ENERGY AUDIT FINAL
POST INSTALLATION REPORT

Results and Recommendations from Energy Audit of Emmonak

For EECBG and VEEP Grants
City of Emmonak, Alaska

July 23, 2012

Prepared By:
Ameresco, Inc.
6643 Brayton Drive
Anchorage, AK 99507

Prepared For:
Alaska Energy Authority
City of Emmonak

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EXECUTIVE SUMMARY AND PREFACE

This Final Post Installation Report summarizes the results of an Ameresco Energy Audit of the City of Emmonak, the initial energy savings measures identified and proposed, and any changes that may have occurred throughout the installation process. The City of Emmonak is a recipient of an Alaska Energy Authority (AEA) Village Energy Efficiency Program (VEEP) grant of $150,000, an Energy Efficiency and Conservation Block Grant (EECBG) of $72,100, and a Whole Village Energy Efficiency Retrofit audit of $400,000.

Ameresco engineers conducted an energy audit of the City of Emmonak on October 18-19, 2010. The table below shows the buildings audited and their respective square footages.

City of Emmonak - Building Summary

Building	Category	Square Footage
School	School	20,000
City Hall, Hotel, and Community Center	Public Building	4,210
Washeteria	Public Building	2,800
Police Department	Public Building	2,400
Waste Water Treatment Plant	Public Facility	4,500
Chuloonawick Native Village Office	Public Building	2,400
Public Works	Public Facility	2,400
Power Plant	Public Facility	*N/A*

The audit identified existing types, conditions, operating modes, and energy consumption profiles for a variety of buildings, facilities and systems. The audit also identified all cost-effective system and facility modifications, adjustments, alterations, additions, and retrofits. Systems investigated during the audit included heating, ventilation, interior and exterior lighting, process exhaust, domestic hot water, motors, building envelopes, utility metering systems, and energy management control systems (EMCS). Options for advanced electric meter systems were considered if they did not already exist. Ameresco also explored opportunities for on-site energy production, both non-renewable and renewable.

The following table shows the results of Ameresco's audit and potential calculation savings, allocated by grant. See *Appendix A, Appendix B,* and *Appendix C* for more detailed calculation results. Project costs include costs incurred from the site visit, engineering time, materials cost, and labor cost, as well as Ameresco's markup. It is important to note that the simple paybacks (SPBs) have been determined according to ECO type. For example, the SPB for an electrical ECO is calculated using only the annual kWh savings, even though the equivalent annual fuel gallon monetary savings is reported.

WHOLE VILLAGE - PROJECT COSTS & EXPECTED SAVINGS - EMMONAK				
ECO		**Cost**	**Savings**	**SPB**
B01 - WEATHER-STRIPPING UPGRADE	$	6,108.66	$ 827.38	7.38
B02 - THERMAL INSULATION UPGRADE	$	43,691.97	$ 1,540.43	28.36
B03 - ENERGY EFFICIENT DOOR UPGRADE	$	13,771.29	$ 900.85	15.29
B04 - INSULATED FLOOR	$	15,762.97	*N/A*	*N/A*
B06 - ROOF UPGRADE	$	305,364.05	$ 3,373.67	90.51
C01 - CONTROLS UPGRADE	$	14,099.27	$ 17,133.47	0.82
E02 - T5 LIGHTING UPGRADE	$	33,757.31	$ 1,365.75	24.72
E05 - LED LIGHTING UPGRADE	$	25,061.95	$ 1,769.27	14.17
M01 - BOILER TUNE-UP	$	19,413.64	$ 24,780.28	0.78
M02 - BOILER UPGRADE	$	37,102.00	$ 2,605.98	14.24
M03 - DOMESTIC WATER HEATER UPGRADE	$	8,070.48	$ 555.48	14.53
TOTAL PROJECT COST	**$**	**522,203.59**	**$ 54,852.57**	**9.52**
TOTAL WHOLE VILLAGE GRANT	**$**	**400,000.00**		
REALLOCATED FROM EMMONAK VEEP FUNDS	**$**	**74,344.94**		
BUDGET EXCEEDED	**$**	**(47,858.65)**		

VEEP - PROJECT COSTS & EXPECTED SAVINGS - EMMONAK				
ECO		**Cost**	**Savings**	**SPB**
E01 - T8 LIGHTING UPGRADE	$	62,277.70	$ 13,563.13	4.59
E03 - INSTALL OCCUPANCY SENSORS	$	13,377.35	$ 7,858.48	1.70
AVAILABLE FUNDING	$	74,344.94		
**Available funding has been allocated to the Whole Village scope.*				
TOTAL PROJECT COST	**$**	**75,655.06**	**$ 21,421.61**	**3.53**
TOTAL GRANT	**$**	**150,000.00**		

EECBG - PROJECT COSTS & EXPECTED SAVINGS - EMMONAK				
ECO		**Cost**	**Savings**	**SPB**
B05 - ENERGY EFFICIENT WINDOW UPGRADE	$	22,313.78	$ 200.13	111.49
C02 - PROGRAMMABLE THERMOSTATS	$	4,155.94	$ 9,405.35	0.44
E04 - PREMIUM EFFICIENCY MOTORS UPGRADE	$	36,453.86	$ 1,082.54	33.67
M04 - PIPING INSULATION	$	2,230.83	$ 2,213.87	1.01
M05 - UNIT HEATER UPGRADE	$	6,897.50	$ 793.64	8.69
AVAILABLE FUNDING	$	48.09		
**Remaining funding at this site will be considered as available funding on future EECBG projects within the contract.*				
TOTAL	**$**	**72,100.00**	**$ 13,695.54**	**5.26**

1.0 Building Descriptions

1.1 EMMONAK SCHOOL

Description: The Emmonak School is a combination elementary, middle school, and high school building. The building space is a combination of classroom, office, library, gymnasium, and cafeteria space. Emmonak School caters to about 230 students and 30 staff members. The school is one of the best maintained buildings in the city, though many opportunities exist for improvement.

General Conditions: The building is comprised of two sections. The section of the building that currently contains the high school and gymnasium was the original school building. An addition was later built that currently houses the administrative offices, elementary, middle school, and cafeteria. The building appears to be in good condition, though there were several areas for improvement noticed throughout the audit.

Pictures of general conditions found during the field audit immediately follow this building description.

Building Envelope: The building structure overall appears to be in good condition. The double-pane clear glass windows are in excellent condition. Doors are insulated aluminum frame; most weather-stripping appears adequate, though some doors require weather-stripping repair or replacement. The roof is constructed from angled standing seam metal and appears to be in good condition. The building exterior walls are covered in standing seam metal; the newer portion of the building appears to be in excellent condition, while the older section of the building is showing signs of weathering. The walls appear to have about 6 inches of batt insulation and an inch of rigid insulation.

Air Distribution: A Trane makeup air unit (MAU) from 1991 handles the air distribution needs of the newer section of the building. This MAU is a Modular Climate Changer and provides 3240 cubic feet per

minute (cfm) or air to the building. The High School section was initially designed to be heated with multiple oil-fired hot air furnaces located in the crawl space below the roof. Over time, all but one furnace has been parted out to keep the heat on in the section. The unit has been pieced together so many times that it was impossible to determine the actual make and model of the equipment at the time of the audit. During Ameresco's visit, auditors found that the unit never shuts down, which is reflected in the oil bills received by the school system.

Heating: Two Weil-McLain fuel oil model 88 boilers provide heating to the building. These boilers are listed as 84% efficient. A combustion analysis found these boilers to be performing at 79% efficiency.

Controls: The building does not currently have a direct digital control (DDC) energy management control system (EMCS). The Trane MAU has a Square D electronic controller. Building zone temperatures are controlled by digital thermostats.

Lighting: Interior lighting consists primarily of T12 fluorescent lamps with magnetic ballasts. The gym contains metal halide (MH) fixtures that appear to be about 200 watts. In the lobby, there are compact fluorescent (CFL) fixtures in addition to the T12 lighting. The cafeteria area contains MH fixtures that appear to be 200-250 watts in size. In the computer lab area, there are a series of what appears to be recessed mini bi-pin halogen lighting. Exterior lighting consists of high pressure sodium (HPS) fixtures. There are no occupancy sensors in the building.

Domestic Water: There are two domestic water heaters at the school for the provision of hot water. The first, located in the school's exterior mechanical room, is a Bock 68 gallon fuel-oil domestic water heater (installed at an unknown date). This boiler has a significant dent at the base, but it does not appear to be leaking. The second, located in interior mechanical room above the gym, is a Rheem 120 gallon electric water heater (manufactured December 2009). Lavatory faucets range from 1.5 to 4 gpm, and toilets range from 1.6 gpf to 3 gpf.

Building Photos: Emmonak School

Weil-McLain Boilers

Bock Domestic Hot Water Heater

Trane Makeup Air Unit

Filters in Need of Replacement

New Rheem Domestic Water Heater

Missing Weather-stripping – Leaky Doors

Missing Weather-stripping

High School Exterior

1.2 EMMONAK CITY HALL, HOTEL, AND COMMUNITY CENTER

Description: The City Hall building in Emmonak is a multi-functional building that also houses the community center and City Hotel. The building has seen some wear and weathering over the years, but is holding up well. This building also sees much activity due to the busy nature of the office as well as almost daily use for evening gatherings in the community center portion of the building.

General Conditions: The structure overall is in fair condition, though it seems to still be holding up adequately. The exterior shows many signs of weathering and age, but it does not appear to be seriously compromised in any fashion. Some windows are boarded up, and there are some areas where the building façade is damaged and insulation is visible, but does not appear to be overly deteriorated. The condition of the HVAC equipment is in poor condition, though some is under repair.

Pictures of general conditions found during the field audit immediately follow this building description.

Building Envelope: The structure itself has many flaws, though most of these appear to be cosmetic in nature. The exterior of the building is covered in plywood that is showing age and weathering. The roof is standing seam metal and appears to still be in good condition with some batt insulation above the ceiling. The windows are double-pane clear glass and are in fair condition. The windows that are untouched by vandalism are in excellent condition, but many of the windows have one or more of their panes cracked or broken. Some have been covered by plexiglass because of the vandalism issues. Others have been boarded up completely. One window is closed off using Styrofoam and aluminum foil. Doors are aluminum frame and appear to be in good condition.

Heating: Two Weil-McLain boilers located in the building's mechanical room provide heating. One is currently inoperable and is under repair, so the remaining boiler is forced to supply the entire building's

heat. The age of these boilers is unknown, but based on product literature, they were probably manufactured in the mid-1990s. According to a product brochure, these boilers were 82-84% efficient at time of manufacture. A combustion analysis found the functional boiler to be 78% efficient.

Controls: The heating of building zones is controlled by a series of mechanical thermostats placed throughout the building.

Lighting: Interior lighting fixtures are mostly T12 fluorescent with magnetic ballasts. There are a few fixtures that have been retrofitted with T8 lamps. These fixtures, however, are still not as efficient as desired because they are still operating on magnetic ballasts and will severely impact the life of the bulb. There are a few 75 watt incandescent fixtures throughout the facility as well. There are no occupancy sensors in the building.

Domestic Water: A 50 gallon Bock fuel oil fired domestic water heater provides hot water to the building. This size domestic water heater is a residential model with an energy factor of 0.66 and a recovery efficiency of 80%.

Building Photos: Emmonak City Hall, Hotel, and Community Center

Typical Cracked Window

Boiler Under Repair

Debris in Boiler Flue

Boiler Stack and Mechanical Room

1.3 EMMONAK WASHETERIA

Description: The Emmonak Washeteria is used by most of the villagers for their laundering needs. The building is open 3 days each week to accommodate the needs of the villagers. There are also men's and women's saunas and showers located in the facility.

General Conditions: The building structurally appears to be kept in good condition. The interior spaces, however, are excessively overheated. The building is so hot, that villagers usually keep the front door and windows open while doing laundry to make the environment bearable. There are many reasons for the high temperature of the facility, from lack of dryer heat exchanger control to non-functioning room control. The village no longer utilizes the sauna heaters, as the space is now heated with the building system and kept over 110°F. During the audit, the women's sauna temperature reading was found to be 124°F. The dryers are on continuous heat loops, which create excess heat in an already overheated interior space. The only comfortable room in the facility is one which houses an HRV, yet appears to be used only for storage. This facility is ripe with opportunities for energy improvements.

Pictures of general conditions found during the field audit immediately follow this building description.

Building Envelope: The building exterior is covered in brown and blue plywood that appears to be in good condition; it shows little signs of weathering or wear. The angled standing seam metal roof appears to be in good condition as well. The double pane clear glass windows are in excellent condition and are well sealed. The doors are in good condition as well, although they could use new weather-stripping.

Heating: Two Weil-McLain Model 80 boilers provide the building with heating, along with 5 unit heaters (1 in the mechanical room and 4 in the crawl space below the building) and one heat recovery ventilator (HRV). One boiler is a 6-section unit, while the other is a 4-section unit. The 6-section unit runs continuously, while the 4-section unit has been manually turned off. In discussions with site maintenance personnel, Ameresco engineers were told that the smaller boiler is turned on once the temperature drops, as they cannot maintain the high building temperatures. During mild conditions, such as those encountered during the audit (38 deg.F day/ 28 deg. F night), the opposite operational sequence is

expected. A combustion analysis of the boilers found them to be 82% efficient. The Fantech HRV is located in a side room across the building from the mechanical room and was set to a medium airflow rate at the time of the audit. Four air vents located throughout the building tie into the ductwork of this HRV unit. A mechanical thermostat is also located in this side room; the thermostat was set to 70 degrees at the time of the audit, but the temperature reading was found to be well over 80 degrees due to the excess heat in the building. Four Beacon Morris unit heaters rated at 900 cfm heat the crawl space beneath the building. These heaters are tied into a single mechanical thermostat set to 60 degrees and appear to be functioning normally.

Controls: The boilers are equipped with Tekmar four-stage boiler controls, but they have been overridden. Because the boilers are being used to heat the sauna areas, the mechanical thermostats located throughout the building are not functioning as designed.

Lighting: Interior lighting is primarily T8 fluorescent with electronic ballasts. The crawl space is lit with 75 watt incandescent fixtures. There are no occupancy sensors in the building.

Domestic Water: Two large, relatively new WHS-series Amtrol BoilerMate indirect-fired water heaters provide the building with domestic hot water. One water heater holds 60 gallons, while the other holds 80 gallons.

Laundry Equipment: There are a total of 7 Continental Girbau washers (40-pound) and 10 Huebsch dryers (actually 5 units, where each unit has 2 dryers, 30-pound capacity) located in the Emmonak Washeteria. The washers currently meet ENERGY STAR performance requirements. The Continental Girbau washers have a modified energy factor (MEF) of 1.96 and a water factor (WF) of 5.04. Current ENERGY STAR requirements stipulate a MEF of 1.8 or greater and a WF of 7.5 or less. In January of 2011, however, the requirements will change to a MEF of 2.0 or greater and a WF of 6.0 or less. ENERGY STAR does not currently offer a label for clothes dryers because most models use similar amount of energy. Because the Huebsch dryers are relatively new, they are most likely on the same efficiency level as other commercial dryers on the market. These dryers, however, are currently consuming a large amount of energy because they are not being properly controlled.

Building Photos: Emmonak Washeteria

Fantech HRV

Amtrol Boilermate Indirect Water Heaters

Weil-McLain 480 Model Boiler

Weil-McLain 680 Model Boiler

Huebsch Dryers – Constantly Heated

Continental Girbau Washer

1.4 EMMONAK POLICE DEPARTMENT (ALASKA COURT SYSTEM)

Description: The Emmonak Police Department building houses the police department offices, the jailhouse, and the courtroom. Emmonak Court operates Monday through Friday, 8 am to noon, and 1 pm to 4:30 pm.

General Conditions: Structurally, the building appears to be in good condition, with a few cosmetic flaws. The building is riddled with mechanical thermostats, but only one appears to be working at this time. The heating system is in need of maintenance and repair. The facility overall, however, appears to be in usable condition.

Pictures of general conditions found during the field audit immediately follow this building description.

Building Envelope: The building has a plywood exterior that is in good condition and shows few signs of weathering and age. The angled standing seam metal roof is in good condition. According to occupants, the building is 30-40 years old, but it appears to be in fair condition for that age. The double pane clear glass windows are in good condition. Exterior doors do not close properly and are in need of new weather-stripping.

Heating: Two oil fired Weil-McLain boilers provide the building with heating, though they are not operating effectively at this time. A combustion analysis was performed on both of these boilers. One boiler was found to have a combustion efficiency of 81.1%. The second boiler was found to have a combustion efficiency of 80.2%, with high carbon monoxide levels. The combustion efficiency will increase with increased excess air, until the heat loss in the excess air is larger than the heat provided by more efficient combustion. When fuel and oxygen in the air are in perfect balance, the combustion is said to be stoichiometric. Proper maintenance and system calibration will increase and maintain higher efficiency levels and reduce operating costs.

Upon further investigation, Ameresco found this particular model of Weil-McLain boiler to be discontinued. Because these boilers and associated systems are functioning so ineffectively, two electric room heaters are used to keep the building warm. According to occupants, the electric heaters cannot overcome the colder temperatures experienced during the winter, and the building becomes exceedingly cold during these months, especially in the jailhouse.

Controls: The building appears to be set up for 3 heating zones with mechanical thermostats. As previously stated, however, these zones have gone through extensive re-design over the years and are no longer functioning properly. The building also has constant problems with air being introduced into the system that the system circulators cannot overcome becoming air locked. Air pockets in the piping system can function as blockages to stop flow and at one time causing a freeze up of the facility.

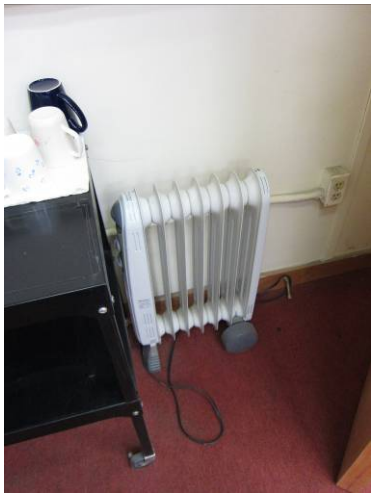
Lighting: Interior lighting is a mixture of T12 fluorescent fixtures and T8 fluorescent fixtures, all with magnetic ballasts. There are no occupancy sensors in the system.

Domestic Water: An Ariston point-of-use 4 gallon electric water heater has replaced the now-defunct Bock domestic water heater. This Ariston water heater appears to be fairly new and is in good condition. The plumbing fixtures in the jailhouse are no longer operational, so prisoners must be escorted out of their cells to use the restroom. The water heater currently meets the requirements of the limited fixtures. Should the restrooms be repaired, the domestic hot water system will need to be revised.

Building Photos: Emmonak Police Department

Old Weil-McLain Boilers

Ariston Domestic Water Heater



Oil-Filled Heater (for Courtroom)

Lasko Electric Heater (for Jailhouse)

Controls Box Containing Relays

Deteriorating Piping Insulation

1.5 EMMONAK WATER TREATMENT PLANT

Description: The Emmonak Water Treatment Plant provides clean water to the entire city. The plant has a single operator, but receives extra maintenance help when needed. The building is in good condition. Most of the equipment housed at the facility has been well-maintained, though there are several outdated pumps and motors that could be replaced with more efficient models.

General Conditions: The water treatment plant is in good condition overall. All of the mechanical equipment has been kept in good condition, even though some the HVAC is somewhat dated. No major defects were noticed during the audit walkthrough.

Pictures of general conditions found during the field audit immediately follow this building description.

Building Envelope: The building's exterior plywood façade is in good condition and shows few signs of weathering or age. The standing seam metal roof is in good condition. The double pane windows have also been kept in good condition as well. Doors are insulated aluminum frame, and weather-stripping is adequate.

Heating: Two oil-fired Weil-McLain Model 688 Series 3 boilers provide the building with heating; heat is also added from the power plant. A combustion analysis was performed and found the boilers to be 80.1% efficient. One of the boilers, however, constantly drifts out of combustion requirements, as the burner oxygen linkage is damaged and currently held together by bail wire. These boilers are also discontinued Weil-McLain models.

Controls: This building is not controlled by a DDC EMCS system. Zones are controlled by mechanical thermostats located throughout the facility.

Lighting: The building is primarily lit by high-intensity discharge (HID) 250 watt MH fixtures. Twenty-six of these fixtures are dispersed throughout the facility.

Domestic Water: The water treatment plant houses many pumps and motors of varying ages and efficiencies. Opportunities exist here for more efficient replacements.

Vacuum System: Vacuum sewage systems are installed in bush Alaska due to permafrost and lack of available pitch. The system originates at the treatment facility and is in good operational condition. The vacuum pump motor runs 24/7 to meet village requirements. A higher efficiency motor will result in measurable savings for this system.

Heat Trace System: To prevent system freeze ups, hot water heat trace pumps that run throughout the water and sewer distribution system originate from this facility. The system is manually controlled and runs at all times or at operators' discretion. Limiting the operation of the heat trace based on outside air or ground temperatures will provide significant savings to the village.

Building Photos: Emmonak Water Treatment Plant

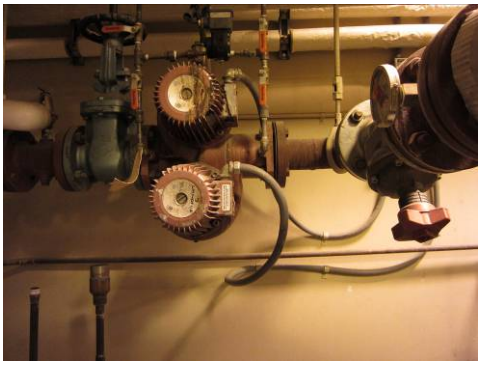
Water Treatment Plant

Boiler Furnace – Missing Linkage

Boiler Room – Missing Insulation

Water Treatment Pumps

Vacuum Pumps



Circulating Pumps

1.6 OTHER EMMONAK BUILDINGS SURVEYED

Chuloonawick Native Village Office: The Chuloonawick Native Village office in Emmonak is in fair condition. Some of the windows have been boarded up, but the remaining windows (with the exception of one broken one) are in good condition. The building exterior and roof are still in good condition. The doors seal adequately when closed. A Toyo stove space heater is used to heat the building. There is a non-function LifeBreath heat exchange ventilator in a side room. If this ventilator were to be repaired, it would greatly improve the building's interior comfort level. Lighting has already been retrofit to T8 lamps with electronic ballasts.

Public Works: The Public Works building is a pre-fabricated steel frame building with deteriorating insulation constructed on a dirt base. All of the doors are extremely leaky, and there are many areas of insulation that have become damaged and are no longer adequate. A scavenged Modine unit heater provides some space heating. Lighting to the main work bay is provided by 4,250 watt HPS hanging fixtures. The office area is lit by two T12 fluorescent fixtures with magnetic ballasts.

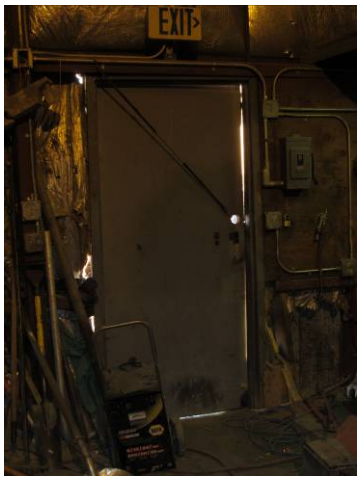
Emmonak Power Plant: The Emmonak power plant is under the authority of the Alaskan Village Electric Cooperative (AVEC). A lighting retrofit opportunity exists here, as there are 20 T12 fixtures lighting the various buildings.

Building Photos: Other Emmonak Buildings Surveyed

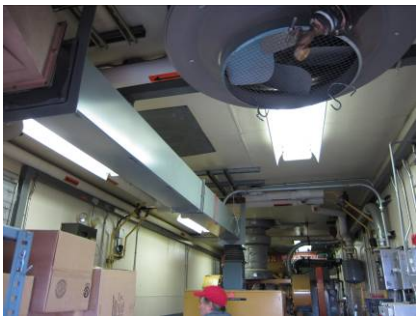
Chuloonawick – Heat Exchange Ventilator

Chuloonawick – Toyostove Heater

Public Works – Scavenged Modine Heater



Public Works – Doors Do Not Seal



Power Plant - Lighting

Power Plant – Heat Exchanger for Jacket Water

2.0 UTILITIES

2.1 ELECTRICITY

The City of Emmonak purchases its electricity from the Alaskan Village Electric Cooperative (AVEC). Village facilities are billed on an electric use and fuel use to provide the electricity. Some facilities may also qualify for a Power Cost Equalization (PCE) incentive. The AVEC rates for the City of Emmonak are listed below.

AVEC Cost of Fuel (Added to Customer Electric Bill)	$	0.2206
Rate Per kWh, Fuel Cost Included (1-700 kWh)	$	0.5206
Rate Per kWh, Fuel Cost Included (Over 700 kWh)	$	0.4206
PCE Rate (1-700 kWh)	$	0.3057
PCE Rate (Over 700 kWh)	$	0.2767

The following buildings currently receive PCE funding:

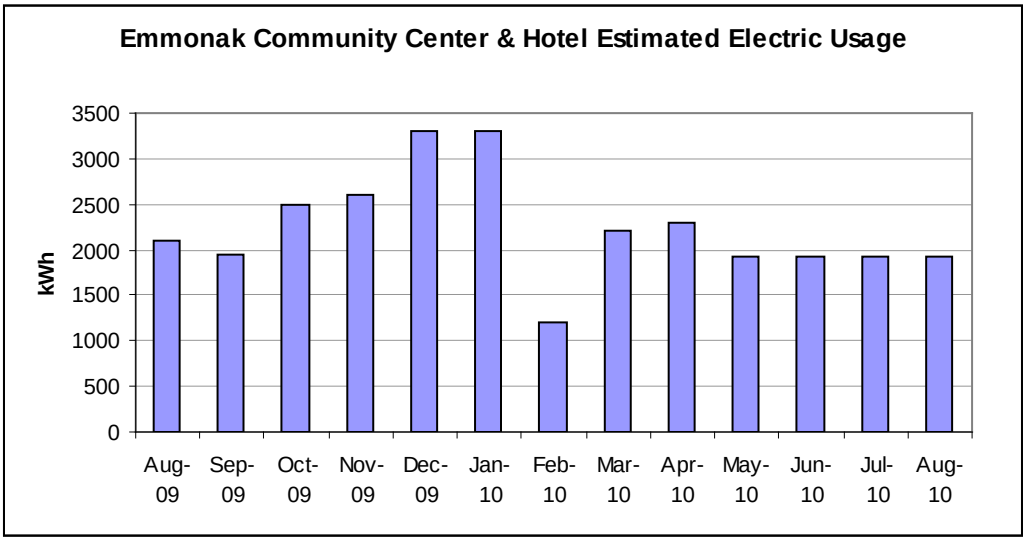
Emmonak Washeteria
Emmonak Police Department (Alaska Court System)
Emmonak Water Treatment Plant
Chuloonawick Native Village Office
Public Works Building
Emmonak Power Plant

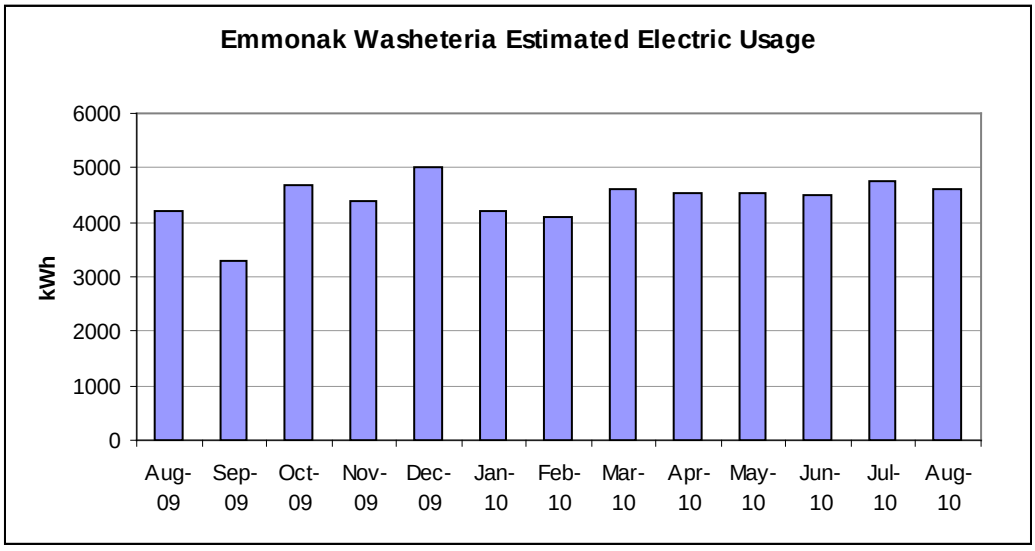
The Emmonak City Hall, Hotel, and Community Center building does not receive a monthly PCE credit at this time.

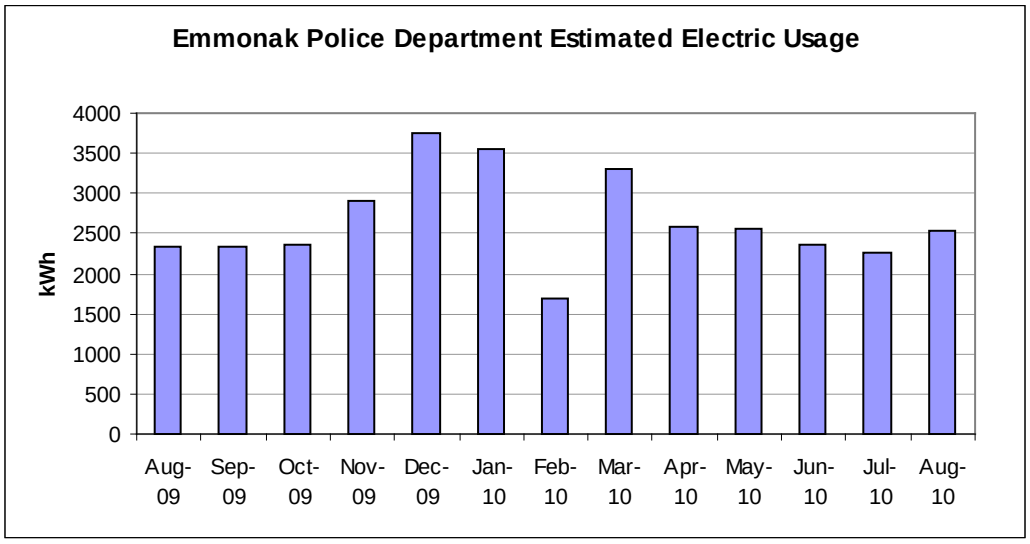
The Lower Yukon School District has its own agreement with AVEC, and, like the City Hall building, does not receive PCE funding. The AVEC rates for the Emmonak School are listed below.

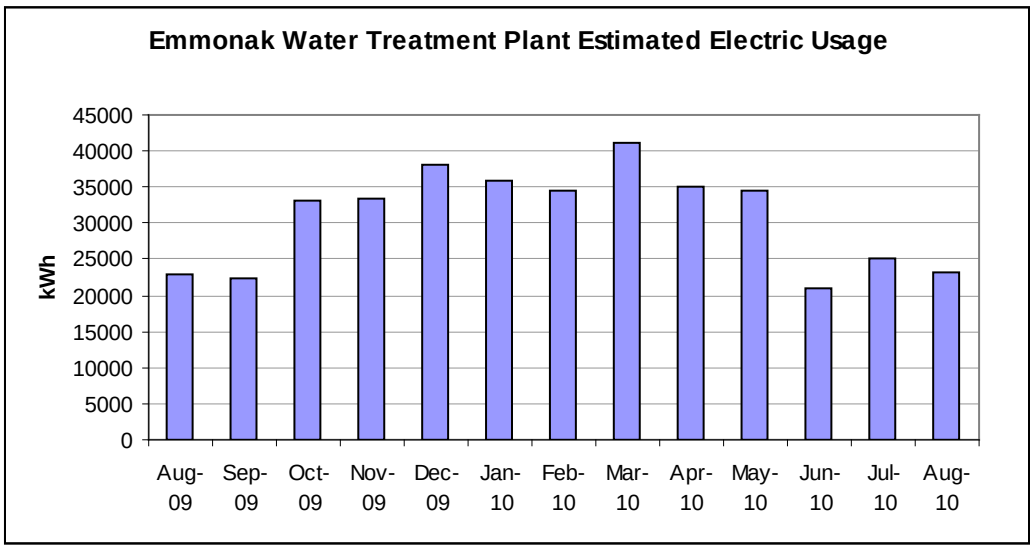
AVEC Average Cost of Fuel	$	0.2078
Rate Per kW	$	45.00
Rate Per kWh, Fuel Cost Included (1-1,500 kWh)	$	0.3278
Rate Per kWh, Fuel Cost Included (Over 1,500 kWh)	$	0.2478

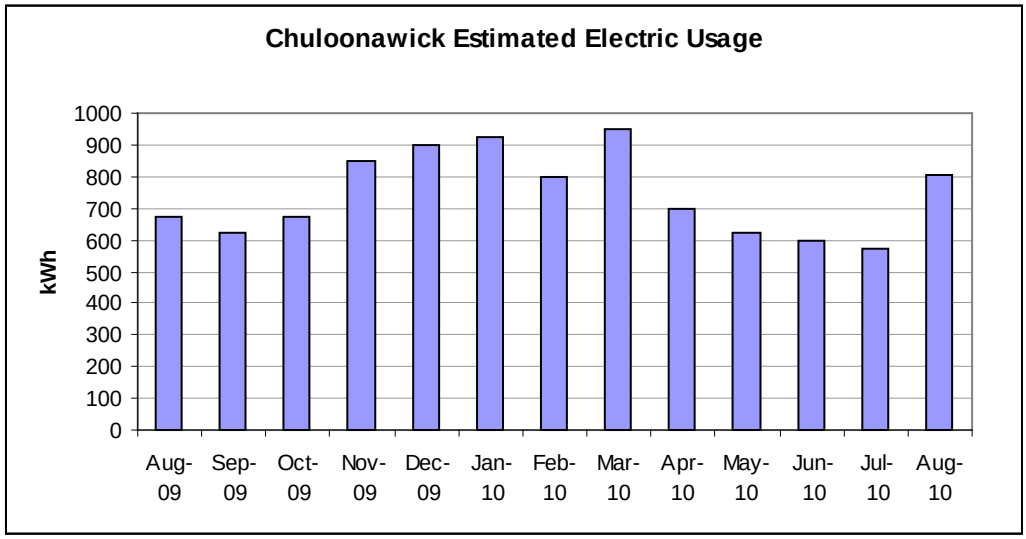
2.1.1 Electricity Usage Profiles

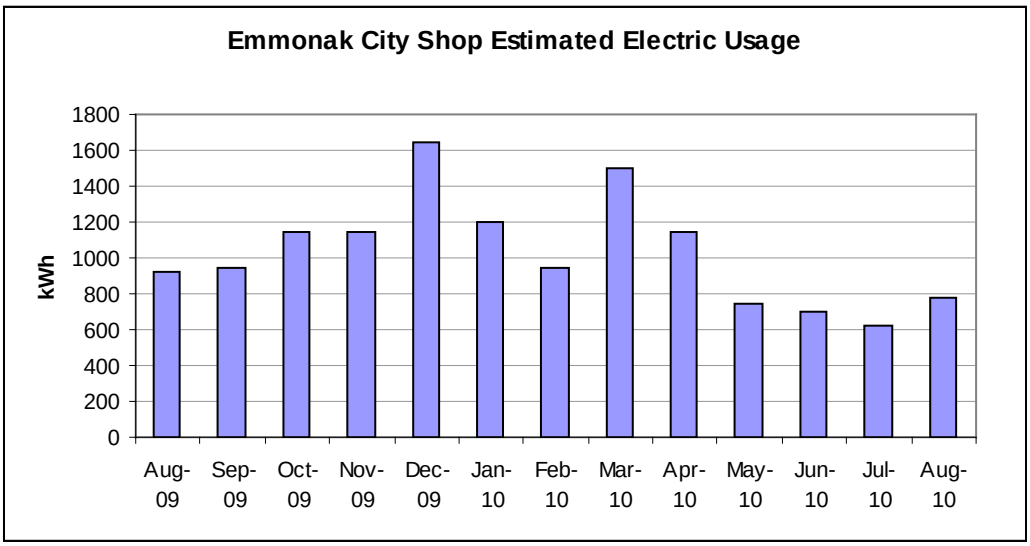


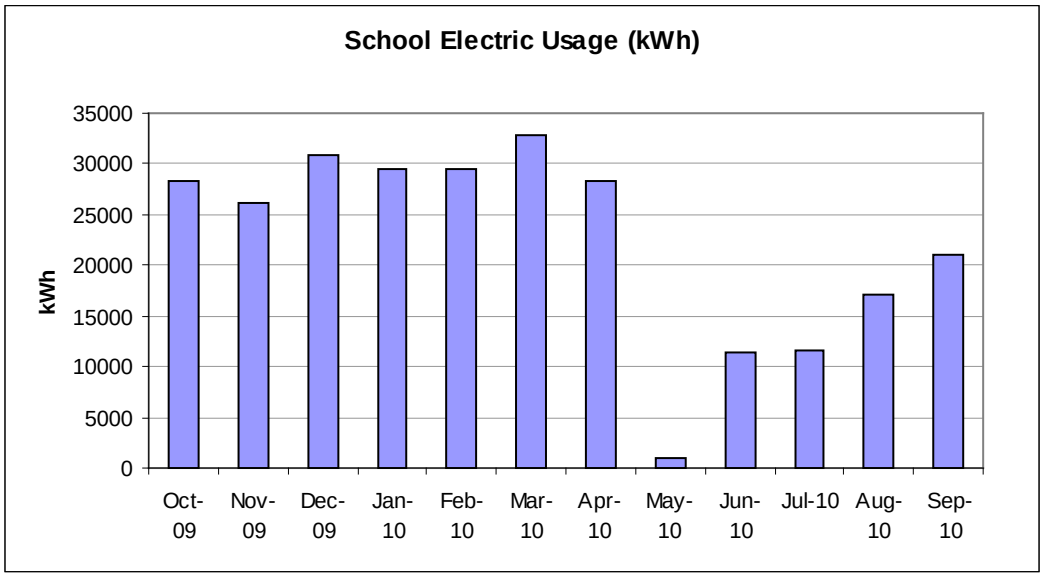


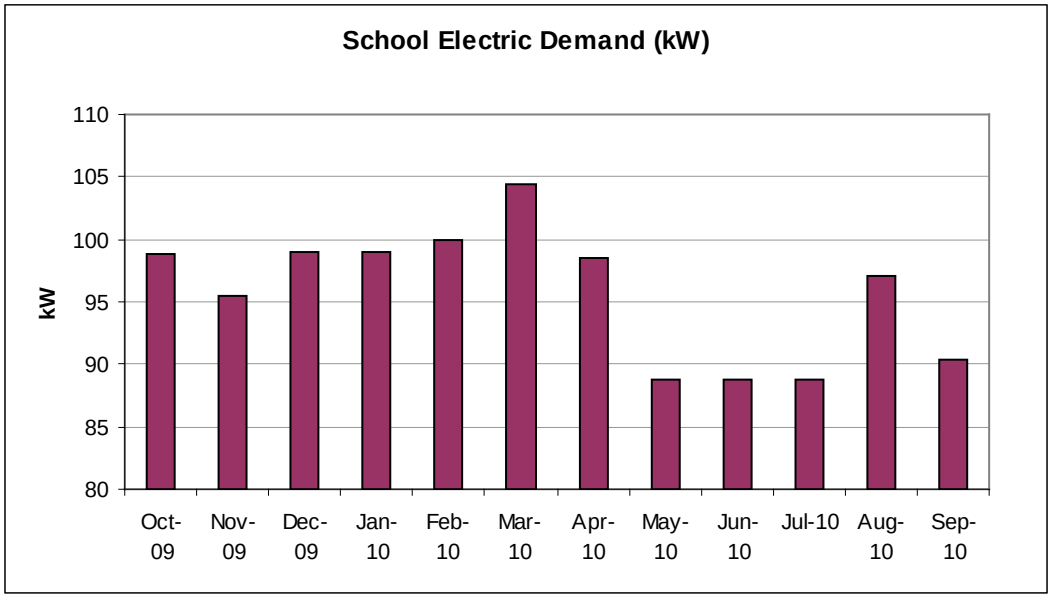

Emmonak Police Department Estimated Electric Usage
kWh
4000
3500
3000
2500
2000
1500
1000
500
0
Aug-09
Sep-09
Oct-09
Nov-09
Dec-09
Jan-10
Feb-10
Mar-10
Apr-10
May-10
Jun-10
Jul-10
Aug-10


Emmonak Water Treatment Plant Estimated Electric Usage
kWh
45000
40000
35000
30000
25000
20000
15000
10000
5000
0
Aug-09
Sep-09
Oct-09
Nov-09
Dec-09
Jan-10
Feb-10
Mar-10
Apr-10
May-10
Jun-10
Jul-10
Aug-10


Chuloonawick Estimated Electric Usage
kWh
1000
900
800
700
600
500
400
300
200
100
0
Aug-09
Sep-09
Oct-09
Nov-09
Dec-09
Jan-10
Feb-10
Mar-10
Apr-10
May-10
Jun-10
Jul-10
Aug-10


Emmonak City Shop Estimated Electric Usage
kWh
1800
1600
1400
1200
1000
800
600
400
200
0
Aug-09
Sep-09
Oct-09
Nov-09
Dec-09
Jan-10
Feb-10
Mar-10
Apr-10
May-10
Jun-10
Jul-10
Aug-10


School Electric Usage (kWh)
kWh
35000
30000
25000
20000
15000
10000
5000
0
Oct-09
Nov-09
Dec-09
Jan-10
Feb-10
Mar-10
Apr-10
May-10
Jun-10
Jul-10
Aug-10
Sep-10


School Electric Demand (kW)
kW
110
105
100
95
90
85
80
Oct-09
Nov-09
Dec-09
Jan-10
Feb-10
Mar-10
Apr-10
May-10
Jun-10
Jul-10
Aug-10
Sep-10

2.2 FUEL

The City of Emmonak purchases its fuel from Delta Western, Inc. Delta Western provides both diesel fuel as well as gasoline to the city in two bulk shipments each year. The rates paid for each fuel type are listed below.

Diesel (June 2010)	$ 3.4001
Gasoline (June 2010)	$ 3.5836
Diesel (September 2010)	$ 3.4317

The Chuloonawick Native Village office pays the Emmonak Corporation for fuel at a rate of $5.00/gallon. Chuloonawick purchases stove oil from the Emmonak Corporation every 2 to 3 months.

The Emmonak School has its own fuel contract with Crowley Petroleum Distribution, Inc. The school purchases its fuel from Crowley at a rate of $2.9286/gallon.

3.0 OPERATIONS/MAINTENANCE PRACTICES

The village has a number of designated maintenance personnel that seem to possess the basic skills required to clean and maintain selected equipment. From Ameresco's observations, if the equipment should fall into disrepair, the staff does not have the training or experience to repair the equipment per the manufacturer's requirements and tends to piece together the equipment to maintain operation. Over time, the systems no longer function as required, which currently appears to be the case of most equipment and systems with in the village.

Operations and maintenance is one area in energy services where improvement and training costs are lower than equipment replacement costs, and the energy efficiency return is high. During the site audit, Ameresco found that outside of general cleaning, most of the equipment is not maintained to meet standard manufacturers' recommendations. Dirty filters, boilers in disrepair, systems altered, and control systems disconnected are a result of limited funding and lack of system training. This results in excessive energy use, premature equipment failure, and employee and resident discomfort. An annual system check by a qualified burner service technician to perform services such as boiler cleaning, boiler tune ups, system check out, and control system reviews will not only extend the overall life of the equipment, but improve occupant comfort as well as increase and maintain long term energy efficiency.

4.0 WHOLE VILLAGE AUDIT INITIATIVES - PROPOSED

Section 4 details opportunities for the City of Emmonak's Whole Village Energy Efficiency Retrofit granted by the Alaska Energy Authority. See *Appendix B* for calculation results pertaining to Whole Village Initiatives.

4.1 LIGHTING EXCHANGE PROGRAM

Ameresco proposes a lighting exchange program that will encompasses all village buildings. Since fixtures in village building are incandescent, Ameresco proposes to send a pre-determined number of 7-watt LED lights to be exchanged for incandescent bulbs from village buildings. This program, if instituted, will decrease energy usage and costs for lighting for all buildings that take advantage of this program.

5.0 ENERGY CONSERVATION OPPORTUNITIES

The ECO matrix below summarizes the energy conservation opportunities identified during the site survey and baseline analysis. A description of each energy conservation opportunity follows the matrix. ***Please Note:*** This matrix applies to the initial proposal and the ECOs identified during that stage of the Emmonak project. There are some ECOs included in this section that were not performed, or the scope of work may have changed. *Section 5* is for reference only. See *Section 6* for updated project information.

ECO No.	ECO Description B=Building Envelope; C=Controls; E=Electrical; M=Mechanical; W=Water/Wastewater; R=Renewable	ECO MATRIX EMMONAK								
		School	City Hall	Washeteria	Police Dept	Water Treatment	Chuloonawick	Public Works	Power Plant	Whole Village
Building Envelope										
B01	Door Weather-stripping Upgrade	X	X		X					
B02	Insulation Upgrade		X				X	X		
B03	Energy Efficient Door Upgrade							X		
B04	Insulated Floor							X		
B05	Energy Efficient Window Upgrade		X							
Controls										
C01	Controls Upgrade		X	X	X					
C02	Thermostat Upgrade					X		X		
C03	System Flow Control				X	X				
Electrical										
E01	T-8 Lighting Upgrade	X	X						X	
E02	T-5 Lighting Upgrade					X		X		
E03	Occupancy Sensors	X	X	X	X		X			
E04	Premium Efficiency Motors					X				
E05	LED Lighting Upgrade									X
Mechanical										
M01	Boiler Tune-Up	X	X	X	X	X				
M02	Boiler Upgrade		X							
M03	DHW Upgrade		X							
M04	Piping Insulation		X		X					
M05	Unit Heater Upgrade							X		

VEEP - INITIAL PROPOSAL (FINAL AUDIT REPORT)				
ECO		**Cost**	**Savings**	**SPB**
B01 - WEATHERSTRIPPING	$	8,624.00	$ 827.38	10.42
E01 - T8 LIGHTING UPGRADE	$	116,454.52	$ 13,673.75	8.52
E03 - INSTALL OCCUPANCY SENSORS	$	16,500.00	$ 15,689.88	1.05
DESIGN	$	8,000.00	N/A	N/A
AVAILABLE FUNDING	$	421.48		
* Available funding allocated for travel expenses, shipping, additional labor, etc				
TOTAL	**$**	**150,000.00**	**$ 30,191.02**	**4.97**

WHOLE VILLAGE - INITIAL PROPOSAL (FINAL AUDIT REPORT)				
ECO		**Cost**	**Savings**	**SPB**
B02 - THERMAL INSULATION UPGRADE	$	29,760.00	$ 2,275.31	13.08
B04 - INSULATED FLOOR	$	157,640.00	$ 900.85	174.99
C01 - CONTROLS UPGRADE	$	85,876.00	$ 21,028.34	4.08
C02 - PROGRAMMABLE THERMOSTATS	$	1,218.00	$ 11,732.79	0.10
C03 - SYSTEM FLOW CONTROL	$	15,960.00	$ 160.63	99.36
E02 - T5 LIGHTING UPGRADE	$	9,515.00	$ 1,225.01	7.77
E05 - LED LIGHTING UPGRADE	$	20,400.00	$ 1,436.40	14.20
M01 - BOILER TUNE-UP	$	18,900.00	$ 69,851.93	0.27
M02 - BOILER UPGRADE	$	42,000.00	$ 13,185.08	3.19
M03 - DOMESTIC WATER HEATER UPGRADE*	$	-	$ 555.48	0.00
AVAILABLE FUNDING	$	18,731.00		
TOTAL	**$**	**400,000.00**	**$ 122,351.83**	**3.27**

EECBG - INITIAL PROPOSAL (FINAL AUDIT REPORT)				
ECO		**Cost**	**Savings**	**SPB**
B03 - ENERGY EFFICIENT DOOR UPGRADE	$	16,800.00	$ 900.85	18.65
B05 - ENERGY EFFICIENT WINDOW UPGRADE	$	9,458.25	$ 200.13	47.26
E04 - PREMIUM EFFICIENCY MOTORS UPGRADE	$	17,556.00	$ 1,171.83	14.98
M04 - PIPING INSULATION	$	1,820.00	$ 2,213.87	0.82
M05 - UNIT HEATER UPGRADE	$	10,080.00	$ 793.64	12.70
DESIGN	$	14,100.00	N/A	N/A
AVAILABLE FUNDING	$	2,285.75		
TOTAL	**$**	**72,100.00**	**$ 5,280.33**	**13.65**

** M03 is bundled with M02, therefore there is no cost applied to this ECO although the savings are broken out. See Section 5.1.4 for more details.*

5.1 ECO DESCRIPTIONS – PROPOSED

Below are the descriptions of the Energy Conservation Opportunities (ECOs) that Ameresco analyzed for the Village of Emmonak. These include Ameresco's initial project recommendations for the village.

5.1.1 Building Envelope Opportunities

B01 – Door Weather-stripping Upgrade

This ECO proposes applying weather stripping to exterior door perimeters to reduce air infiltration into the buildings. Many building doors have existing weather stripping material which is worn or missing.

B02 – Thermal Insulation Upgrade

This ECO proposes installing blown-in roof insulation on existing building envelopes to reduce energy consumption. Insulation can be added to roofs to increase or renew their insulating ratings (R-value).

B03 – Energy Efficient Doors

This ECO proposes installing new insulated doors. The installation would improve U-values of the current hollow metal doors, single pane glass doors, and un-insulated bay doors connected to conditioned spaces.

B04 – Insulated Floor Upgrade

This ECO proposes installing an insulated floor in the Emmonak Public Works building. The structure currently resides on a dirt floor, which allows much of the building's heating to escape. An insulated floor would prevent the majority of this energy from escaping and would in turn greatly lower the building's fuel usage.

B05 – Energy Efficient Windows

This ECO proposes installing new windows with improved heat transfer resistivity. This ECO would improve insulating values of the fenestration and reduce the negative energy effects of insolation.

5.1.2 Controls Opportunities

C01 – Controls Upgrade

This ECO proposes installing or repairing existing control systems to effectively minimize energy demand and consumption. A properly operational control system will also result in O&M savings, improved comfort, and energy savings. In many cases, this ECO also includes installing programmable thermostats in village buildings to ensure proper HVAC scheduling. This ECO also encompasses the dryer heating system in the Emmonak Washeteria.

C02 – Thermostat Upgrade

This ECO proposes replacing the outdated mechanical thermostats with 7-day programmable thermostats. The programmable thermostats would allow a building's HVAC system to be scheduled to operate in comfortable conditions while occupied and allow for night set-backs.

C03 – System Flow Control

This ECO proposes redesigning the system flow in various facilities to be more efficient. Projects identified include the Police Department's building heating system and the heat trace system at the Water Treatment Plant.

5.1.3 Electrical Opportunities

E01 – T8 Lighting Upgrade

This ECO proposes replacing current T-12 fluorescent lighting and magnetic ballast with T-8 lamps and electronic ballasts. Post-light levels will be nearly equal or better to that of the existing lighting systems,

E02 – T5 Lighting Upgrade

This ECO proposes replacing high intensity discharge (HID) lighting systems in the medium and high bay areas such as the water treatment plant, maintenance shops, school, etc., with T5 fluorescent fixtures. HID lighting is often used in areas with high ceilings or roof structures. The fixtures generate high luminous flux, are reasonably energy efficient, and are long lasting. Such systems often remain illuminated continuously since the re-strike times make periodic switching in irregularly occupied spaces a nuisance. Continuous operation of HID fixtures reduces the overall energy efficiency of lighting systems designed around their use. Newer, high output fluorescent sources, characterized by quick warm-up, with instant light output and improved efficiency, are now being used in place of many medium wattage HID fixtures in low and high bay applications. Post-light levels will be nearly equal to that of the existing lighting systems

E03 – Occupancy Sensors

Lighting systems are often left energized in unoccupied areas. This ECO proposes to install sensors to shut off lighting in unoccupied spaces. Common sensing technologies include infrared, ultrasonic, and audible sound, often combining multiple types of sensing in one unit to avoid shutting off lights in an occupied area.

E04 – Premium Efficiency Motors

This ECO proposes installing National Electrical Manufacturers Association (NEMA) premium efficiency motors to replace standard and high efficiency motors. There are various mechanical systems

operating with inefficient motors throughout the base. Premium efficiency motors typically increase energy efficiency by 2-3%.

E05 – LED Lighting Upgrade

See *Section 4.3.*

5.1.4 Mechanical Opportunities

M01 – Boiler Tune-Up

This ECO proposes a comprehensive re-commissioning of the boilers in each building to optimize system operations. Such efforts include:

- Replace, repair, calibrate or install sensors or switches
- Repair air linkages
- Conduct combustion efficiency test services
- Clean combustion chambers and stacks

M02 – Boiler Upgrade

This ECO proposes replacing existing hot-water heating boilers with more energy efficient units. Many of the existing units in the village are original to the buildings they serve and have reached the end of their useful service life. Boilers employing modern technology can be installed to reduce energy consumption, improve system operations, and reduce maintenance costs. In some cases, this ECO proposes adding a storage tank to replace a building's domestic water heater. See *M03* for details.

M03 – Domestic Hot Water Heater Upgrade

This ECO proposes replacing the current inefficient fuel oil burning domestic water heaters (DWHs) with more efficient electric models. Because the cost of fuel is so high in Emmonak, the cost-saving potential in fuel oil vs. electric is quite high. From the consumer's view, this ECO generates enough savings to merit installation. When considering the cost of generating electricity to run the new DWHs, however, this ECO is no longer viable unless an old DWH is already in need of replacement. Because of this high cost of producing electricity, this ECO is no longer viable for the Emmonak School.

In the case of the Emmonak City Hall, Hotel, and Community Center, however, this ECO has been tied together with M02. The current domestic water heater at the City Hall will be demolished and a storage tank will be included in the boiler upgrade to the building. M03 in *Appendix A*, therefore, reflects only the savings of no longer running a stand-alone domestic water heater. The installation costs for the storage tank have been included in the pricing of M02 in *Appendix B.*

M04 – Piping Insulation

Un-insulated or poorly insulated hot water pipes and result in unnecessary heat gain/loss and lead to longer runs times for boilers. This ECO proposes to add insulation where it is non-existent or to replace damaged insulation.

M05 – Unit Heater Upgrade

Ameresco proposed to install a new fuel oil unit heater at the city Public Works building and eliminate the currently installed model. The current fuel oil burner is a Modine model POR145B with a heating capacity of 145MBH. The burner has a hand-written install date of 1999, but occupants informed Ameresco that this particular heater had been scavenged for the Public Works building at another date, so this install date is inaccurate. A more efficient Reznor model has been chosen as the replacement.

6.0 FINAL COSTING AND CHANGES FROM INITIAL REPORTING

Due to the brief nature of these contracts and the high cost of travel to and from the villages, audits were conducted a quickly and efficiently as possible. Once engineers have left the villages, communication is strained at best, and gathering additional information is difficult. Because of this, assumptions must be made during the initial ECO assessments and project cost estimates. Occasionally, Ameresco engineers have found that previously identified projects have been externally funded from another source, but this information usually comes too late in the process. As a result of all these factors, some previously identified projects have been modified or abandoned. Final project costs and expected annual savings can be found in *Appendix A*, *Appendix B*, and *Appendix C*.

6.1 CHANGES FROM INITIAL REPORTING – WHOLE VILLAGE (APPENDIX A)

B01 – Weather-stripping

Installed as planned.

B02 – Thermal Insulation Upgrade

Newly added ECO. Completed in the Chuloonawick Native Village Office and Public Works building.

B03 – Energy Efficient Door Upgrade

Two of the three originally proposed doors were installed as planned.

B04 – Insulated Floor Upgrade

ECO removed from scope. GDM engineers completed the design drawings, but there was not enough available funding to complete the project.

B05 – Energy Efficient Window Upgrade

Removed from the Whole Village scope. This ECO has been completed under the EECBG scope.

B06 – Roof Upgrade

Newly added ECO. Completed in the City Hall building.

C01 – Controls Upgrade

Completed as planned.

C02 – Programmable Thermostat Upgrade

Removed from the Whole Village scope. This ECO has been completed under the EECBG scope.

C03 – System Flow Control

Removed. This ECO was completed under the scope of C01.

E02 – T5 Lighting Upgrade

Installed as planned.

E05 – LED Lighting Upgrade

Completed as planned. The Alaska Housing Craftsman Program distributed 600 LED light bulbs during a Village Energy Efficiency Fair.

M01 – Boiler Tune-Up

Completed as planned in all buildings except for the City Hall. The boilers in the City Hall were replaced instead under the scope of M02.

M02 – Boiler Upgrade

Installed as planned. The City Hall boiler upgrade has been included in the scope of this ECO.

M03 – Domestic Water Heater Upgrade

Installed as planned.

6.2 CHANGES FROM INITIAL REPORTING – VEEP (APPENDIX B)

E01 – T8 Lighting Upgrade

Installed as planned in all buildings except for the Power Plant. Power Plant fixtures were high output (HO) fixtures and could not be replaced with typical T8 fixtures.

E03 – Occupancy Sensor

Installed as planned, though only 36 of the originally proposed 55 sensors could be installed due to grounding and work box sizing issues.

6.3 CHANGES FROM INITIAL REPORTING – EECBG (APPENDIX C)

B05 – Energy Efficient Window Upgrade

Newly added to the EECBG scope (previously under Whole Village). This ECO was installed as planned.

C02 – Programmable Thermostat Upgrade

Newly added to the EECBG scope (previously under Whole Village). This ECO was installed as planned.

E04 – Premium Efficiency Motor Upgrade

Installed as planned for 9 of the originally proposed 11 motors. Stripped isolation valves prevented 2 of the motors from being replaced.

M04 – Piping Insulation Upgrade

Installed as planned.

M05 – Unit Heater Upgrade

Installed as planned.

6.3 FUNDING ALLOCATION SUMMARY TABLES

WHOLE VILLAGE - PROJECT COSTS & EXPECTED SAVINGS - EMMONAK				
ECO	**Cost**	**Savings**	**SPB**	
B01 - WEATHER-STRIPPING UPGRADE	$ 6,108.66	$ 827.38	7.38	
B02 - THERMAL INSULATION UPGRADE	$ 43,691.97	$ 1,540.43	28.36	
B03 - ENERGY EFFICIENT DOOR UPGRADE	$ 13,771.29	$ 900.85	15.29	
B04 - INSULATED FLOOR	$ 15,762.97	*N/A*	*N/A*	
B06 - ROOF UPGRADE	$ 305,364.05	$ 3,373.67	90.51	
C01 - CONTROLS UPGRADE	$ 14,099.27	$ 17,133.47	0.82	
E02 - T5 LIGHTING UPGRADE	$ 33,757.31	$ 1,365.75	24.72	
E05 - LED LIGHTING UPGRADE	$ 25,061.95	$ 1,769.27	14.17	
M01 - BOILER TUNE-UP	$ 19,413.64	$ 24,780.28	0.78	
M02 - BOILER UPGRADE	$ 37,102.00	$ 2,605.98	14.24	
M03 - DOMESTIC WATER HEATER UPGRADE	$ 8,070.48	$ 555.48	14.53	
TOTAL PROJECT COST	**$ 522,203.59**	**$ 54,852.57**	**9.52**	
TOTAL WHOLE VILLAGE GRANT	**$ 400,000.00**			
REALLOCATED FROM EMMONAK VEEP FUNDS	**$ 74,344.94**			
BUDGET EXCEEDED	**$ (47,858.65)**			

VEEP - PROJECT COSTS & EXPECTED SAVINGS - EMMONAK			
ECO	**Cost**	**Savings**	**SPB**
E01 - T8 LIGHTING UPGRADE	$ 62,277.70	$ 13,563.13	4.59
E03 - INSTALL OCCUPANCY SENSORS	$ 13,377.35	$ 7,858.48	1.70
AVAILABLE FUNDING	$ 74,344.94		
**Available funding has been allocated to the Whole Village scope.*			
TOTAL PROJECT COST	**$ 75,655.06**	**$ 21,421.61**	**3.53**
TOTAL GRANT	**$ 150,000.00**		

EECBG - PROJECT COSTS & EXPECTED SAVINGS - EMMONAK					
ECO		**Cost**		**Savings**	**SPB**
B05 - ENERGY EFFICIENT WINDOW UPGRADE	$	22,313.78	$	200.13	111.49
C02 - PROGRAMMABLE THERMOSTATS	$	4,155.94	$	9,405.35	0.44
E04 - PREMIUM EFFICIENCY MOTORS UPGRADE	$	36,453.86	$	1,082.54	33.67
M04 - PIPING INSULATION	$	2,230.83	$	2,213.87	1.01
M05 - UNIT HEATER UPGRADE	$	6,897.50	$	793.64	8.69
AVAILABLE FUNDING **Remaining funding at this site will be considered as available funding on future EECBG projects within the contract.*	$	48.09			
TOTAL	**$**	**72,100.00**	**$**	**13,695.54**	**5.26**

APPENDIX A

WHOLE VILLAGE PROJECT COSTS & EXPECTED SAVINGS

APPENDIX A - WHOLE VILLAGE PROJECT COSTS & EXPECTED SAVINGS - EMMONAK

Note: All savings reported below are annual savings for each ECO, unless specifically stated otherwise.
Note: The reported simple paybacks are based on the type of ECO listed. For example, electrical ECOs only use the Annual kWh Cost Savings column to calculate the SPB, even though the Annual Equivalent Fuel Cost Savings is still reported.

B01 - WEATHER-STRIPPING UPGRADE

Building	# of Doors	Price Per Door	Total Cost	Electric kWh Savings	Fuel mmBtu Savings	Total mmBtu Savings	Equivalent Fuel Gallons Savings	Annual kWh Cost Savings	Annual Equivalent Fuel Cost Savings	Simple Payback
School	8	$555.33	$4,442.66	0.00	26.35	26.35	195.21	$0.00	$571.71	7.77
City Hall	2	$555.33	$1,110.67	0.00	7.36	7.36	54.51	$0.00	$186.41	5.96
Police Department	1	$555.33	$555.33	0.00	2.73	2.73	20.25	$0.00	$69.27	8.02

B02 - THERMAL INSULATION UPGRADE

Building	Current Insulation	Proposed Insulation	Total Cost	Electric kWh Savings	Fuel mmBtu Savings	Total mmBtu Savings	Equivalent Fuel Gallons Savings	Annual kWh Cost Savings	Annual Equivalent Fuel Cost Savings	Simple Payback
Chuloonawick	R-19	R-38	$31,557.33	0.00	23.77	23.77	176.09	$0.00	$602.24	52.40
Public Works	R-19	R-38	$12,134.64	0.00	37.03	37.03	274.32	$0.00	$938.19	12.93

B03 - ENERGY EFFICIENT DOOR UPGRADE

Building	# of Doors	Price Per Door	Total Cost	Electric kWh Savings	Fuel mmBtu Savings	Total mmBtu Savings	Equivalent Fuel Gallons Savings	Annual kWh Cost Savings	Annual Equivalent Fuel Cost Savings	Simple Payback
Public Works	2	$6,885.64	$13,771.29	0.00	35.56	35.56	263.41	$0.00	$900.85	15.29

B04 - INSULATED FLOOR

Building	Floor Square-Footage	Insulation Added	Total Cost	Electric kWh Savings	Fuel mmBtu Savings	Total mmBtu Savings	Equivalent Fuel Gallons Savings	Annual kWh Cost Savings	Annual Equivalent Fuel Cost Savings	Simple Payback
Public Works	2400	*N/A*	$15,762.97	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*

B06 - ROOF UPGRADE

Building	Current Insulation	Proposed Insulation	Total Cost	Electric kWh Savings	Fuel mmBtu Savings	Total mmBtu Savings	Equivalent Fuel Gallons Savings	Annual kWh Cost Savings	Annual Equivalent Fuel Cost Savings	Simple Payback
City Hall	R-19	R-38	$305,364.05	0.00	138.10	138.10	986.45	0.00	$3,373.67	90.51

C01 - CONTROLS UPGRADE

Building	# of Thermo-stats Installed	Controls Upgrade	Total Cost	Electric kWh Savings	Fuel mmBtu Savings	Total mmBtu Savings	Equivalent Fuel Gallons Savings	Annual kWh Cost Savings	Annual Equivalent Fuel Cost Savings	Simple Payback
Washeteria	1	*1**	$11,270.09	0.00	541.48	541.48	4,010.95	$0.00	$13,717.46	0.82
Police Department	3	*2**	$2,829.18	2,829.18	134.84	134.84	998.83	$0.00	$3,416.01	0.83

**1. A total of 10 3-way valves were installed in the Washeteria.*
**2. Circulator/Air Vent & Scoop*

E02 - T5 LIGHTING UPGRADE

Building	# of Fixtures	Price Per Fixture	Total Cost	Electric kWh Savings	Annual Electric kW Savings	Equivalent mmBtu Savings	Equivalent Fuel Gallons Savings	Annual kWh & kW Cost Savings	Annual Equivalent Fuel Cost Savings	Simple Payback
Water Treatment	13	$1,985.72	$25,814.42	4,277.73	17.63	14.60	310.43	$1,183.65	$1,061.67	21.81
Public Works	4	$1,985.72	$7,942.90	658.11	5.42	2.25	47.76	$182.10	$163.33	43.62

E05 - LED LIGHTING UPGRADE

Number of Bulbs to be Exchanged	Typical Lamp Wattage (kW)	LED Wattage (kW)	Total Cost	Electric kWh Savings	Annual Electric kW Savings	Total mmBtu Savings	Equivalent Fuel Gallons Savings	Total Annual kWh Cost Savings	Annual Equivalent Fuel Cost Savings	Simple Payback
600	60	7	$25,061.95	5,787.60	31.80	19.75	420.00	$1,769.27	$1,436.40	14.17

M01 - BOILER TUNE-UP

Building	Number of Boilers	Increase in Efficiency	Total Cost	Electric kWh Savings	Fuel mmBtu Savings	Total mmBtu Savings	Equivalent Fuel Gallons Savings	Annual kWh Cost Savings	Annual Equivalent Fuel Cost Savings	Simple Payback
School	2	1.4%	$4,853.41	0.00	282.65	282.65	2,018.96	$0.00	$6,904.86	0.70
Washeteria	2	1.7%	$4,853.41	0.00	113.29	113.29	809.18	$0.00	$2,767.41	1.75
Police Department	2	9.0%	$4,853.41	0.00	190.63	190.63	1,361.62	$0.00	$4,656.73	1.04
Water Treatment	2	1.3%	$4,853.41	0.00	427.83	427.83	3,055.93	$0.00	$10,451.29	0.46

M02 - BOILER UPGRADE

Building	# of Boilers to Replace	New Boiler Efficiency (AFUE)	Total Cost	Electric kWh Savings	Fuel mmBtu Savings	Total mmBtu Savings	Equivalent Fuel Gallons Savings	Annual kWh Cost Savings	Annual Equivalent Fuel Cost Savings	Simple Payback
City Hall	2	85.70%	$37,102.00	0.00	106.68	106.68	761.98	$0.00	$2,605.98	14.24

M03 - DOMESTIC WATER HEATER UPGRADE

Building	# of Water Heaters to Replace	Price Per Heater	Total Cost	Current Annual mmBtu	Proposed Annual kWh	Equivalent Annual mmBtu	Current Annual Fuel Cost	Proposed Annual kWh Cost	Annual Equivalent Fuel Cost Savings	Simple Payback
City Hall	1	$8,070.48	$8,070.48	21.93	0.00	0.00	$555.48	$0.00	$555.48	14.53

APPENDIX B

VEEP PROJECT COSTS & EXPECTED SAVINGS

APPENDIX B - VEEP PROJECT COSTS & EXPECTED SAVINGS - EMMONAK

Note: All savings reported below are annual savings for each ECO, unless specifically stated otherwise.
Note: The reported simple paybacks are based on the type of ECO listed. For example, electrical ECOs only use the Annual kWh Cost Savings column to calculate the SPB, even though the Annual Equivalent Fuel Cost Savings is still reported.

E01 - T8 LIGHTING UPGRADE

Building	# of Fixtures	Price Per Fixture	Total Cost	Electric kWh Savings	Annual Electric kW Savings	Equivalent mmBtu Savings	Equivalent Fuel Gallons Savings	Annual kWh & kW Cost Savings	Annual Equivalent Fuel Cost Savings	Simple Payback
School	311	$163.46	$50,835.60	25,615.70	145.20	87.43	1,858.90	$12,881.57	$6,357.45	3.95
City Hall	36	$163.46	$5,884.51	1,676.66	9.50	5.72	121.67	$241.27	$416.12	24.39
Police Department	34	$163.46	$5,557.59	1,591.20	0.68	5.43	0.00	$440.29	$0.00	12.62

Note (School): The savings for E01 at the Emmonak School are high for several reasons -
1. The school is one of the most commonly used facilities in the village, even after regular hours. The lights, therefore, burn longer than those in most other buildings.
2. The quantity of lights to be replaced at the school is much higher than that of the other buildings. The savings, therefore, will be much higher.
3. The school is the only facility to be charged for electric kW demand use. Because E01 reduces demand, the school will also realize savings from this reduction.
4. The Police Department T8 retrofit involves replacing the current T8 and T12 fixtures and magnetic ballasts with T8 fixtures with electronic ballasts.

E03 - INSTALL OCCUPANCY SENSORS

Building	# of Fixtures	Price Per Fixture	Total Cost	Electric kWh Savings	Annual Electric kW Savings	Equivalent mmBtu Savings	Equivalent Fuel Gallons Savings	Annual kWh & kW Cost Savings	Annual Equivalent Fuel Cost Savings	Simple Payback
School	14	$371.59	$5,202.30	23,286.97	0.00	79.48	1,689.91	$5,770.51	$5,779.49	0.90
City Hall	7	$371.59	$2,601.15	4,280.57	0.00	14.61	310.64	$919.90	$1,062.38	2.83
Washeteria	5	$371.59	$1,857.97	1,506.27	0.00	5.14	109.31	$323.70	$373.84	5.74
Police Department	5	$371.59	$1,857.97	1,783.94	0.00	6.09	129.46	$383.37	$442.75	4.85
Chuloonawick	5	$371.59	$1,857.97	2,145.21	0.00	7.32	155.68	$461.01	$532.41	4.03

APPENDIX C

EECBG PROJECT COSTS & EXPECTED SAVINGS

APPENDIX C - EECBG PROJECT COSTS & EXPECTED SAVINGS - EMMONAK

Note: All savings reported below are annual savings for each ECO, unless specifically stated otherwise.
Note: The reported simple paybacks are based on the type of ECO listed. For example, electrical ECOs only use the Annual kWh Cost Savings column to calculate the SPB, even though the Annual Equivalent Fuel Cost Savings is still reported.

B05 - ENERGY EFFICIENT WINDOW UPGRADE

Building	# of Windows	Price Per Window	Total Cost	Electric kWh Savings	Fuel mmBtu Savings	Total mmBtu Savings	Equivalent Fuel Gallons Savings	Annual kWh Cost Savings	Annual Equivalent Fuel Cost Savings	Simple Payback
City Hall	11	Varies w/Size	$22,313.78	0.00	7.90	7.90	58.52	$0.00	$200.13	111.49

C02 - PROGRAMMABLE THERMOSTATS

Building	# of Thermo-stats Installed	Price Per Thermostat	Total Cost	Electric kWh Savings	Fuel mmBtu Savings	Total mmBtu Savings	Equivalent Fuel Gallons Savings	Annual kWh Cost Savings	Annual Equivalent Fuel Cost Savings	Simple Payback
City Hall	3	$415.59	$1,246.78	0.00	153.74	153.74	1,098.18	$0.00	$3,755.77	0.33
Police Department	6	$415.59	$2,493.56	0.00	134.84	134.84	963.16	$0.00	$3,294.01	0.76
Public Works	1	$415.59	$415.59	0.00	96.43	96.43	688.76	$0.00	$2,355.58	0.18

E04 - PREMIUM EFFICIENCY MOTORS UPGRADE

Building	# of Motors	Price Per Motor	Total Cost with Markup	Electric kWh Savings	Annual Electric kW Savings	Equivalent mmBtu Savings	Equivalent Fuel Gallons Savings	Annual kWh & kW Cost Savings	Annual Equivalent Fuel Cost Savings	Simple Payback
Water Treatment	9	Varies w/HP	$36,453.86	3,541.19	1.28	12.09	256.98	$1,082.54	$878.87	33.67

M04 - PIPING INSULATION

Building	Feet of Pipe to Insulate	Price Per Foot of Insulation	Total Cost with Markup	Electric kWh Savings	Fuel mmBtu Savings	Total mmBtu Savings	Equivalent Fuel Gallons Savings	Annual kWh Cost Savings	Annual Equivalent Fuel Cost Savings	Simple Payback
City Hall	100	$6.50	$1,493.33	0.00	50.43	50.43	373.57	$0.00	$1,277.62	1.17
Police Department	100	$6.50	$737.50	0.00	36.96	36.96	273.76	$0.00	$936.25	0.79

M05 - UNIT HEATER UPGRADE

Building	# of Heaters to Install	Price Per Heater	Total Cost with Markup	Electric kWh Savings	Fuel mmBtu Savings	Total mmBtu Savings	Fuel Gallons Savings	Annual kWh Cost Savings	Annual Fuel Cost Savings	Simple Payback
Public Works	1	$6,897.50	$6,897.50	0.00	32.49	32.49	232.06	$0.00	$793.64	8.69

APPENDIX D

EQUATIONS USED IN CALCULATIONS

APPENDIX D - EQUATIONS USED IN CALCULATIONS - EMMONAK

ECO ***Equations***

B01 1. Door Leakage Area (in2) = Door Area x Door Leakage Factor

2. Specific Infiltration (CFM/in2) = [(Stack Coefficient x ΔT) + (Wind Coefficient x [Wind Speed]2)]1/2
3. ΔT = Heating Setpoint Temp - Bin Temp
4. Air Infiltration (CFM) = Specific Infiltration x Door Leakage Area
5. Heat Loss Rate (Btu/hr) = 1.08 x Air Infiltration x ΔT
6. Heating Load (mmBtu) = Heat Loss Rate x Bin Hours / 1,000,000
7. Energy Savings = Baseline - Proposed

Note: This ECO was completed using the RETscreen program.

B02 *Note: This ECO was completed using the RETscreen program.*
Inputs are R-values reported in the appendices as well as the insulation square footage.

B03 *Note: This ECO was completed using the eQuest program.*
Two building models were created and compared using pre- and post-install door upgrade data.

B04 *Note: This ECO was completed using the eQuest program.*
Two building models were created and compared using pre- and post-install insulated floor.

C01 *Note: This ECO is based on bin data, occupancy, heating peak loads, boiler efficiency, and an assumed night setback.*
Baseline Usage = (Peak Load x Occupied Load Profile x All Hours) / Boiler Eff.
ECM Usage = [(Peak Load x Occupied Load Profile x Occupied Hours)
+ (Peak Load x Unoccupied Load Profile x Unoccupied Hours)] / Boiler Eff.
mmBtu Saved = Baseline Usage - ECM Usage

C02 *Note: This ECO is based on bin data, occupancy, heating peak loads, boiler efficiency, and an assumed night setback.*
Baseline Usage = (Peak Load x Occupied Load Profile x All Hours) / Boiler Eff.
ECM Usage = [(Peak Load x Occupied Load Profile x Occupied Hours)
+ (Peak Load x Unoccupied Load Profile x Unoccupied Hours)] / Boiler Eff.
mmBtu Saved = Baseline Usage - ECM Usage

E01 1. Baseline Demand (kW) = (Existing Fixture Wattage) x (Qty) X (12 Months) / (1,000)
2. Baseline Usage (kWh) = (Baseline Demand) x (Fixture Hours)
3. Proposed Demand (kW) = (Proposed Fixture Wattage) x (Qty) X (12 Months) / (1,000)
4. Proposed Usage (kWh) = (Proposed Demand) x (Fixture Hours)
5. Annual Energy Savings = (Baseline Energy Usage) - (Proposed Energy Usage)
6. Annual Cost Savings = (Energy Savings) x (Energy Cost)

E02 1. Baseline Demand (kW) = (Existing Fixture Wattage) x (Qty) X (12 Months) / (1,000)
2. Baseline Usage (kWh) = (Baseline Demand) x (Fixture Hours)
3. Proposed Demand (kW) = (Proposed Fixture Wattage) x (Qty) X (12 Months) / (1,000)
4. Proposed Usage (kWh) = (Proposed Demand) x (Fixture Hours)
5. Annual Energy Savings = (Baseline Energy Usage) - (Proposed Energy Usage)
6. Annual Cost Savings = (Energy Savings) x (Energy Cost)

E03 1. Baseline Usage (kWh) = (Existing Fixture Wattage) x (Qty) x (Existing Hours) / (1,000)
2. Proposed Usage (kWh) = (Existing Fixture Wattage) x (Qty) x [(Existing Hours) - (Hours Reduced)] / (1,000)
3. Annual Energy Savings = (Baseline Energy Usage) - (Proposed Energy Usage)
4. Annual Cost Savings = (Energy Savings) x (Energy Cost)

E04 1. Existing/Proposed Motor Demand (kW) = (Motor HP) x (Load Factor) x (0.746 kW/HP)/ Motor Efficiency
2. Existing/Proposed Motor Consumption (kWh) = (Motor Demand) x (Diversity Factor) x (Annual Hours)
3. kW Savings = [(Baseline kW) - (Proposed kW)] x (12 Months)
4. kWh Savings = (Baseline kWh) - (Proposed kWh)
5. Energy Cost Savings = Energy Savings (kW or kWh) x (Energy Unit Cost)

E05 1. Baseline Demand (kW) = (Existing Fixture Wattage) x (Qty) X (12 Months) / (1,000)
2. Baseline Usage (kWh) = (Baseline Demand) x (Fixture Hours)
3. Proposed Demand (kW) = (Proposed Fixture Wattage) x (Qty) X (12 Months) / (1,000)
4. Proposed Usage (kWh) = (Proposed Demand) x (Fixture Hours)
5. Annual Energy Savings = (Baseline Energy Usage) - (Proposed Energy Usage)
6. Annual Cost Savings = (Energy Savings) x (Energy Cost)

M01 Savings (MBtu) = (Boiler Input Rating) x ((1/Tested Efficiency)-(1/Desired Efficiency)) x (Hours per Year)
Savings ($) = (MBtu Savings) x (Energy Cost)

M02 Savings (MBtu) = (Boiler Input Rating) x ((1/Old Boiler Efficiency)-(1/New Boiler Efficiency)) x (Hours per Year)
Savings ($) = (MBtu Savings) x (Energy Cost)

M03
1. Annual Energy Usage (mmBtu) = (41,045 Btu/Day) x (Total Days/Yr) x (Total Heaters) / (Energy Factor or Thermal Efficiency)
2. Annual Energy Usage (kWh) = (12.03 kWh/Day) x (Total Days/Yr) x (Total Heaters) / (Energy Factor or Thermal Efficiency)
3. (Commercial Type Heaters) Annual Standby Losses (mmBtu) = (Btu/Hr) x (24 Hrs/Day) x (Total Days/Yr) x (Total Heaters) / (1,000,000)
4. (Electric Type Heaters) Annual kW Use = System kW x 12
5. (Commercial Type Heaters) Total Annual Energy Usage (mmBtu) = Annual Energy Usage + Annual Standby Losses
6. Annual Savings = Baseline Conditions - Proposed Conditions

M04 Energy Loss (MBtu) = (uninsulated loss - insulated loss) x (system hours) x (# of ft or sqft of hot surface)
Savings ($) = (energy loss in MBtu) x (cost of source fuel per MBtu)

M05 *Note: This ECO is based on bin data, occupancy, heating peak loads, heater efficiency, and an assumed night setback.*
Baseline Usage = (Peak Load x Occupied Load Profile x All Hours) / (Old Heater Efficiency)
ECM Usage = (Peak Load x Occupied Load Profile x All Hours) / (New Heater Efficiency)
mmBtu Saved = Baseline Usage - ECM Usage

FOR C03

Tables 2A and 2B - 1995 Commercial Building Energy Consumption
2003 ASHRAE Applications Handbook, Chapter 35

	Energy End-Use (1,000 Btu/ft^2-yr)		
Building Characteristics	**Space Heat**	**Cool**	**Ventilation**
Education	32.8	4.8	1.6
Food sales	27.5	13.4	4.4
Food service	30.9	19.5	5.3
Health care	55.2	9.9	7.2
Lodging	22.7	8.1	1.7
Mercantile and service	30.6	5.8	2.5
Office	24.3	9.1	5.2
Public assembly	53.6	6.3	3.5
Public order and safety	27.8	6.1	2.3
Religious worship	23.7	1.9	0.9
Storage/Warehouse	15.7	0.9	0.3
Vacant	11.9	0.6	0.3

FOR E03 - Hours Reduced

From the Energy Management Handbook, Turner, 4th Edition Table 13.8 p361
Savings from installing occupancy sensors are as follows:

Offices (Private)	25-50%
Offices (Open Spaces)	20-25%
Rest Rooms	30-75%
Corridors	30-40%
Storage Areas	45-65%
Meeting Rooms	45-65%
Conference Rooms	45-65%
Warehouses	50-75%

FOR E04

Load factor assumed to be 80% except in some cases. Vacuum pumps assumed 100% load factor.
Diversity factor assumed to be 95%.

APPENDIX E

POST INSTALLATION PHOTOS

APPENDIX E – POST INSTALLATION PHOTOS - EMMONAK

Boiler Upgrade

T8 Lighting Upgrade

Window Upgrade

High Efficiency Motor Upgrade