	10	0	**0%**	0	**55**	0	0
87	1	100%	6,600	7	7	15%	990	72	74	57	124,587	10	9	9	0%	0	57	0	0
82	10	100%	6,600	7	73	15%	990	72	74	59	106,615	9	7	73	0%	0	59	0	0
77	31	100%	6,600	7	227	15%	990	72	73	60	88,642	7	6	188	0%	0	60	0	0
72	85	100%	6,600	7	622	100%	6,600	72	72	62	70,669	6	5	411	0%	0	62	0	0
67	124	100%	6,600	7	908	100%	6,600	72	67	64	22,402	2	2	190	0%	0	64	0	0
62	279	100%	6,600	7	2,043	100%	6,600	72	62	62	0	0	0	0	5%	330	70	1	233
57	570	100%	6,600	7	4,173	20%	1,320	70	67	67	0	0	0	0	10%	660	72	1	508
52	1,034	100%	6,600	7	7,570	15%	990	70	67	67	0	0	0	0	15%	990	73	2	1,955
47	1,399	100%	6,600	7	10,242	15%	990	70	67	67	0	0	0	0	20%	1,320	75	4	4,939
42	1,115	100%	6,600	7	8,163	15%	990	70	66	66	0	0	0	0	25%	1,650	77	6	6,328
37	796	100%	6,600	7	5,827	15%	990	70	65	65	0	0	0	0	30%	1,980	78	8	6,627
32	253	100%	6,600	7	1,852	15%	990	70	64	64	0	0	0	0	35%	2,310	80	11	2,904
27	61	100%	6,600	7	447	15%	990	70	64	64	0	0	0	0	40%	2,640	82	15	923
22	60	100%	6,600	7	439	15%	990	70	63	63	0	0	0	0	45%	2,970	83	19	1,158
17	14	**100%**	6,600	7	102	**15%**	990	**70**	62	**65**	0	0	0	0	**50%**	3,300	**80**	16	219
Total	5,832				42,696									871					25,796

AHU 3 and 4 – Summer – Baseline

	Assumptions		
	High Bin	Mid Bin	Low Bin
Total Airflow (%)	100%	-	100%
Outside Airflow (%)	15%	Econo	15%
RAT (F)	72	-	70
SAT (F)	55	-	65
Air Re-heated (%)	0%	-	50%
Air Re-heated Temp (F)	60	-	80

AHU 3 and AHU 4

Constant volume with cooling only at unit and electric duct reheat
Operates from 5am to 9pm during the months of June - September

OAT (F)	Hours / Year	Total Airflow (%)	Total Airflow (cfm)	Fan Power (kW)	Fan Energy (kWh)	Outside Airflow (%)	Outside Airflow (cfm)	Return Air Temp (F)	Mixed Air Temp (F)	AHU Supply Air Temp (F)	Cooling (Btus/hr)	Cooling (Tons)	Cooling Power (kW)	Cooling Energy (kWh)	Air Reheated (%)	Air Reheated (cfm)	Air Reheated Temp (F)	Reheat Energy (kW)	Reheat Energy (kWh)
92	13	**100%**	6,600	7	95	**15%**	990	**72**	75	**55**	142,560	12	10	127	**0%**	0	55	0	0
87	29	100%	6,600	7	212	15%	990	72	74	57	124,587	10	9	247	0%	0	57	0	0
82	80	100%	6,600	7	586	15%	990	72	74	59	106,615	9	7	584	0%	0	59	0	0
77	147	100%	6,600	7	1,076	15%	990	72	73	60	88,642	7	6	892	0%	0	60	0	0
72	254	100%	6,600	7	1,860	100%	6,600	72	72	62	70,669	6	5	1,229	0%	0	62	0	0
67	226	100%	6,600	7	1,655	100%	6,600	72	67	64	22,402	2	2	347	0%	0	64	0	0
62	334	100%	6,600	7	2,445	100%	6,600	72	62	62	0	0	0	0	5%	330	70	1	279
57	246	100%	6,600	7	1,801	20%	1,320	70	67	67	0	0	0	0	10%	660	72	1	219
52	58	100%	6,600	7	425	15%	990	70	67	67	0	0	0	0	15%	990	73	2	110
47	5	100%	6,600	7	37	15%	990	70	67	67	0	0	0	0	20%	1,320	75	4	18
42	0	100%	6,600	7	0	15%	990	70	66	66	0	0	0	0	25%	1,650	77	6	0
37	0	100%	6,600	7	0	15%	990	70	65	65	0	0	0	0	30%	1,980	78	8	0
32	0	100%	6,600	7	0	15%	990	70	64	64	0	0	0	0	35%	2,310	80	11	0
27	0	100%	6,600	7	0	15%	990	70	64	64	0	0	0	0	40%	2,640	82	15	0
22	0	100%	6,600	7	0	15%	990	70	63	63	0	0	0	0	45%	2,970	83	19	0
17	0	**100%**	6,600	7	0	**15%**	990	**70**	62	**65**	0	0	0	0	50%	3,300	**80**	16	0
Total	1,392				10,191									3,427					626

AHU 3 and 4 – Winter – Proposed

	Assumptions		
	High Bin	Mid Bin	Low Bin
Total Airflow (%)	100%	-	100%
Outside Airflow (%)	15%	Econo	15%
RAT (F)	72	-	70
SAT (F)	55	-	65
Air Re-heated (%)	0%	-	50%
Air Re-heated Temp (F)	55	-	80

HU 3 and AHU 4 Constant volume with cooling only at unit and electric duct reheat

Schedule units to operate during occupied period from 7am to 9pm (assume unit actually run 5am to 9pm for morning warm up)

OAT (F)	Hours / Year	Total Airflow (%)	Total Airflow (cfm)	Fan Power (kW)	Fan Energy (kWh)	Outside Airflow (%)	Outside Airflow (cfm)	Return Air Temp (F)	Mixed Air Temp (F)	AHU Supply Air Temp (F)	Cooling (Btus/hr)	Cooling (Tons)	Cooling Power (kW)	Cooling Energy (kWh)	Air Reheated (%)	Air Reheated (cfm)	Air Reheated Temp (F)	Reheat Energy (kW)	Reheat Energy (kWh)
92	0	**100%**	6,600	7	0	**15%**	990	**72**	75	**55**	142,560	12	10	0	**0%**	0	**55**	0	0
87	0	100%	6,600	7	0	15%	990	72	74	57	124,587	10	9	0	0%	0	57	0	0
82	6	100%	6,600	7	44	15%	990	72	74	59	106,615	9	7	44	0%	0	59	0	0
77	20	100%	6,600	7	146	15%	990	72	73	60	88,642	7	6	121	0%	0	60	0	0
72	61	100%	6,600	7	445	100%	6,600	72	72	62	70,669	6	5	294	0%	0	62	0	0
67	71	100%	6,600	7	516	100%	6,600	72	67	64	22,402	2	2	108	0%	0	64	0	0
62	146	100%	6,600	7	1,069	100%	6,600	72	62	62	0	0	0	0	5%	330	70	1	122
57	237	100%	6,600	7	1,735	20%	1,320	70	67	67	0	0	0	0	10%	660	72	1	211
52	465	100%	6,600	7	3,404	15%	990	70	67	67	0	0	0	0	15%	990	73	2	879
47	486	100%	6,600	7	3,556	15%	990	70	67	67	0	0	0	0	20%	1,320	75	4	1,715
42	394	100%	6,600	7	2,886	15%	990	70	66	66	0	0	0	0	25%	1,650	77	6	2,238
37	239	100%	6,600	7	1,752	15%	990	70	65	65	0	0	0	0	30%	1,980	78	8	1,992
32	76	100%	6,600	7	556	15%	990	70	64	64	0	0	0	0	35%	2,310	80	11	872
27	21	100%	6,600	7	156	15%	990	70	64	64	0	0	0	0	40%	2,640	82	15	322
22	25	100%	6,600	7	179	15%	990	70	63	63	0	0	0	0	45%	2,970	83	19	473
17	3	**100%**	6,600	7	20	**15%**	990	**70**	62	**65**	0	0	0	0	**50%**	3,300	**80**	16	43
Total	2,249				16,465								0	567				0	8,867
				Saved	26,231								Saved	304				Saved	16,929

AHU 3 and 4 – Summer - Proposed

	Assumptions		
	High Bin	Mid Bin	Low Bin
Total Airflow (%)	100%	-	100%
Outside Airflow (%)	15%	Econo	15%
RAT (F)	72	-	70
SAT (F)	55	-	65
Air Re-heated (%)	0%	-	50%
Air Re-heated Temp (F)	60	-	80

AHU 3 and AHU 4 Constant volume with cooling only at unit and electric duct reheat

Schedule units to operate during occupied period from 7am to 9pm (assume unit actually run 5am to 9pm for morning warm up)

OAT (F)	Hours / Year	Total Airflow (%)	Total Airflow (cfm)	Fan Power (kW)	Fan Energy (kWh)	Outside Airflow (%)	Outside Airflow (cfm)	Return Air Temp (F)	Mixed Air Temp (F)	AHU Supply Air Temp (F)	Cooling (Btus/hr)	Cooling (Tons)	Cooling Power (kW)	Cooling Energy (kWh)	Air Reheated (%)	Air Reheated (cfm)	Air Reheated Temp (F)	Reheat Energy (kW)	Reheat Energy (kWh)
92	13	**100%**	6,600	7	95	15%	990	**72**	75	**55**	142,560	12	10	127	**0%**	0	55	0	0
87	25	100%	6,600	7	185	15%	990	72	74	57	124,587	10	9	215	0%	0	57	0	0
82	70	100%	6,600	7	509	15%	990	72	74	59	106,615	9	7	508	0%	0	59	0	0
77	118	100%	6,600	7	862	15%	990	72	73	60	88,642	7	6	715	0%	0	60	0	0
72	194	100%	6,600	7	1,420	100%	6,600	72	72	62	70,669	6	5	939	0%	0	62	0	0
67	167	100%	6,600	7	1,221	100%	6,600	72	67	64	22,402	2	2	256	0%	0	64	0	0
62	273	100%	6,600	7	1,995	100%	6,600	72	62	62	0	0	0	0	5%	330	70	1	228
57	213	100%	6,600	7	1,559	20%	1,320	70	67	67	0	0	0	0	10%	660	72	1	190
52	54	100%	6,600	7	397	15%	990	70	67	67	0	0	0	0	15%	990	73	2	103
47	5	100%	6,600	7	37	15%	990	70	67	67	0	0	0	0	20%	1,320	75	4	18
42	0	100%	6,600	7	0	15%	990	70	66	66	0	0	0	0	25%	1,650	77	6	0
37	0	100%	6,600	7	0	15%	990	70	65	65	0	0	0	0	30%	1,980	78	8	0
32	0	100%	6,600	7	0	15%	990	70	64	64	0	0	0	0	35%	2,310	80	11	0
27	0	100%	6,600	7	0	15%	990	70	64	64	0	0	0	0	40%	2,640	82	15	0
22	0	100%	6,600	7	0	15%	990	70	63	63	0	0	0	0	45%	2,970	83	19	0
17	0	**100%**	6,600	7	0	15%	990	**70**	62	**65**	0	0	0	0	50%	3,300	**80**	16	0
Total	1,131				8,280								0	2,760				0	538
				Saved	1,911								Saved	668				Saved	88

Chilled Water Pump – Baseline

Existing	Chiller Pump Operates 24/7		
OAT (F)	Hours / Year	kW	kWh
92	25	2.8	69
87	54	2.8	149
82	146	2.8	402
77	246	2.8	678
72	462	2.8	1,273
67	496	2.8	1,367
62	1,049	2.8	2,890
57	1,288	2.8	3,549
52	1,259	2.8	3,469
47	1,436	2.8	3,956
42	1,115	2.8	3,072
37	796	2.8	2,193
32	253	2.8	697
27	61	2.8	168
22	60	2.8	165
17	14	2.8	39
Total	8,760		24,135

Chilled Water Pump – Proposed

Occupied

Proposed	Chiller pump lock out at 65 degf. Chiller operates under 35 degF for freeze protection.		
OAT (F)	Hours / Year	kW	kWh
92	13	2.8	36
87	24	2.8	66
82	72	2.8	198
77	127	2.8	350
72	231	2.8	636
67	209	2.8	576
62	0	2.8	0
57	0	2.8	0
52	0	2.8	0
47	0	2.8	0
42	0	2.8	0
37	0	2.8	0
32	43	2.8	118
27	10	2.8	28
22	19	2.8	52
17	0	2.8	0
	748		2,061

Unoccupied

Proposed	Chiller operates under 35 degF for freeze protection		
OAT (F)	Hours / Year	kW	kWh
92	0	2.8	0
87	0	2.8	0
82	0	2.8	0
77	0	2.8	0
72	0	2.8	0
67	0	2.8	0
62	0	2.8	0
57	0	2.8	0
52	0	2.8	0
47	0	2.8	0
42	0	2.8	0
37	0	2.8	0
32	210	2.8	579
27	51	2.8	141
22	41	2.8	113
17	14	2.8	39
	316		871
Total Proposed Annual kWH			2,931
Saved			21,203

Building 3

SF 1 and SF 2 – Baseline

	Assumptions		
	High Bin	Mid Bin	Low Bin
Total Airflow (%)	100%	-	100%
Outside Airflow (%)	15%	Econo	15%
RAT (F)	72	-	70
SAT (F)	55	-	59
Air Re-heated (%)	0%	-	90%
Air Re-heated Temp (F)	55	-	80

SF 1 and SF 2 Constant volume with cooling only at unit and hot water reheat from natural gas boiler
Operates 4am to 6pm M-F

OAT (F)	Hours / Year	Total Airflow (%)	Total Airflow (cfm)	Fan Power (kW)	Fan Energy (kWh)	Outside Airflow (%)	Outside Airflow (cfm)	Return Air Temp (F)	Mixed Air Temp (F)	AHU Supply Air Temp (F)	Cooling (Btus/hr)	Cooling (Tons)	Cooling Power (kW)	Cooling Energy (kWh)	Air Reheated (%)	Air Reheated (cfm)	Air Reheated Temp (F)	Reheat Energy (BTU/h)	Reheat Energy (Therms)
92	13	100%	15,050	9.3	121	**15%**	2,258	**72**	75	**55**	325,080	27	31	402	**0%**	0	**55**	0	0
87	29	100%	15,050	9.3	271	15%	2,258	72	74	57	284,097	24	27	785	0%	0	57	0	0
82	79	100%	15,050	9.3	738	15%	2,258	72	74	59	243,113	20	23	1,829	0%	0	59	0	0
77	145	100%	15,050	9.3	1,354	15%	2,258	72	73	60	202,130	17	19	2,791	0%	0	60	0	0
72	263	100%	15,050	9.3	2,456	100%	15,050	72	72	62	161,147	13	15	4,036	0%	0	62	0	0
67	236	100%	15,050	9.3	2,204	100%	15,050	72	67	64	51,084	4	5	1,148	0%	0	64	0	0
62	430	100%	15,050	9.3	4,016	15%	2,258	72	71	71	0	0	0	0	5%	753	71	0	0
57	490	100%	15,050	9.3	4,576	15%	2,258	70	68	68	0	0	0	0	14%	2,174	72	8,230	52
52	573	100%	15,050	9.3	5,351	15%	2,258	70	67	67	0	0	0	0	24%	3,595	73	20,623	151
47	528	100%	15,050	9.3	4,931	15%	2,258	70	67	67	0	0	0	0	33%	5,017	74	38,558	261
42	436	100%	15,050	9.3	4,072	15%	2,258	70	66	66	0	0	0	0	43%	6,438	75	62,037	347
37	269	100%	15,050	9.3	2,512	15%	2,258	70	65	65	0	0	0	0	52%	7,859	76	91,060	314
32	94	100%	15,050	9.3	878	15%	2,258	70	64	64	0	0	0	0	62%	9,281	77	125,625	151
27	26	100%	15,050	9.3	243	15%	2,258	70	64	64	0	0	0	0	71%	10,702	78	165,735	55
22	26	100%	15,050	9.3	243	15%	2,258	70	63	63	0	0	0	0	81%	12,124	79	211,387	70
17	3	100%	15,050	9.3	28	**15%**	2,258	**70**	62	**62**	0	0	0	0	**90%**	13,545	**80**	262,583	10
Total	3,640				33,993									10,992					1,412

SF 1 and 2 – Proposed

	Assumptions		
	High Bin	Mid Bin	Low Bin
Total Airflow (%)	100%	-	100%
Outside Airflow (%)	15%	Econo	15%
RAT (F)	72	-	70
SAT (F)	55	-	59
Air Re-heated (%)	0%	-	90%
Air Re-heated Temp (F)	55	-	80

SF 1 and SF 2 Constant volume with cooling only at unit and hot water reheat from natural gas boiler
Schedule 6am to 6pm

OAT (F)	Hours / Year	Total Airflow (%)	Total Airflow (cfm)	Fan Power (kW)	Fan Energy (kWh)	Outside Airflow (%)	Outside Airflow (cfm)	Return Air Temp (F)	Mixed Air Temp (F)	AHU Supply Air Temp (F)	Cooling (Btus/hr)	Cooling (Tons)	Cooling Power (kW)	Cooling Energy (kWh)	Air Reheated (%)	Air Reheated (cfm)	Air Reheated Temp (F)	Reheat Energy (BTU/h)	Reheat Energy (Therms)
92	13	100%	15,050	9.3	121	**15%**	2,258	**72**	75	**55**	325,080	27	31	402	**0%**	0	**55**	0	0
87	29	100%	15,050	9.3	271	15%	2,258	72	74	57	284,097	24	27	785	0%	0	57	0	0
82	79	100%	15,050	9.3	738	15%	2,258	72	74	59	243,113	20	23	1,829	0%	0	59	0	0
77	145	100%	15,050	9.3	1,354	15%	2,258	72	73	60	202,130	17	19	2,791	0%	0	60	0	0
72	263	100%	15,050	9.3	2,456	100%	15,050	72	72	62	161,147	13	15	4,036	0%	0	62	0	0
67	234	100%	15,050	9.3	2,185	100%	15,050	72	67	64	51,084	4	5	1,138	0%	0	64	0	0
62	400	100%	15,050	9.3	3,736	15%	2,258	70	69	69	0	0	0	0	5%	753	69	0	0
57	398	100%	15,050	9.3	3,717	15%	2,258	70	68	68	0	0	0	0	14%	2,174	70	4,239	22
52	470	100%	15,050	9.3	4,389	15%	2,258	70	67	67	0	0	0	0	24%	3,595	71	14,022	84
47	448	100%	15,050	9.3	4,184	15%	2,258	70	67	67	0	0	0	0	33%	5,017	72	29,348	169
42	346	100%	15,050	9.3	3,231	15%	2,258	70	66	66	0	0	0	0	43%	6,438	73	50,217	223
37	194	100%	15,050	9.3	1,812	15%	2,258	70	65	65	0	0	0	0	52%	7,859	74	76,630	191
32	61	100%	15,050	9.3	570	15%	2,258	70	64	64	0	0	0	0	62%	9,281	75	108,586	85
27	16	100%	15,050	9.3	149	15%	2,258	70	64	64	0	0	0	0	71%	10,702	76	146,085	30
22	23	100%	15,050	9.3	215	15%	2,258	70	63	63	0	0	0	0	81%	12,124	77	189,128	56
17	1	100%	15,050	9.3	9	**15%**	2,258	**70**	62	**62**	0	0	0	0	**90%**	13,545	**80**	262,583	3
Total	3,120				29,137								0	10,982					862
				Saved	4,856								Saved	10				Saved	550

SF 3 – Baseline

	Assumptions		
	High Bin	Mid Bin	Low Bin
Total Airflow (%)	100%	-	100%
Outside Airflow (%)	15%	Econo	15%
RAT (F)	72	-	70
SAT (F)	55	-	68
Air Re-heated (%)	0%	-	90%
Air Re-heated Temp (F)	55	-	80

SF 3 Constant volume with cooling only at unit and hot water reheat from natural gas boiler
Operates 5am to 6pm M-F

OAT (F)	Hours / Year	Total Airflow (%)	Total Airflow (cfm)	Fan Power (kW)	Fan Energy (kWh)	Outside Airflow (%)	Outside Airflow (cfm)	Return Air Temp (F)	Mixed Air Temp (F)	AHU Supply Air Temp (F)	Cooling (Btus/hr)	Cooling (Tons)	Cooling Power (kW)	Cooling Energy (kWh)	Air Reheated (%)	Air Reheated (cfm)	Air Reheated Temp (F)	Reheat Energy (BTU/h)	Reheat Energy (Therms)
92	13	**100%**	4,110	3.9	50	**15%**	617	**72**	75	**55**	88,776	7	8	110	**0%**	0	**55**	0	0
87	29	100%	4,110	3.9	112	15%	617	72	74	57	77,584	6	7	214	0%	0	57	0	0
82	79	100%	4,110	3.9	304	15%	617	72	74	59	66,392	6	6	500	0%	0	59	0	0
77	145	100%	4,110	3.9	559	15%	617	72	73	60	55,200	5	5	762	0%	0	60	0	0
72	263	100%	4,110	3.9	1,013	100%	4,110	72	72	62	44,008	4	4	1,102	0%	0	62	0	0
67	235	100%	4,110	3.9	905	100%	4,110	72	67	64	13,951	1	1	312	0%	0	64	0	0
62	414	100%	4,110	3.9	1,595	15%	617	72	71	71	0	0	0	0	5%	206	71	0	0
57	448	100%	4,110	3.9	1,726	15%	617	70	68	68	0	0	0	0	14%	594	72	2,248	13
52	520	100%	4,110	3.9	2,003	15%	617	70	67	67	0	0	0	0	24%	982	73	5,632	38
47	485	100%	4,110	3.9	1,869	15%	617	70	67	67	0	0	0	0	33%	1,370	74	10,530	65
42	393	100%	4,110	3.9	1,514	15%	617	70	66	66	0	0	0	0	43%	1,758	75	16,942	85
37	232	100%	4,110	3.9	894	15%	617	70	65	65	0	0	0	0	52%	2,146	76	24,867	74
32	76	100%	4,110	3.9	293	15%	617	70	64	64	0	0	0	0	62%	2,535	77	34,307	33
27	21	100%	4,110	3.9	81	15%	617	70	64	64	0	0	0	0	71%	2,923	78	45,260	12
22	25	100%	4,110	3.9	96	15%	617	70	63	63	0	0	0	0	81%	3,311	79	57,728	19
17	2	**100%**	4,110	3.9	8	**15%**	617	**70**	62	**68**	0	0	0	0	**90%**	3,699	**80**	47,939	1
Total	3,380				13,022									3,001					341

SF 3 – Proposed

	Assumptions		
	High Bin	Mid Bin	Low Bin
Total Airflow (%)	100%	-	100%
Outside Airflow (%)	15%	Econo	15%
RAT (F)	72	-	70
SAT (F)	55	-	68
Air Re-heated (%)	0%	-	90%
Air Re-heated Temp (F)	55	-	80

SF 3 Constant volume with cooling only at unit and hot water reheat from natural gas boiler
Schedule 6am to 6pm

OAT (F)	Hours / Year	Total Airflow (%)	Total Airflow (cfm)	Fan Power (kW)	Fan Energy (kWh)	Outside Airflow (%)	Outside Airflow (cfm)	Return Air Temp (F)	Mixed Air Temp (F)	AHU Supply Air Temp (F)	Cooling (Btus/hr)	Cooling (Tons)	Cooling Power (kW)	Cooling Energy (kWh)	Air Reheated (%)	Air Reheated (cfm)	Air Reheated Temp (F)	Reheat Energy (BTU/h)	Reheat Energy (Therms)
92	13	**100%**	4,110	3.9	50	**15%**	617	**72**	75	**55**	88,776	7	8	110	**0%**	0	**55**	0	0
87	29	100%	4,110	3.9	112	15%	617	72	74	57	77,584	6	7	214	0%	0	57	0	0
82	79	100%	4,110	3.9	304	15%	617	72	74	59	66,392	6	6	500	0%	0	59	0	0
77	145	100%	4,110	3.9	559	15%	617	72	73	60	55,200	5	5	762	0%	0	60	0	0
72	263	100%	4,110	3.9	1,013	100%	4,110	72	72	62	44,008	4	4	1,102	0%	0	62	0	0
67	234	100%	4,110	3.9	902	100%	4,110	72	67	64	13,951	1	1	311	0%	0	64	0	0
62	400	100%	4,110	3.9	1,541	15%	617	72	71	71	0	0	0	0	5%	206	71	0	0
57	398	100%	4,110	3.9	1,533	15%	617	70	68	68	0	0	0	0	14%	594	72	2,248	11
52	470	100%	4,110	3.9	1,811	15%	617	70	67	67	0	0	0	0	24%	982	73	5,632	34
47	448	100%	4,110	3.9	1,726	15%	617	70	67	67	0	0	0	0	33%	1,370	74	10,530	60
42	346	100%	4,110	3.9	1,333	15%	617	70	66	66	0	0	0	0	43%	1,758	75	16,942	75
37	194	100%	4,110	3.9	747	15%	617	70	65	65	0	0	0	0	52%	2,146	76	24,867	62
32	61	100%	4,110	3.9	235	15%	617	70	64	64	0	0	0	0	62%	2,535	77	34,307	27
27	16	100%	4,110	3.9	62	15%	617	70	64	64	0	0	0	0	71%	2,923	78	45,260	9
22	23	100%	4,110	3.9	89	15%	617	70	63	63	0	0	0	0	81%	3,311	79	57,728	17
17	1	**100%**	4,110	3.9	4	**15%**	617	**70**	62	**62**	0	0	0	0	**90%**	3,699	**80**	71,709	1
Total	3,120				12,020					.			0	2,999					297
				Saved	1,002								Saved	1				Saved	44

SF 4 – Baseline

	Assumptions		
	High Bin	Mid Bin	Low Bin
Total Airflow (%)	100%	-	100%
Outside Airflow (%)	15%	Econo	15%
RAT (F)	72	-	70
SAT (F)	55	-	90

SF 4 Constant volume with hot water heating and DX cooling at the unit
Operates 5am to 6pm M-F

OAT (F)	Hours / Year	Total Airflow (%)	Total Airflow (cfm)	Fan Power (kW)	Fan Energy (kWh)	Outside Airflow (%)	Outside Airflow (cfm)	Return Air Temp (F)	Mixed Air Temp (F)	AHU Supply Air Temp (F)	Heating (Btus/hr)	Heating (therms)	Cooling (Btus/hr)	Cooling (Tons)	Cooling Power (kW)	Cooling Energy (kWh)
92	13	**100%**	4,000	1.4	19	**15%**	600	**72**	75	**55**	0	0	86,400	7	8	107
87	29	100%	4,000	1.4	42	15%	600	72	74	57	0	0	75,507	6	7	209
82	79	100%	4,000	1.4	114	15%	600	72	74	59	0	0	64,615	5	6	486
77	145	100%	4,000	1.4	208	15%	600	72	73	60	0	0	53,722	4	5	742
72	263	100%	4,000	1.4	378	100%	4,000	72	72	62	0	0	42,830	4	4	1,073
67	235	100%	4,000	1.4	338	100%	4,000	72	67	64	0	0	13,577	1	1	304
62	414	100%	4,000	1.4	595	15%	600	72	71	71	0	0	0	0	0	0
57	448	100%	4,000	1.4	644	15%	600	70	68	73	19,944	115	0	0	0	0
52	520	100%	4,000	1.4	747	15%	600	70	67	75	32,544	217	0	0	0	0
47	485	100%	4,000	1.4	697	15%	600	70	67	77	45,144	281	0	0	0	0
42	393	100%	4,000	1.4	565	15%	600	70	66	79	57,744	291	0	0	0	0
37	232	100%	4,000	1.4	333	15%	600	70	65	81	70,344	209	0	0	0	0
32	76	100%	4,000	1.4	109	15%	600	70	64	84	82,944	81	0	0	0	0
27	21	100%	4,000	1.4	30	15%	600	70	64	86	95,544	26	0	0	0	0
22	25	100%	4,000	1.4	36	15%	600	70	63	88	108,144	35	0	0	0	0
17	2	**100%**	4,000	1.4	3	**15%**	600	**70**	62	**90**	120,744	3	0	0	0	0
Total	3,380				4,856							1,257				2,920

SF 4 – Proposed

	Assumptions		
	High Bin	Mid Bin	Low Bin
Total Airflow (%)	100%	-	100%
Outside Airflow (%)	15%	Econo	15%
RAT (F)	72	-	70
SAT (F)	55	-	90

SF 4 Constant volume with hot water heating and DX cooling at the unit
Schedule 6am to 6pm

OAT (F)	Hours / Year	Total Airflow (%)	Total Airflow (cfm)	Fan Power (kW)	Fan Energy (kWh)	Outside Airflow (%)	Outside Airflow (cfm)	Return Air Temp (F)	Mixed Air Temp (F)	AHU Supply Air Temp (F)	Heating (Btus/hr)	Heating (therms)	Cooling (Btus/hr)	Cooling (Tons)	Cooling Power (kW)	Cooling Energy (kWh)
92	13	**100%**	4,000	1.4	19	**15%**	600	**72**	75	**55**	0	0	86,400	7	8	107
87	29	100%	4,000	1.4	42	15%	600	72	74	57	0	0	75,507	6	7	209
82	79	100%	4,000	1.4	114	15%	600	72	74	59	0	0	64,615	5	6	486
77	145	100%	4,000	1.4	208	15%	600	72	73	60	0	0	53,722	4	5	742
72	263	100%	4,000	1.4	378	100%	4,000	72	72	62	0	0	42,830	4	4	1,073
67	234	100%	4,000	1.4	336	100%	4,000	72	67	64	0	0	13,577	1	1	303
62	400	100%	4,000	1.4	575	15%	600	72	71	71	0	0	0	0	0	0
57	398	100%	4,000	1.4	572	15%	600	70	68	73	19,944	102	0	0	0	0
52	470	100%	4,000	1.4	675	15%	600	70	67	75	32,544	196	0	0	0	0
47	448	100%	4,000	1.4	644	15%	600	70	67	77	45,144	259	0	0	0	0
42	346	100%	4,000	1.4	497	15%	600	70	66	79	57,744	256	0	0	0	0
37	194	100%	4,000	1.4	279	15%	600	70	65	81	70,344	175	0	0	0	0
32	61	100%	4,000	1.4	88	15%	600	70	64	84	82,944	65	0	0	0	0
27	16	100%	4,000	1.4	23	15%	600	70	64	86	95,544	20	0	0	0	0
22	23	100%	4,000	1.4	33	15%	600	70	63	88	108,144	32	0	0	0	0
17	1	**100%**	4,000	1.4	1	**15%**	600	**70**	62	**90**	120,744	2	0	0	0	0
Total	3,120				4,483							1,106			0	2,919
				Saved	374						Saved	151			Saved	1

Building 4

SF 1, 2, 3, 4, and 5 – Baseline

	Assumptions		
	High Bin	Mid Bin	Low Bin
Total Airflow (%)	100%	-	100%
Outside Airflow (%)	15%	Econo	15%
RAT (F)	80	-	62
SAT (F)	80	-	90

SF 1, 2, 3, 4 and 5 Constant volume with heating only at unit
Operates 4am to 6pm M-F

OAT (F)	Hours / Year	Total Airflow (%)	Total Airflow (cfm)	Fan Power (kW)	Fan Energy (kWh)	Outside Airflow (%)	Outside Airflow (cfm)	Return Air Temp (F)	Mixed Air Temp (F)	AHU Supply Air Temp (F)	Heating (kW)	Heating (kWh)
92	13	**100%**	10,900	3.5	46	**15%**	1,635	**80**	82	**80**	0	0
87	29	100%	10,900	3.5	102	15%	1,635	80	81	80	0	0
82	86	100%	10,900	3.5	302	15%	1,635	78	79	78	0	0
77	167	100%	10,900	3.5	586	100%	10,900	76	77	76	0	0
72	309	100%	10,900	3.5	1,084	100%	10,900	72	72	72	0	0
67	290	100%	10,900	3.5	1,018	15%	1,635	67	67	67	0	0
62	486	100%	10,900	3.5	1,706	15%	1,635	62	62	62	0	0
57	556	100%	10,900	3.5	1,951	15%	1,635	62	61	72	37	20,622
52	638	100%	10,900	3.5	2,239	15%	1,635	62	61	74	47	29,716
47	613	100%	10,900	3.5	2,151	15%	1,635	62	60	76	56	34,368
42	497	100%	10,900	3.5	1,744	15%	1,635	62	59	78	66	32,580
37	313	100%	10,900	3.5	1,098	15%	1,635	62	58	80	75	23,488
32	100	100%	10,900	3.5	351	15%	1,635	62	58	82	85	8,453
27	30	100%	10,900	3.5	105	15%	1,635	62	57	84	94	2,821
22	28	100%	10,900	3.5	98	15%	1,635	62	56	86	104	2,898
17	5	**100%**	10,900	3.5	18	**15%**	1,635	**62**	55	**90**	120	599
Total	4,160				14,599							155,545

	Assumptions		
	High Bin	Mid Bin	Low Bin
Total Airflow (%)	100%	-	100%
Outside Airflow (%)	15%	Econo	15%
RAT (F)	80	-	62
SAT (F)	80	-	90

SF 1, 2, 3, 4 and 5 Constant volume with heating only at unit
Schedule 7am to 8pm

OAT (F)	Hours / Year	Total Airflow (%)	Total Airflow (cfm)	Fan Power (kW)	Fan Energy (kWh)	Outside Airflow (%)	Outside Airflow (cfm)	Return Air Temp (F)	Mixed Air Temp (F)	AHU Supply Air Temp (F)	Heating (kW)	Heating (kWh)
92	13	**100%**	10,900	3.5	46	**15%**	1,635	**80**	82	**80**	0	0
87	29	100%	10,900	3.5	102	15%	1,635	80	81	80	0	0
82	86	100%	10,900	3.5	302	15%	1,635	78	79	78	0	0
77	167	100%	10,900	3.5	586	100%	10,900	76	77	76	0	0
72	308	100%	10,900	3.5	1,081	100%	10,900	72	72	72	0	0
67	286	100%	10,900	3.5	1,004	15%	1,635	67	67	67	0	0
62	438	100%	10,900	3.5	1,537	15%	1,635	62	62	62	0	0
57	410	100%	10,900	3.5	1,439	15%	1,635	62	61	72	37	15,207
52	490	100%	10,900	3.5	1,720	15%	1,635	62	61	74	47	22,823
47	491	100%	10,900	3.5	1,723	15%	1,635	62	60	76	56	27,528
42	367	100%	10,900	3.5	1,288	15%	1,635	62	59	78	66	24,058
37	202	100%	10,900	3.5	709	15%	1,635	62	58	80	75	15,158
32	53	100%	10,900	3.5	186	15%	1,635	62	58	82	85	4,480
27	15	100%	10,900	3.5	53	15%	1,635	62	57	84	94	1,410
22	23	100%	10,900	3.5	81	15%	1,635	62	56	86	104	2,381
17	2	**100%**	10,900	3.5	7	**15%**	1,635	**62**	55	**90**	120	240
Total	3,380				11,862						0	113,285
				Saved	2,737						Saved	42,260

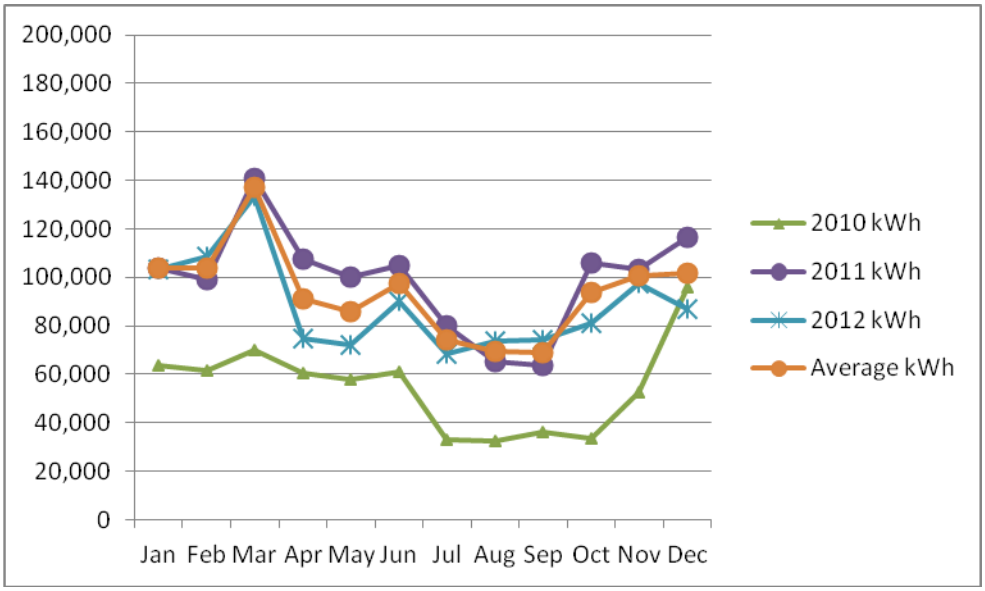
Summary Table of the saved energy from the preceding calculations:

EEM Summary

New HVAC and Controls	kWh Saved	Ave Monthly kW Saved	Therms Saved
Building 1 and 2	285,910	0	0
Pumps	21,203	0	1
Building 3	6,244	0	744
Building 4	44,998	0	0
Totals	358,354	0	745

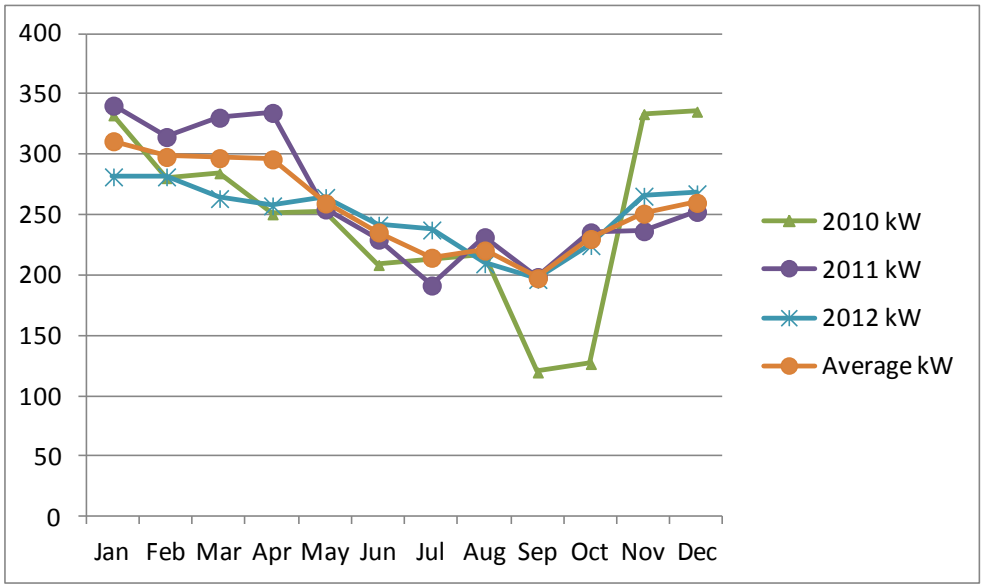
EXISTING (BASELINE) ENERGY BILLS

The recent historical electrical energy use (kWh) is illustrated below, and in the table that follows. There are two electrical meters serving the facility. The facility energy use changed dramatically between 2010 and 2011; during this time, the facility was remodeled and converted from an elementary school to the administrative center. The facility EUI is based on the utility data from 2011 and 2012 (2010 data has been excluded.)



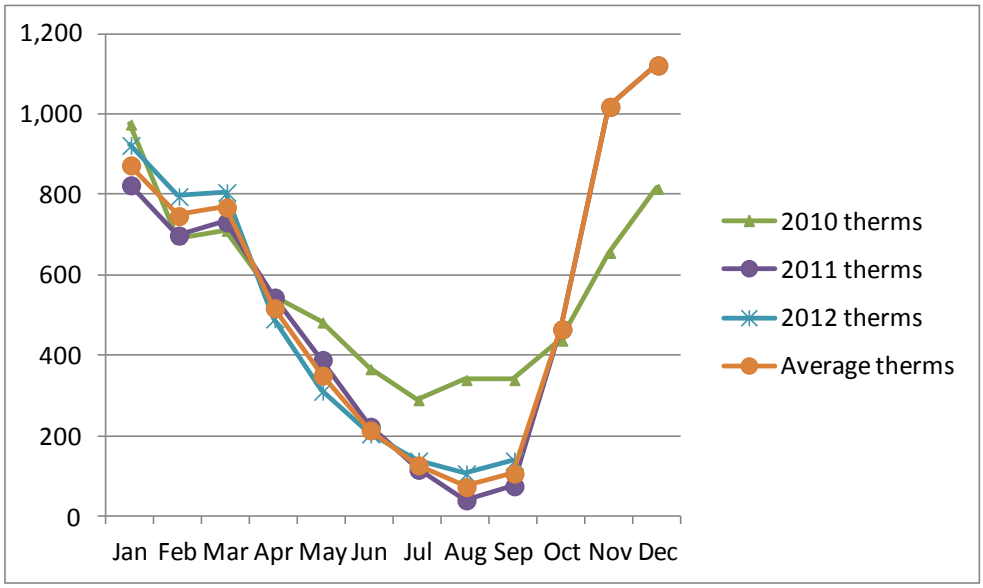
	2010 kWh	2011 kWh	2012 kWh	Average kWh
Jan	63,440	104,080	103,360	103,720
Feb	61,760	99,200	108,640	103,920
Mar	69,760	140,880	133,200	137,040
Apr	60,560	107,440	74,720	91,080
May	57,680	99,920	72,240	86,080
Jun	61,040	104,800	90,000	97,400
Jul	33,040	79,920	68,480	74,200
Aug	32,480	65,360	73,680	69,520
Sep	36,080	63,680	74,080	68,880
Oct	33,360	106,080	81,280	93,680
Nov	52,800	103,280	97,520	100,400
Dec	95,840	116,720	86,880	101,800
Total	657,840	1,191,360	1,064,080	1,127,720

The recent historical electrical energy demand (kW) is illustrated below, and in the table that follows. There are two electrical meters serving the facility. The facility energy use changed dramatically between 2010 and 2011; during this time, the facility was remodeled and converted from an elementary school to the administrative center. The facility EUI is based on the utility data from 2011 and 2012 (2010 data has been excluded.)



	2010 kW	2011 kW	2012 kW	Average kW
Jan	333	341	282	312
Feb	281	315	282	299
Mar	285	331	264	298
Apr	251	335	258	297
May	253	255	265	260
Jun	209	230	242	236
Jul	213	192	238	215
Aug	217	232	210	221
Sep	120	199	197	198
Oct	127	236	225	231
Nov	334	237	266	252
Dec	336	253	268	261
Total	2,959	3,156	2,997	3,077

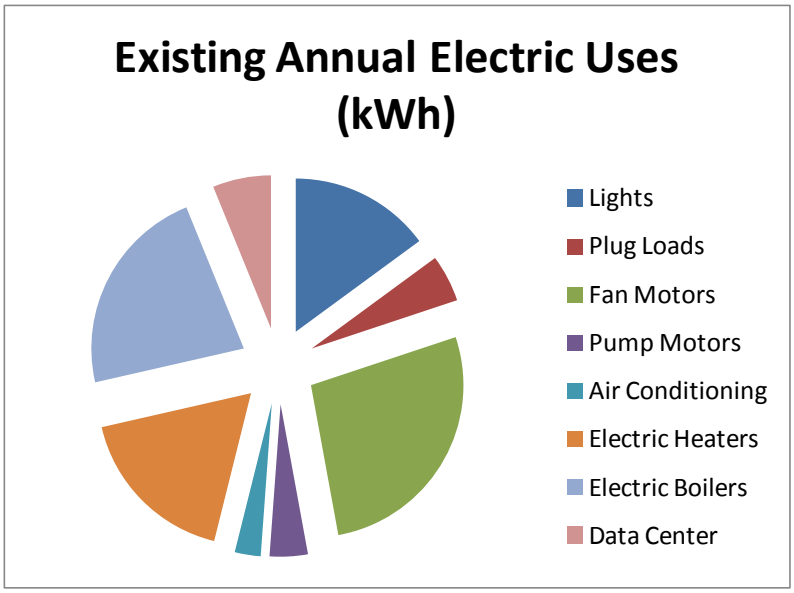
The recent historical natural gas use (therms) is illustrated below, and in the table that follows. There is a single gas meter serving the facility. The facility energy use changed dramatically between 2010 and 2011; during this time, the facility was remodeled and converted from an elementary school to the administrative center. The facility EUI is based on the utility data from 2011 and 2012 (2010 data has been excluded.)

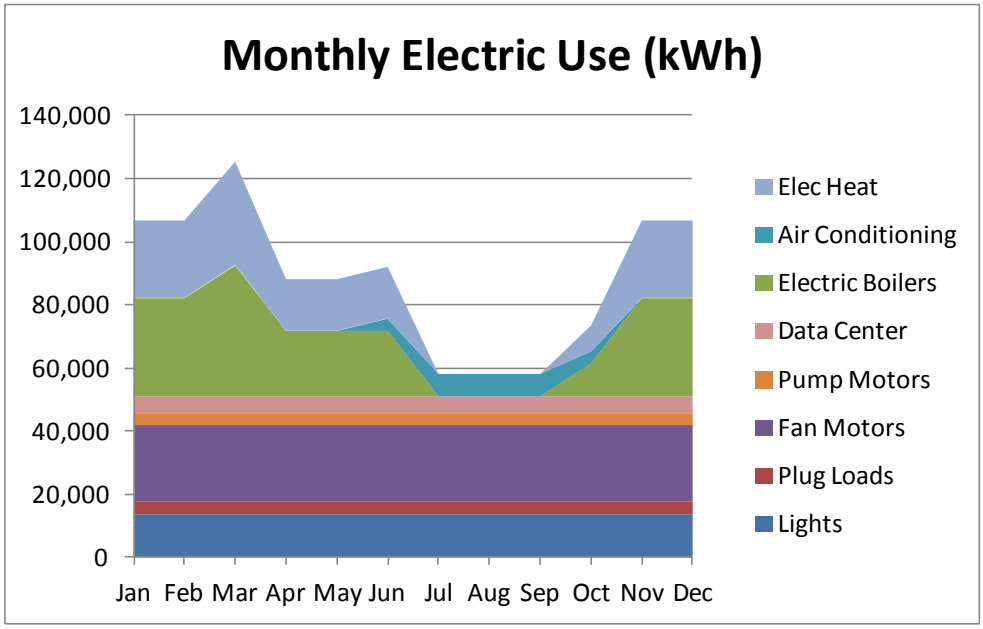


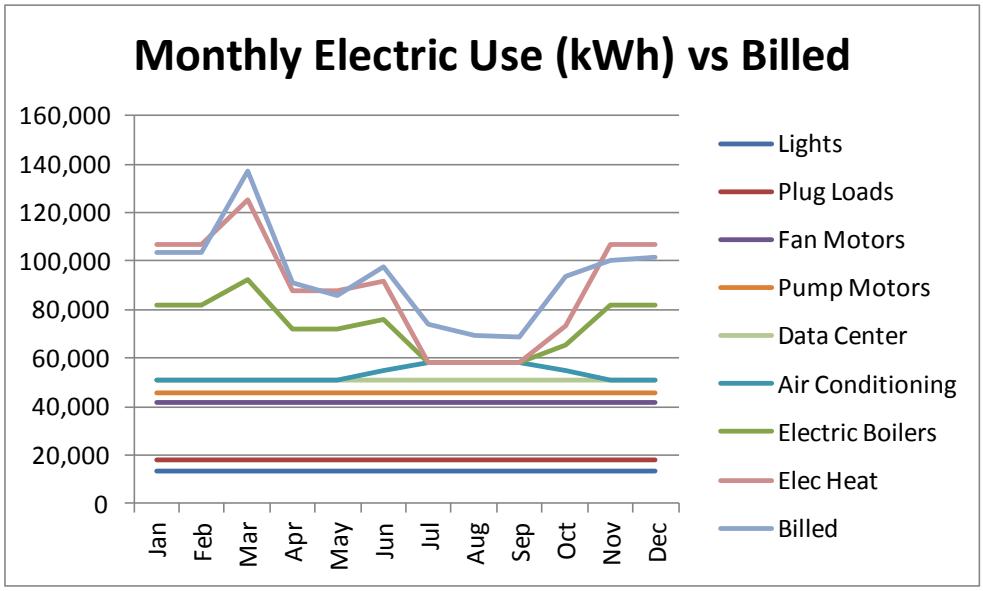
	2010 therms	2011 therms	2012 therms	Average therms
Jan	976	825	924	875
Feb	692	700	797	749
Mar	712	733	807	770
Apr	548	546	493	520
May	484	391	313	352
Jun	368	225	207	216
Jul	291	118	140	129
Aug	341	42	108	75
Sep	341	77	140	109
Oct	439	467		467
Nov	657	1,020		1,020
Dec	816	1,123		1,123
Total	6,665	6,267	3,929	6,403

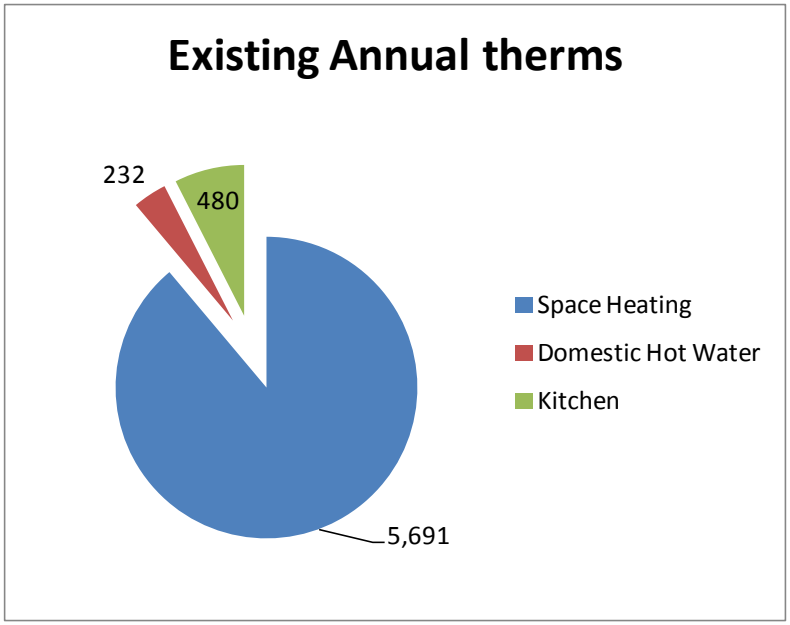
EXISTING (BASELINE) ENERGY END USE ANALYSIS

As the first step in our investment grade energy audit, we first determine where the existing energy in the facility is being used. This step is essential to take in order because it allows us accurately determine what the potential energy savings can be. We conduct this for both the electric use and the natural gas use. The results of this analysis are presented here.




Monthly Electric Use (kWh)
140,000
120,000
100,000
80,000
60,000
40,000
20,000
0
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Elec Heat
Air Conditioning
Electric Boilers
Data Center
Pump Motors
Fan Motors
Plug Loads
Lights


Monthly Electric Use (kWh) vs Billed
160,000
140,000
120,000
100,000
80,000
60,000
40,000
20,000
0
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Lights
Plug Loads
Fan Motors
Pump Motors
Data Center
Air Conditioning
Electric Boilers
Elec Heat
Billed



		Existing Annual therms	Percent of Total Billed therms
Space Heating		5,691	89%
Domestic Hot Water		232	4%
Kitchen		480	7%

PROJECT COST ESTIMATES

The Total Project Costs for EEM 1 and 2 are based on quotes provided by Abacus.

MEASUREMENT AND VERIFICATION PLAN

The electric and natural gas savings anticipated for these upgrades are significant (> 20% of the existing total building gas and electric use), and they affect multiple systems (twenty-three fans, an air conditioning chiller, three boilers, and one pump). Therefore we propose to measure and verify the energy savings based on a whole building utility meter approach. The utility data will be collected after the upgrades are completed, and compared to the average utility data before the upgrade. The difference between the two will be the measured energy savings for this upgrade.

Note about potential change of usage: If after the upgrade the Administration Center significantly increases their operating hours then we would reserve the right to adjust the baseline (existing) energy use to take this into account. For instance, if the building operators change the schedule and the building remains open on Sundays, then the existing energy use will be modified to reflect how much energy the building would have used before the upgrade if it had been operating on Sundays. We would propose to do this using our existing energy end use analysis – by modifying the operating hours appropriately.

Note about significant change in weather: If there is significantly different weather experienced after the upgrade (much hotter than normal in the summer or much colder in the winter than normal) then we reserve the right to adjust the baseline (existing) energy use to determine how much the older systems would have used if they were operated with the current weather. We would propose to do this with linear regression models that depict the energy use based on monthly heating degree days for natural gas use, and monthly cooling degree days for electric use. Then the after-upgrade energy use would be compared to the adjusted baseline energy use to determine the actual energy savings.

APPENDIX B – FINANCIAL TABLES

ENERGY SERVICES PROPOSAL
Camas School District
Lacamas Elementary & J.D. Zellerbach February 4, 2013

Budget Summary

Project:	Camas School District - Lacamas ES, JD Zellerbach Camas, Washington	Measure: Date: Phase:	Energy Upgrades 2/4/2013 ESPC Proposal	
A. CONSTRUCTION COSTS				Proposed Cost
	Labor and Material:			
L-1	HVAC Controls / Refurbish Pod HVAC		$	87,840
L-3	Replace Computer Room RTHP		$	11,200
L-4	New HP's for U6, U7, UV1		$	73,576
L-5	Office new HP's & combine zones		$	43,200
JDZ-1	Controls & Repairs		$	90,627
Subtotal Labor and Materials Cost			$	306,444
	Permits	0.15%	$	460
	Construction Bond	2.00%	$	6,129
TOTAL CONSTRUCTION COST			$	313,032
B. PROFESSIONAL SERVICES FEES				
	Audit Fee (Paid by Utility)	0.0%	$	-
	Design M,E,C,S	7.0%	$	21,912
	Construction Management	6.0%	$	18,782
	Commissioning	3.0%	$	9,391
	ESCO M and V Cost	2.0%	$	6,261
	Ongoing M&V (Years 2 and 3)	2.0%	$	6,261
	Overhead and Profit	15.0%	$	46,955
TOTAL ESCO FEES			$	109,561
C. OTHER COSTS				
	Project Contingency	5.0%	$	21,130
TOTAL OTHER COSTS			$	21,130
D. TOTAL GUARANTEED CONSTRUCTION & ESCO SERVICES			$	443,723
E. NON-GUARANTEED COSTS				
	Sales Tax - Construction Portion	8.4%	$	26,295
	Sales Tax - Professional Services Portion	8.4%	$	9,203
	Sales Tax - Contingency Portion	8.4%	$	1,775
	DES Admin. Fee (estimated)		$	29,000
	DES M and V Fee (Years 2 & 3 - estimated)		$	4,000
TOTAL NON GUARANTEED COSTS			$	70,273
F. TOTAL PROJECT COST			$	513,996
	Utility Incentives (Estimate)		$	91,371
	OSPI Grant (Estimate)		$	128,499
	Net Project Cost		$	294,126
	Estimated Annual Utility & Maintenance Cost Savings		$	23,713
	Total Project Simple Payback in Years			12.4

ENERGY SERVICES PROPOSAL
Camas School District
Lacamas Elementary & J.D. Zellerbach February 4, 2013

Measure #				
L-1	HVAC Controls / Refurbish Pod HVAC	Controls Estimate		$ 55,722
		Mech scope to refurbish AHU's		$9,918
		Mech Scope to clean & replace EDH's		$ 22,201
			Total EEM Cost:	$ 87,840
L-3	Replace Computer Room RTHP	Controls Estimate		$ 1,500
		Mechanical		$ 8,900
		Electrical		$ 800
			Total EEM Cost:	$ 11,200
L-4	New HP's for U6, U7, UV1	Controls Estimate		$ 19,000
		Mechanical		$ 46,256
		Electrical		$ 8,320
			Total EEM Cost:	$ 73,576
L-5	Office new HP's & combine zones	Controls Estimate		$ 7,000
		Mechanical		$ 30,600
		Electrical		$ 5,600
			Total EEM Cost:	$ 43,200
JDZ-1	Controls & Repairs	Controls Estimate	Total EEM Cost:	$ 90,627
			Total Recommended Measures:	**$ 306,444**