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ENERGY AUDIT
POST INSTALLATION REPORT

Results and Recommendations from Energy Audit of Kaltag

For VEEP Grants
City of Kaltag, Alaska

June 20, 2012

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APPENDICES

EXECUTIVE SUMMARY AND PREFACE

This Post Installation Report summarizes the results of an Ameresco Energy Audit of the City of Kaltag, the initial energy savings measures identified and proposed, and any changes that may have occurred throughout the installation process. The City of Kaltag is a recipient of an Alaska Energy Authority (AEA) Village Energy Efficiency Program (VEEP) grant of $150,000.

Ameresco engineers conducted an energy audit of the City of Kaltag on January 10-11, 2011. The table below shows the buildings audited and their respective square footages.

City of Kaltag - Building Summary

Building	Category	Square Footage
City Office	Public Building	1,920
Clinic	Public Facility	1,050
Fire Hall	Public Building	576
School	School	17,125
Washeteria & Water Treatment Plant	Public Facility	2,450
Youth & Learning Center	Public Building	713

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).

The table below shows the actual costs of the project and expected annual savings. See *Appendix A* 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.

VEEP ECOS - PROJECT COSTS & EXPECTED SAVINGS - KALTAG

ECO	Cost	Savings	SPB
B01 - WEATHERSTRIPPING	$ 12,181.97	$ 1,218.83	9.99
B02 - THERMAL INSULATION UPGRADE	$ 36,265.40	$ 1,442.51	25.14
C01 - THERMOSTAT UPGRADE	$ 1,469.97	$ 1,301.81	1.13
E01 - T8 LIGHTING UPGRADE	$ 9,305.39	$ 809.27	11.50
E02 - T5 LIGHTING UPGRADE	$ 10,246.33	$ 2,016.56	5.08
E03 - INSTALL OCCUPANCY SENSORS	$ 8,642.00	$ 3,286.07	2.63
E04 - PREMIUM EFFICIENCY MOTORS UPGRADE	$ 15,141.84	$ 511.46	29.60

VEEP ECOS - PROJECT COSTS & EXPECTED SAVINGS - KALTAG			
ECO	**Cost**	**Savings**	**SPB**
E05 - CFL LIGHTING UPGRADE	$ 1,755.68	$ 498.60	3.52
E06- STREET LIGHTING UPGRADE	$ 22,529.82	$ 3,107.15	7.25
M01 - BOILER TUNE-UP	$ 7,526.16	$ 6,818.95	1.10
M02 - DOMESTIC WATER HEATER UPGRADE	$ 25,463.92	$ 1,159.89	21.95
TOTAL	**$150,528.49**	**$22,171.11**	**6.79**
TOTAL GRANT	**$150,000.00**		
BUDGET EXCEEDED	**$ (528.49)**		

1.0 BUILDING DESCRIPTIONS

1.1 KALTAG CITY OFFICE

Description: The City Office building contains office space, storage space, and a gym. Typical building operating hours are 0900 to 1700 hours, Monday through Friday.

General Conditions: Although this is one of the largest buildings in the village, at the time of the audit, only one person occupied the space. This city manager works in the offices on the second floor of the building. The building was most likely constructed during the 1970's. There are several offices and a gym facility, but these are not used at this time.

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

Building Envelope: The building structure of the log cabin-style facility appears to be in good condition. The maintenance operator informed Ameresco engineers that there is no insulation between the interior and exterior walls, but the fuel bills gathered by Ameresco do not reflect this assumption. This building does see higher fuel use than many other village facilities, but this is most likely due to the size of the building and not the absence of insulation. The roof is in fair condition, but melting snow shows evidence of poor attic insulation. The weather-stripping is in poor condition and needs to be upgraded. There are some penetrations left from the old boiler stack that maintenance personnel have filled with fiberglass insulation and plastic bags, but it is not adequately sealed.

Heating: Building heating is provided by a Buderus boiler that is paired with a hot water storage tank. The boiler is a model G115 series, and the hot water storage tank is a 160-gallon LT model. The Buderus boiler is newly installed, and operators are pleased with its operation and fuel consumption rates. A combustion analysis was performed on this boiler over the course of the audit and showed the boiler to be operating at 84.2% combustion efficiency.
Controls: Building heating is controlled by a single digital thermostat.

Lighting: Interior lighting consists primarily of T8 fluorescent lamps with electronic ballasts. There are no occupancy sensors in the building.

Domestic Water: There is not a domestic water system in place in this building.

Building Photos: Kaltag City Office

Building Exterior – Note Melting Snow

Attic Insulation

Break in Interior Wall – No Insulation

Buderus Boiler and Hot Water Storage Tank

Old Boiler Stack Penetration

Failing Window

1.2 KALTAG CLINIC

Description: The Kaltag Clinic treats minor ailments and injuries in the village. Those in more serious conditions are sent to larger towns for treatment. The Clinic's typical operating hours are 0900 to 1600 hours, Monday through Friday.

General Conditions: The building is in fair condition overall and there are some concerns of cold air entering the building through its floor due to poor insulation. There have been several issues with the sewer system, most likely due to freezing.

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

Building Envelope: The building is in fair condition, and the roof has inadequate insulation that is allowing heat to escape the building and the snow on the roof to melt. The double pane windows are in fair condition with wood frames. Weather-stripping is in poor condition and needs to be upgraded.

Heating: Building heating is provided by two Monitor oil stoves with internal thermostats. One stove serves as the primary unit, and the other serves as a backup when the temperature drops. There is also an Amana window AC unit with no nameplate. The condenser side of this unit has not been properly insulated for the weather conditions.

Controls: The oil stoves have internal thermostats that control heating output. There are no additional building controls.

Lighting: Interior lighting fixtures are primarily T8 fluorescent lamps with electromagnetic ballasts. There are no occupancy sensors in the building.

Domestic Water: A 30 gallon Rheem electric water heater provides the building with domestic hot water.

Building Photos: Kaltag Clinic

Attic Insulation

Insulation and Sewer System Under Building

Monitor Heater

Rheem Water Heater

Amana Window Unit

Monitor Heater

1.3 KALTAG FIRE HALL (FORMER)

Description: The Kaltag Fire Hall building no longer functions as the village's fire department. This building is now used primarily as a rental property during the Iditarod dog sled race. Because of this, the building does not have typical operating hours. The village will most likely keep this building shut down during non-Iditarod winter months to save money. The building was operational at the time of the audit, but this could be due to the recent installation of a new boiler and performance testing.

General Conditions: The building was constructed most likely in the 1970's and is in fair condition overall. Although there are several opportunities for improvement, because this facility is used so infrequently, energy efficient upgrades do not merit closer investigation at this time.

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

Building Envelope: The roof is in poor condition and does not have enough insulation to retain the building heat load. Due to this lack of insulation, the roof ventilation has been somewhat sealed to prevent airflow. Attic insulation should be upgraded so that the ventilation can be reopened to prevent the wood from rotting due to condensation. Windows are in good condition. Exterior doors are in poor condition, and weather-stripping needs to be upgraded.

Heating: Building heating is provided by a Buderus boiler that is paired with a hot water storage tank. The boiler is a model G115 series, and the hot water storage tank is a 160-gallon LT model. The Buderus boiler is newly installed, and operators are pleased with its operation and fuel consumption rates.

Controls: There is one mechanical thermostat and one digital thermostat that control space heating. One thermostat is designated per floor of the building.

Lighting: Interior lighting is primarily T12 fluorescent fixtures with magnetic ballasts. There are no occupancy sensors in this building.

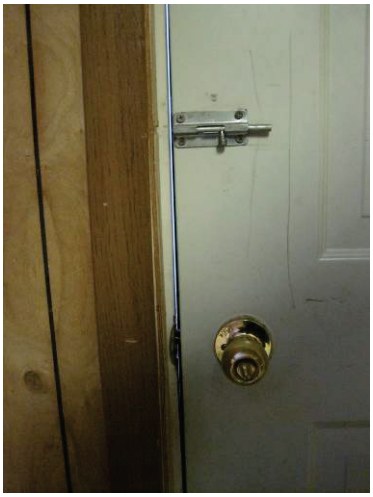
Domestic Water: Domestic hot water is provided by a 40-gallon Rheem electric water heater.

Building Photos: Kaltag Fire House (Former)

Attic Insulation

Buderus Boiler and Hot Water Storage Tank

Roof Ventilation Blocked



Missing Weather-stripping

Bathroom and Rheem Electric Water Heater

Exterior Windows in Good Condition

1.4 KALTAG SCHOOL

Description: The Kaltag School houses elementary through high school students. Typical operating hours are 0800 to 1700, Monday through Friday, but the building is also used for a variety of after school activities throughout the week.

General Conditions: The building was constructed in 1973 and is in fair condition overall. There are several concerns with leaking building envelope components, and there are many opportunities for improvement.

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

Building Envelope: The roof is in poor condition, and there is not enough roof insulation to retain building heat. Maintenance statements show that this is causing the snow on the roof to melt and leak into offices; this is most likely due to the lack of rain gutters on the roof to properly distribute precipitation. Windows are in good condition. Exterior doors are in good condition, though a weather-stripping upgrade is recommended. The exterior mechanical room does not have an attic or cold zone, so nothing is preventing the heat from escaping through the roof.

Heating: The boiler room is a separate building located behind the school. There are 5 residential Weil-McLain Gold Oil boilers that provide the building with heat. A ventilation fan with an auto start feature engages every time one of the boilers turns on, regardless of the internal temperature of the mechanical room. Combustion analyses were performed on these boilers at the time of the audit and showed them to be operating at 83.8 to 84.8% combustion efficiency. The gym has several hot water unit heaters to provide additional space heating when needed.

Controls: The boilers operate on a direct-digital control (DDC) system. Further investigation is required to determine whether the system is programmed correctly with night set backs.

Lighting: Lighting is primarily T8 fluorescent fixtures with electronic ballasts, though a few T12 fixtures remain scattered throughout the school. Gym lighting consists of 400 W mercury vapor (MV) and metal

halide (MH) fixtures. Restrooms have occupancy sensors. Installing occupancy sensors in classrooms would generate substantial energy savings.

Domestic Water: A Bock 68 gallon fuel oil water heater provides the building with domestic hot water.

Building Photos: Kaltag School

Weil-McLain Boilers

Glycol Overflow Lines

Exhaust Fan

Gym Lighting

Exposed Insulation

Unit Heaters and Piping in Gym

1.5 KALTAG WASHETERIA AND WATER TREATMENT PLANT

Description: The Kaltag 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. The building also houses a Washeteria facility to meet the village's laundering needs. The Washeteria operates 1400 to 1800 hours, Monday, Wednesday, and Friday. The Washeteria is also open 1100 to 1800 hours on Saturdays, as well as from 1200 to 1700 hours on Sundays. The Water Treatment Plant has a 4 hour shift Monday through Friday, but the operator is on call as needed.

General Conditions: The water treatment plant is in good condition overall, having been built sometime between 2000 and 2002. 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 roof is in fair condition. The current attic insulation levels are not adequately retaining building heat. Windows are in fair condition, and some of them do not operate properly. Doors are in good condition, though weather-stripping, when present, is inadequate. There is a gap between a backwash waste line and the roof that has been sealed with silicon; this seal is not tight, however, and water is leaking into the building.

Heating: Three Weil-McLain boilers provide the building with heating and hot water. Two of these boilers are commercial models, while one is a residential Gold Oil model. At the time of the audit, one of the commercial boilers was out of order. Before Ameresco engineers left the village, however, the boiler was fixed and a combustion analysis was performed. The analysis showed the boiler to be operating at 83, 84.5, and 87.4% combustion efficiencies. There is also a hydronic Modine unit heater in the Washeteria area.

Controls: Building heating is controlled by a mechanical thermostat.

Lighting: The building is primarily lit by T12 fluorescent fixtures with magnetic ballasts. Several incandescent fixtures are present as well. There are no occupancy sensors in the building.

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: Kaltag Washeteria and Water Treatment Plant

Washeteria Thermostat

Penetration Not Sealed Well – Leaking Water

Melting Snow – Poor Insulation

Weil-McLain Boilers

Modine Hydronic Unit Heater

Washeteria Setup

Water Treatment Pumps – Rust Building Up

No Weather-stripping

1.6 KALTAG YOUTH AND LEARNING CENTER

Description: The Kaltag Youth and Learning Center functions as an after school program for the children of the village. Typical operating hours are 1800 to 2000 hours, Monday through Friday. The Youth Center also houses overnight visitors to the village on any night of the week.

General Conditions: The building was constructed in 1982 and is in fair condition overall.

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

Building Envelope: The building is in fair condition overall. The roof has poor insulation, and the snow is melting due to heat loss. The single pane windows are in fair condition. Weather-stripping is inadequate and is in need of an upgrade.

Heating: Two Toyostove oil stove provide the building with space heating. One of these stoves serves as the primary heating source, while the second is a backup for when the temperature falls, or if the first one fails.

Controls: There are no additional building controls.

Lighting: The building is primarily lit by T8 fluorescent fixtures with electronic ballasts. There are no occupancy sensors in the building.

Domestic Water: A 50 gallon American electric domestic water heater provides the building with hot water.

Building Photos: Kaltag Youth and Learning Center

Low Roof Insulation – Melting Snow

American Water Heater

Poor Weather-stripping

Backup Toyostove

Primary Toyostove

2.0 UTILITIES

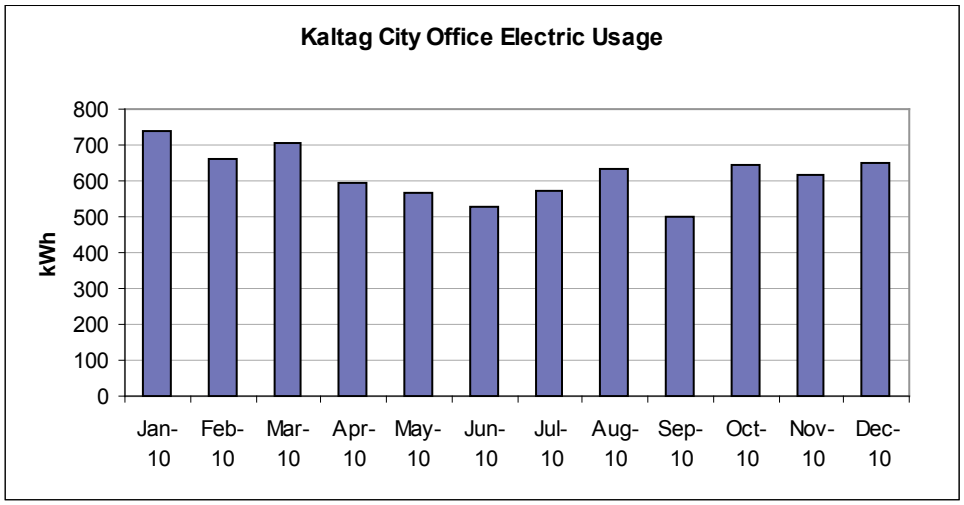
2.1 ELECTRICITY

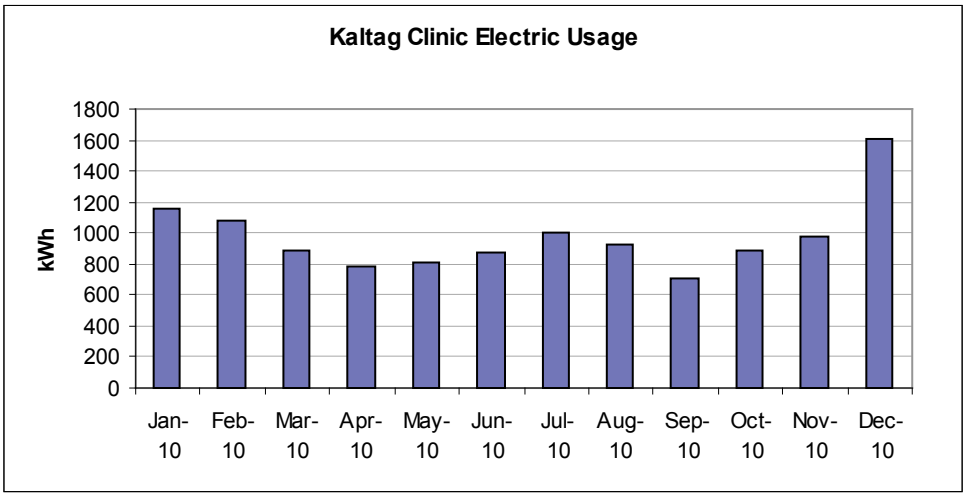
The City of Kaltag purchases its electricity from the Alaskan Village Electric Cooperative (AVEC). Village facilities are billed on an electric use and fuel use to provide the electricity. Some facilities may also qualify for a Power Cost Equalization (PCE) incentive. The AVEC rates for the City of Kaltag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

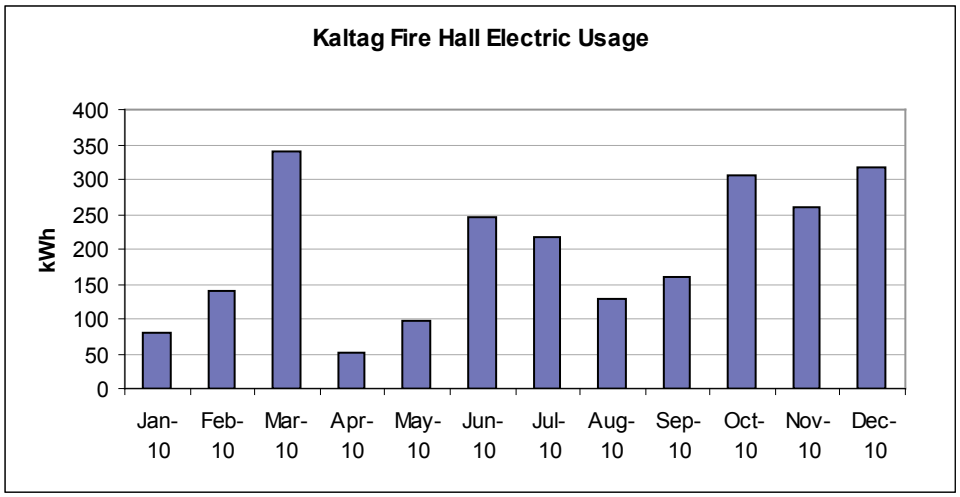
Current Rates as of January 2011	
AVEC Cost of Fuel (Added to Customer Electric Bill)	$ 0.2155
Rate Per kWh, Fuel Cost Included (1-700 kWh)	$ 0.5155
Rate Per kWh, Fuel Cost Included (Over 700 kWh)	$ 0.4155
PCE Rate (1-700 kWh)	$ 0.3009
PCE Rate (Over 700 kWh)	$ 0.2729
Rates August 2010 - December 2010	
AVEC Cost of Fuel (Added to Customer Electric Bill)	$ 0.2415
Rate Per kWh, Fuel Cost Included (1-700 kWh)	$ 0.5415
Rate Per kWh, Fuel Cost Included (Over 700 kWh)	$ 0.4415
PCE Rate (1-700 kWh)	$ 0.3256
PCE Rate (Over 700 kWh)	$ 0.2976
Rates for Calculations, Including Fuel Cost and PCE Incentive	
Rate for Calcs (1-700 kWh)	$ 0.2146
Rate for Calcs (700+ kWh)	$ 0.1426

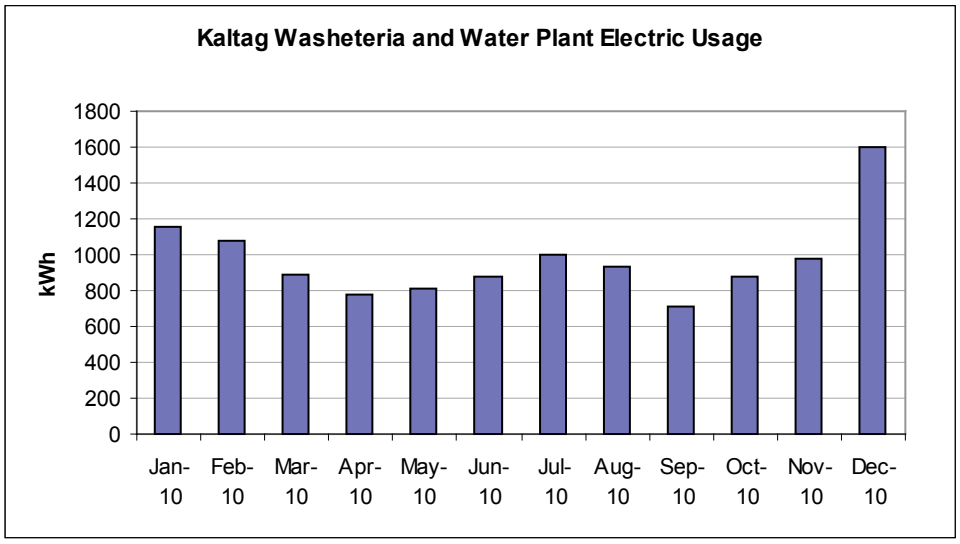
Bills for the Kaltag School were not readily available at the time of the audit. The school has therefore been assumed to pay the same electric rates as the rest of the village. Most AVEC affiliated schools also pay a $45/kW charge, so this was included in savings calculations as well.

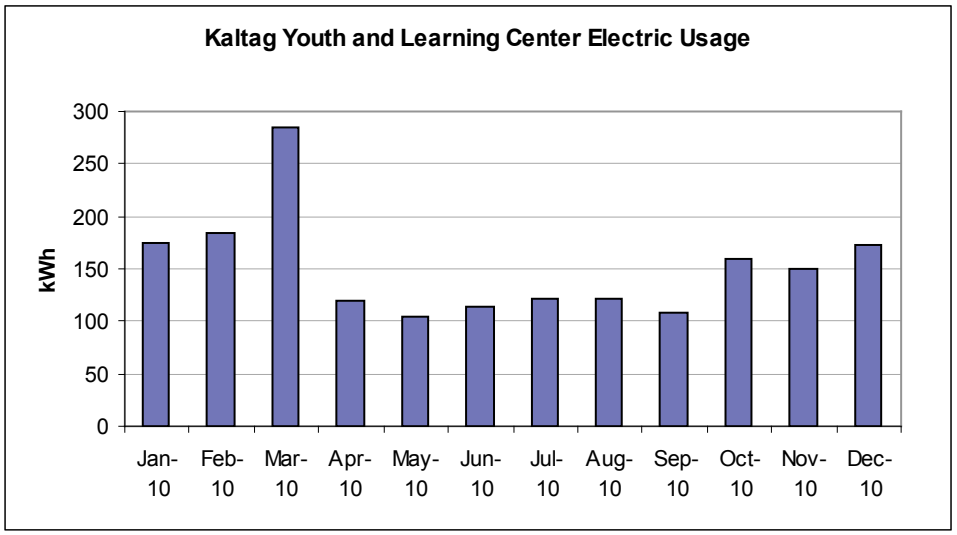
2.1.1 Electricity Usage Profiles







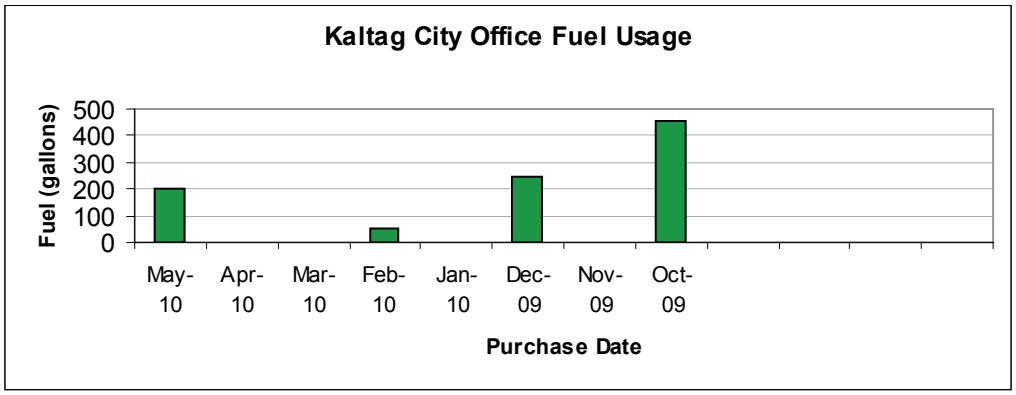


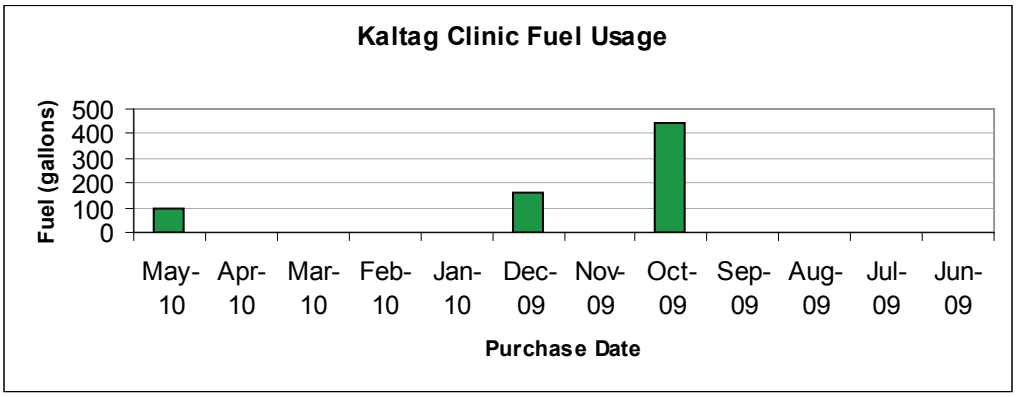


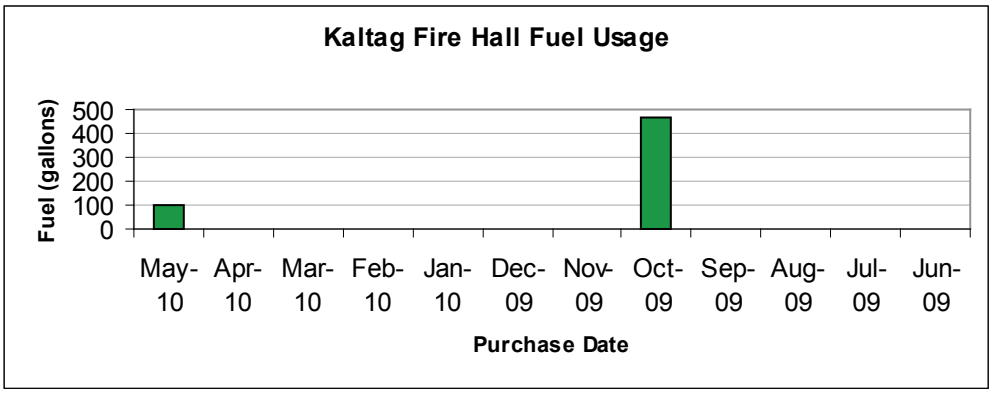
2.2 FUEL

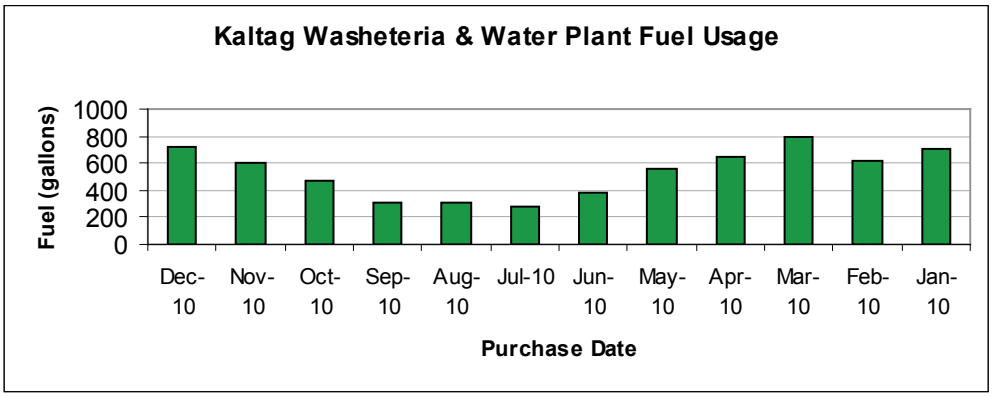
The City of Kaltag purchases its fuel from Crowley Petroleum Distribution. Bills were not readily available at the time of the audit, so Ameresco engineers average fuel rates from the surrounding villages of Koyukuk, Nikolai, Beaver, Holy Cross, Shageluk, and Fort Yukon. The average rate used for calculations is $4.67/gallon.

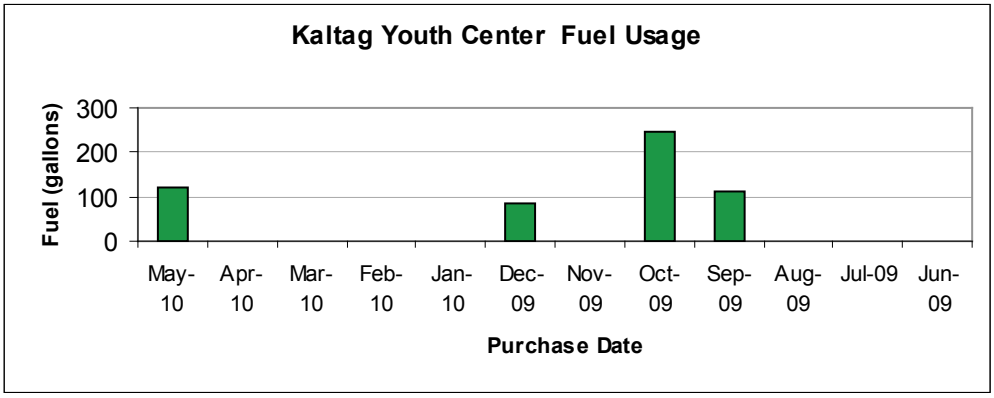
2.2.1 Fuel Usage Profiles








Kaltag Washeteria & Water Plant Fuel Usage
Fuel (gallons)
1000
800
600
400
200
0
Dec-10
Nov-10
Oct-10
Sep-10
Aug-10
Jul-10
Jun-10
May-10
Apr-10
Mar-10
Feb-10
Jan-10
Purchase Date


Kaltag Youth Center Fuel Usage
Fuel (gallons)
300
200
100
0
May-10
Apr-10
Mar-10
Feb-10
Jan-10
Dec-09
Nov-09
Oct-09
Sep-09
Aug-09
Jul-09
Jun-09
Purchase Date

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 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 Koyukuk project. There are some ECOs included in this section that were not performed, or the scope of work may have changed. *Section 4* is for reference only. See *Section 5* for updated project information.

ECO No.	ECO Description B=Building Envelope; C=Controls; E=Electrical; M=Mechanical; W=Water/Wastewater; R=Renewable	ECO MATRIX KALTAG				
		City Office	Clinic	School	Washeteria & Water Treatment	Youth Center
Building Envelope						
B01	Door Weather-stripping Upgrade	X	X	X	X	X
B02	Insulation Upgrade	X	X		X	X
Controls						
C01	Thermostat Upgrade	X			X	
Electrical						
E01	T-8 Lighting Upgrade			X	X	
E02	T-5 Lighting Upgrade			X		
E03	Occupancy Sensors	X	X	X	X	X
E04	Premium Efficiency Motors				X	
E05	CFL Lighting Upgrade		X	X	X	X
Mechanical						
M01	Boiler Tune-Up	X		X	X	
M02	Domestic Water Heater Upgrade		X		X	

VEEP – INITIAL PROPOSAL (FINAL AUDIT REPORT)			
ECO	**Cost**	**Savings**	**SPB**
B01 - WEATHERSTRIPPING	$ 11,000.00	$ 1,218.83	9.03
B02 - THERMAL INSULATION UPGRADE	$ 30,000.00	$ 1,778.26	16.87
C01 - THERMOSTAT UPGRADE	$ 1,800.00	$ 6,260.71	0.29
E01 - T8 LIGHTING UPGRADE	$ 16,000.00	$ 828.62	19.31
E02 - T5 LIGHTING UPGRADE	$ 18,000.00	$ 2,016.56	8.93
E03 - INSTALL OCCUPANCY SENSORS	$ 13,000.00	$ 3,459.39	3.76
E04 - PREMIUM EFFICIENCY MOTORS UPGRADE	$ 14,000.00	$ 511.46	27.37
E05 - CFL LIGHTING UPGRADE	$ 750.00	$ 498.60	1.50
M01 - BOILER TUNE-UP	$ 20,000.00	$ 8,833.23	2.26
M02 - DOMESTIC WATER HEATER UPGRADE	$ 6,500.00	$ 1,159.89	5.60
DESIGN/AUDIT	$ 2,500.00		
AVAILABLE FUNDING	$ 16,450.00		
** Available funding allocated for travel expenses, shipping, additional labor, etc*			
TOTAL	**$ 150,000.00**	**$ 26,565.56**	**5.65**

4.1 ECO DESCRIPTIONS

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

4.1.1 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).

4.1.2 Controls Opportunities

C01 – 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.

4.1.3 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 – CFL Lighting Upgrade

This ECO proposes replacing current incandescent bulbs in audited village buildings with compact fluorescent (CFL) lamps. This is a simple and effective retrofit with easy installation.

4.1.4 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 existing electric or fuel oil tank-type water heaters with fuel oil instantaneous Toyotomi OM-128 models. Standby losses will be eliminated, as there is no need to continuously heat tanks of water until they are needed. Where electric water heaters are replaced, additional savings will come from the cost of generating electricity.

5.0 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 *Section 5.2* and *Appendix A*. ECOs that were categorized as "Not Funded," whether in the initial stages of the proposal or during construction, can be found in *Appendix B*.

5.1 CHANGES FROM INITIAL REPORTING

B01 – Door Weather-stripping Upgrade

Installed as planned.

B02 – Thermal Insulation Upgrade

Installed as planned in the City Office, Clinic, and Youth Center. This ECO was rejected at the Washeteria building and instead installed in the Fire Hall and Head Start building.

C01 – Programmable Thermostat Upgrade

Installed as planned in the City Office. This ECO was rejected at the Washeteria due to voltage compatibility issues.

E01 – T8 Lighting Upgrade

Installed at expected at the Washeteria. The Fire Hall received the T8 upgrade in lieu of the School due to a previously completed T8 lighting upgrade at the Kaltag School.

E02 – T5 Lighting Upgrade

Installed as planned.

E03 – Install Occupancy Sensors

Installed as planned at the City Office, School, and Washeteria. This ECO was rejected at the Clinic and Youth Center.

E04 – Premium Efficiency Motors Upgrade

Installed as planned at the Water Treatment Plant, though a smaller quantity of motors was upgraded than originally planned.

E05 – CFL Lighting Upgrade

Installed as planned.

E06 – Street Lighting Upgrade

Newly added ECO. This ECO was later added after Ameresco reached an agreement with AVEC to install LED street light retrofits. The village should work with AVEC energy cost savings to be realized.

M01 – Boiler Tune-Up

Performed as planned at the City Office and Washeteria. The school superintendent would not permit Ameresco to tune up the school boilers, so this ECO was instead performed at the Fire Hall.

M02 – Domestic Water Heater Upgrade

Installed as planned.

5.2 Funding Allocation Summary Tables

VEEP ECOS - PROJECT COSTS & EXPECTED SAVINGS - KALTAG			
ECO	**Cost**	**Savings**	**SPB**
B01 - WEATHERSTRIPPING	$ 12,181.97	$ 1,218.83	9.99
B02 - THERMAL INSULATION UPGRADE	$ 36,265.40	$ 1,442.51	25.14
C01 - THERMOSTAT UPGRADE	$ 1,469.97	$ 1,301.81	1.13
E01 - T8 LIGHTING UPGRADE	$ 9,305.39	$ 809.27	11.50
E02 - T5 LIGHTING UPGRADE	$ 10,246.33	$ 2,016.56	5.08
E03 - INSTALL OCCUPANCY SENSORS	$ 8,642.00	$ 3,286.07	2.63
E04 - PREMIUM EFFICIENCY MOTORS UPGRADE	$ 15,141.84	$ 511.46	29.60
E05 - CFL LIGHTING UPGRADE	$ 1,755.68	$ 498.60	3.52
E06- STREET LIGHTING UPGRADE	$ 22,529.82	$ 3,107.15	7.25
M01 - BOILER TUNE-UP	$ 7,526.16	$ 6,818.95	1.10
M02 - DOMESTIC WATER HEATER UPGRADE	$ 25,463.92	$ 1,159.89	21.95
TOTAL	**$150,528.49**	**$22,171.11**	**6.79**
TOTAL GRANT	**$150,000.00**		
BUDGET EXCEEDED	**$ (528.49)**		

ECOS NOT FUNDED - REJECTED IN CONSTRUCTION PHASE			
ECO	**Cost**	**Savings**	**SPB**
B02 - THERMAL INSULATION UPGRADE	$ 12,000.00	$ 723.59	16.58
C01 - THERMOSTAT UPGRADE	$ 900.00	$ 4,958.90	0.18
E01 - T8 LIGHTING UPGRADE	$ 5,000.00	$ 151.90	32.92
E03 - INSTALL OCCUPANCY SENSORS	$ 2,700.00	$ 273.70	9.86
M01 - BOILER TUNE-UP	$ 7,310.83	$ 2,507.32	2.92
TOTAL	**$ 27,910.83**	**$ 8,615.41**	**3.24**

**Project costs are based on initial projections and have not been updated in regards to post installation pricing changes.*

APPENDIX A

VEEP PROJECT COSTS & EXPECTED SAVINGS

APPENDIX A - VEEP PROJECT COSTS & EXPECTED SAVINGS - KALTAG

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 - WEATHERSTRIPPING

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	Total Annual Savings	Simple Payback
City Office	3	$937.07	$2,811.22	0.00	7.87	7.87	56.24	$0.00	$262.63	$262.63	10.70
Clinic	2	$937.07	$1,874.15	0.00	5.17	5.17	36.92	$0.00	$172.44	$172.44	10.87
School	4	$937.07	$3,748.30	0.00	10.43	10.43	74.48	$0.00	$347.83	$347.83	10.78
Washeteria, etc	3	$937.07	$2,811.22	0.00	10.62	10.62	75.89	$0.00	$354.38	$354.38	7.93
Youth Center	1	$937.07	$937.07	0.00	2.44	2.44	17.46	$0.00	$81.55	$81.55	11.49

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	Total Annual Savings	Simple Payback
City Office	R-19	R-38	$13,652.86	0.00	16.78	16.78	119.87	$0.00	$559.81	$559.81	24.39
Clinic	R-19	R-38	$7,466.41	0.00	9.07	9.07	64.80	$0.00	$302.62	$302.62	24.67
Fire Hall	R-19	R-38	$4,031.86	0.00	5.00	5.00	35.71	$0.00	$166.77	$166.77	24.18
Head Start	R-20	R-39	$6,044.23	0.00	6.63	6.63	47.34	$0.00	$221.08	$221.08	27.34
Youth Center	R-19	R-38	$5,070.05	0.00	5.76	5.76	41.16	$0.00	$192.24	$192.24	26.37

C01 - THERMOSTAT UPGRADE

Building	# of Thermostats Installed	Cost 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	Total Annual Savings	Simple Payback
City Office	2	$734.98	$1,469.97	0.00	39.03	39.03	278.76	$0.00	$1,301.81	$1,301.81	1.13

E01 - T8 LIGHTING UPGRADE

Building	# of Fixtures	Price Per Fixture	Total Cost	Electric kWh Savings	Electric kW Savings	Equivalent mmBtu Savings	Equivalent Fuel Gallons Savings	Annual kW & kWh Cost Savings	Annual Equivalent Fuel Cost Savings	Total Annual Savings	Simple Payback
Fire Hall	10	$273.69	$2,736.88	64.06	2.64	0.22	4.65	$132.55	$21.71	$154.26	20.65
Washeteria, etc	24	$273.69	$6,568.51	3,153.40	19.99	10.76	228.84	$676.72	$1,068.68	$1,745.40	9.71

E02 - T5 LIGHTING UPGRADE

Building	# of Fixtures	Price Per Fixture	Total Cost	Electric kWh Savings	Electric kW Savings	Equivalent mmBtu Savings	Equivalent Fuel Gallons Savings	Annual kW & kWh Cost Savings	Annual Equivalent Fuel Cost Savings	Total Annual Savings	Simple Payback
School	16	$640.40	$10,246.33	5,129.19	20.35	17.51	372.22	$2,016.56	$1,738.27	$3,754.83	5.08

E03 - INSTALL OCCUPANCY SENSORS

Building	# of Sensors	Price Per Fixture	Total Cost	Electric kWh Savings	Electric kW Savings	Equivalent mmBtu Savings	Equivalent Fuel Gallons Savings	Annual kWh Cost Savings	Annual Equivalent Fuel Cost Savings	Total Annual Savings	Simple Payback
City Office	16	$298.00	$4,768.00	838.24	0.00	2.86	60.83	$179.89	$284.08	$463.96	26.51
School	6	$298.00	$1,788.00	11,345.91	0.00	38.72	823.36	$2,434.83	$3,845.09	$6,279.93	0.73
Washeteria, etc	7	$298.00	$2,086.00	3,128.39	0.00	10.68	227.02	$671.35	$1,060.20	$1,731.56	3.11

E04 - PREMIUM EFFICIENCY MOTORS UPGRADE

Building	# of Motors	Price Per Motor	Total Cost	Electric kWh Savings	Electric kW Savings	Equivalent mmBtu Savings	Equivalent Fuel Gallons Savings	Annual kWh Cost Savings	Annual Equivalent Fuel Cost Savings	Total Annual Savings	Simple Payback
Water Treatment	3	Varies w/HP	$15,141.84	2,383.33	0.86	8.13	172.96	$511.46	$807.70	$1,319.17	29.60

E05 - CFL LIGHTING UPGRADE											
Building	**# of Incans to be Replaced**	**Wattages to be Replaced**	**Total Cost**	**Electric kWh Savings**	**Electric kW Savings**	**Equivalent mmBtu Savings**	**Equivalent Fuel Gallons Savings**	**Annual kW & kWh Cost Savings**	**Annual Equivalent Fuel Cost Savings**	**Total Annual Savings**	**Simple Payback**
Clinic	5	75w	$381.67	185.03	3.66	0.63	13.43	$39.71	$62.71	$102.42	9.61
School	8	75w, 90w	$610.67	357.68	5.93	1.22	25.96	$343.52	$121.22	$464.74	1.78
Washeteria, etc	9	75w, 90w	$687.01	516.46	6.88	1.76	37.48	$110.83	$175.03	$285.86	6.20
Youth Center	1	75w	$76.33	21.15	0.73	0.07	1.53	$4.54	$7.17	$11.70	16.82

E06 - STREETLIGHTING UPGRADE											
Building	**# of Fixtures**	**Price Per Fixture**	**Total Cost**	**Electric kWh Savings**	**Electric kW Savings**	**Equivalent mmBtu Savings**	**Equivalent Fuel Gallons Savings**	**Annual kWh Cost Savings**	**Annual Equivalent Fuel Cost Savings**	**Total Annual Savings**	**Simple Payback**
Whole Village	19	$1,185.78	$22,529.82	9,195.81	25.19	31.39	0.00	$3,107.15	$0.00	$1,319.17	7.25

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**	**Total Annual Savings**	**Simple Payback**
City Office	1	2.90%	$1,505.23	0.00	28.72	28.72	205.12	$0.00	$957.91	$957.91	1.57
Fire Hall	1	2.60%	$1,505.23	0.00	4.20	4.20	30.00	$0.00	$140.10	$140.10	10.74
Washeteria	3	1.40%	$4,515.70	0.00	171.51	171.51	1,225.04	$0.00	$5,720.94	$5,720.94	0.79

M02 - DOMESTIC WATER HEATER UPGRADE											
Building	**# of Water Heaters to Replace**	**New Water Heater Efficiency (AFUE)**	**Total Cost**	**Electric kWh Savings**	**Equivalent Fuel mmBtu Savings**	**New Fuel mmBtu Use**	**Equivalent Fuel Gallons Savings**	**Annual kWh Cost Savings**	**Annual Equivalent Fuel Cost Savings**	**Total Annual Savings**	**Simple Payback**
Clinic	1	88.00%	$12,731.96	3,475.33	11.86	12.13	165.58	$745.81	$773.26	$1,519.07	16.47
Youth Center	1	88.00%	$12,731.96	1,737.67	5.93	6.06	82.79	$372.90	$386.63	$759.53	32.93

APPENDIX B

ECO CALCULATION RESULTS – NOT FUNDED

APPENDIX B - ECO CALCULATION RESULTS - NOT FUNDED - KALTAG

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.

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
Washeteria, etc	R-19	R-38	$12,000.00	0.00	21.69	21.69	154.94	$0.00	$723.59	16.58

C01 - THERMOSTAT UPGRADE

Building	# of Thermo-stats Installed	Cost 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
Washeteria, etc	1	$290.00	$900.00	0.00	148.66	148.66	1,061.86	$0.00	$4,958.90	0.18

E01 - T8 LIGHTING UPGRADE

Building	# of Fixtures	Price Per Fixture	Total Cost	Electric kWh Savings	Electric kW Savings	Equivalent mmBtu Savings	Equivalent Fuel Gallons Savings	Annual kW & kWh Cost Savings	Annual Equivalent Fuel Cost Savings	Simple Payback
School	9	Varies w/# of lamps	$5,000.00	209.58	2.38	0.72	15.21	$151.90	$71.03	32.92

E03 - INSTALL OCCUPANCY SENSORS

Building	# of Sensors	Price Per Fixture	Total Cost	Electric kWh Savings	Electric kW Savings	Equivalent mmBtu Savings	Equivalent Fuel Gallons Savings	Annual kWh Cost Savings	Annual Equivalent Fuel Cost Savings	Simple Payback
Clinic	7	Varies w/Type and Location	$2,200.00	698.43	0.00	2.38	50.68	$149.88	$236.69	9.29
Youth Center	1	Varies w/Type and Location	$500.00	109.20	0.00	0.37	7.92	$23.43	$37.01	13.51

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	5	~1%	$7,310.83	0.00	75.17	75.17	536.90	$0.00	$2,507.32	2.92

APPENDIX C

EQUATIONS USED IN CALCULATIONS

APPENDIX C - EQUATIONS USED IN CALCULATIONS - KALTAG

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

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

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)

E06 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 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

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%.

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

APPENDIX D

POST INSTALLATION PHOTOS

APPENDIX D – POST INSTALLATION PHOTOS – KALTAG

Completed Insulation Upgrade

Completed Thermostat Upgrade

Completed T8 Lighting Upgrade

Completed Occupancy Sensor Installation