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ENERGY AUDIT
POST INSTALLATION REPORT

Results and Recommendations from Energy Audit of Kotlik

For VEEP Grants

City of Kotlik, Alaska

June 20, 2012

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EXECUTIVE SUMMARY AND PREFACE

This Post Installation Report summarizes the results of an Ameresco Energy Audit of the City of Kotlik, the initial energy savings measures identified and proposed, and any changes that may have occurred throughout the installation process. The City of Kotlik 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 Kotlik on October 21, 2010. The table below shows the buildings audited and their respective square footages.

City of Kotlik - Building Summary

Building	Category	Square Footage
City Hall	Public Building	5,000
Community Center	Public Building	4,000
Water Treatment Plant	Public Facility	4,200
School	School	20,000

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 results of Ameresco's audit and potential calculation savings, allocated by grant. 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 - TOTAL PROJECT COSTS & EXPECTED SAVINGS - KOTLIK

	Cost	Savings	SPB
TOTAL PROJECT COSTS	**$ 183,641.76**	**$ 19,759.91**	**9.29**

VEEP (INITIAL GRANT) - PROJECT COSTS & EXPECTED SAVINGS - KOTLIK			
ECO	**Cost**	**Savings**	**SPB**
B01 - WEATHERSTRIPPING	$ 974.97	*N/A*	*N/A*
B02 - THERMAL INSULATION UPGRADE	$ 24,067.25	$ 1,338.25	17.98
B03 - INSTALL ACCESS DOOR TO ATTIC	$ 1,881.21	$ 37.45	50.24
B04 - ENERGY EFFICIENT DOOR UPGRADE	$ 39,992.02	$ 732.00	54.63
E01 - T8 LIGHTING UPGRADE	$ 26,835.40	$ 1,552.26	17.29
E02 - INSTALL OCCUPANCY SENSORS	$ 3,260.93	$ 669.02	4.87
E03 - PREMIUM EFFICIENCY MOTORS UPGRADE	$ 25,601.56	$ 518.35	49.39
M01 - BOILER TUNE-UP	$ 7,344.19	$ 12,271.08	0.60
M02 - FURNACE UPGRADE	$ 19,066.74	$ 564.08	33.80
AVAILABLE FUNDING	$ 975.72		
** Available funding allocated to street lighting upgrade*			
TOTAL	**$ 150,000.00**	**$ 17,682.50**	**8.48**

VEEP - STREETLIGHTING COSTS & EXPECTED SAVINGS - KOTLIK			
ECO	**Cost**	**Savings**	**SPB**
E04 - STREET LIGHTING UPGRADE	$ 34,617.48	$ 2,077.41	16.66
REMAINING KOTLIK FUNDING	*$ 975.72*		
FUNDING REALLOCATED FROM AKIACHAK	*$ 7,460.31*		
FUNDING REALLOCATED FROM ALAKANUK	*$ 25,207.04*		
FUNDING REALLOCATED FROM BEAVER	*$ 2,921.12*		
FUNDING REALLOCATED FROM FORT YUKON	*$ 5,455.13*		
FUNDING REALLOCATED FROM HOLY CROSS	*$ 321.83*		
FUNDING REALLOCATED FROM KIPNUK	*$ 6,363.62*		
FUNDING REALLOCATED FROM NEWTOK	*$ 10,668.75*		
FUNDING REALLOCATED FROM NIKOLAI	*$ 390.55*		
FUNDING REALLOCATED FROM PILOT STATION	*$ 2,204.08*		
TOTAL AVAILABLE PROJECT FUNDS	**$ 61,968.15**		
REMAINING FUNDING	**$ 27,350.67**		

** Remaining funding applied to other VEEP projects that exceeded their initial budget constraints.*

1.0 BUILDING DESCRIPTIONS

1.1 KOTLIK CITY HALL

Description: The Kotlik City Hall houses several offices including those of the mayor and village tribal council. A section of the building has also been converted into a jailhouse. Residents pay their cable bills in the City Hall office as well.

General Conditions: The building is in fair condition. Structurally, the building appears to be sound with no major defects. The exterior of the building is showing many signs of age and weathering. The interior of the building is also showing some age due to floor and wall façade deterioration. Occupants complain of considerable draftiness, especially during the winter months. Many of the old ductwork vents have been blocked off in an attempt to fight this draftiness. Upon further investigation, most of the cold air appears to be coming into the building through the attic, which has poor insulation and does not have a door to block warm air from escaping.

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

Building Envelope: The wood exterior of the building is in fair condition and shows many signs of wear. The standing seam metal and plywood roof appears to be in good condition. Windows are in fair condition, as many of them are broken or "fixed" with plexiglass. Door are in fair to poor condition; weatherstripping needs to be replaced, some doors do not seal properly, and the exterior jailhouse door is not insulated (it is merely constructed from plywood and does not insulate from the elements). Of most concern is the draftiness because of the attic. The insulation in the attic is in poor condition, and the lack of a door to the attic creates an escape for the building's warm air.

Heating: Two Monitor 2400 room heaters provide the building with heat. One heater is located in the main City Hall office, and the other is in the jailhouse area. The building was formerly furnace-heated, but the furnace became a fire hazard and was removed.

Controls: There are no controls in the City Hall building. Desired space temperatures are set on the Monitor room heaters to provide the space with adequate heating.

Lighting: Interior lighting consists primary of T12 fluorescent fixtures with magnetic ballasts. There are 2 exterior fixtures that appear to be 150 watt metal halide (MH) fixtures.

Domestic Water: The Kotlik City Hall receives it water directly from the village water plant. This facility does not have a domestic water heater.

Building Photos: Kotlik City Hall

Damaged Plexiglass Window Replacement

No Door Blocking Attic Draft

Jailhouse Exterior Door

Ceiling Damage in Jailhouse

Blocked Furnace Exhaust and Burned Ceiling

Exterior Door Does Not Closer Properly

1.2 KOTLIK COMMUNITY CENTER

Description: The Kotlik Community Center is the main gathering place for the village residents. The building is used 7 days a week for a wide variety of activities including traditional dancing and game nights.

General Conditions: The building is in fair condition overall. The Kotlik Community Center appears to be structurally sound, and the interior spaces are in fair condition. The mechanical equipment is in poor shape and in need of replacement. Some of the electrical wiring is no longer safe, and there are exposed wires.

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

Building Envelope: The building insulation is poor at best. The attic has very little insulation, and the doors do not seal well due to worn weather-stripping. Only one window remains and is in poor condition due to damage and cracking; all other windows have been boarded up. The standing seam metal roof appears to be in good condition.

Heating: A Heil/Quaker furnace from around 1985 provides the building with heating. The furnace is listed as 80.2% efficient. The building's radiant heating system no longer functions; occupants believe this is connected to some recent utility work.

Controls: Heating is controlled by a mechanical thermostat located in the main gathering room.

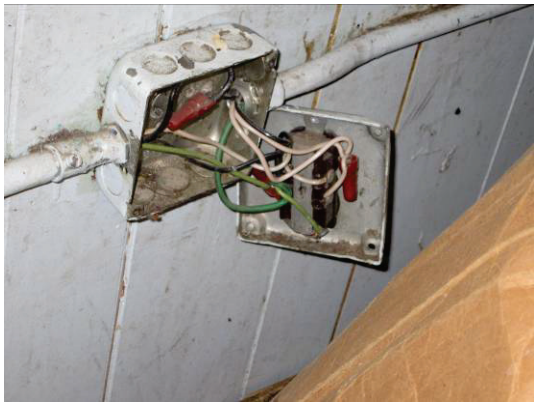
Lighting: Interior lighting fixtures are T12 fluorescent fixtures with magnetic ballasts.

Domestic Water: Water is provided by the village water plant. The Community Center building does not have a domestic water heater.

Building Photos: Kotlik Community Center

Furnace Stack

Not Much Insulation in Attic



Exposed Wiring

Cracked Windows

Doors Need New Weatherstripping

Mechanical Thermostat

1.3 KOTLIK SCHOOL

Description: The Kotlik School houses elementary through high school age students. The school is divided into wings – a high school section, and an elementary and middle school section. The building also contains a cafeteria and gym.

General Conditions: The building is in good condition and is probably the best maintained facility in the village. Structurally, the building appears to have no major defects, and the exterior and roof and in good condition. The HVAC and other mechanical equipment are in good condition and appear to be well-maintained.

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

Building Envelope: The building appears to be in good condition. Doors seal properly and have adequate weather-stripping. Windows are double-pane clear glass and are in good condition.

Heating: Three York AHUs provide the building with heating and air distribution. These AHUs appear to date to the mid-1990s, but are still in good condition.

Controls: AHU-3 is connected to a Square D Enclosed 48 soft start motor drive controller. This controller allows the AHU motor to slowly ramp-up over time instead of a sudden start when the unit engages.

Lighting: Interior lighting mainly consists of T8 fluorescent fixtures with electronic ballasts.

Domestic Water: Four water heaters provide the school with domestic hot water. Two of these are indirect-fired water heaters; one has a 60 gallon capacity, and the other has a 120 gallon capacity. These BoilerMate water heaters appear to be in good condition. The remaining 2 water heaters are 50 galloon Rheem electric water heaters in good condition and were manufactured in 2007.

Building Photos: Kotlik School

AHU-2 – York AHU

Circulating Pumps

Rheem Water Heaters

Amtrol BoilerMate Water Heaters

1.4 KOTLIK WATER TREATMENT PLANT

Description: The Kotlik Water Treatment Plant provides the village with clean water for daily use. Most buildings use septic systems to treat wastewater, but the school's wastewater is treated at the Water Treatment Plant.

General Conditions: The facility is in fair condition, but is in need of a new generator. The current generator no longer functions, so if power goes out, the water plant can no longer operate.

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

Building Envelope: The building appears to be in good condition – the exterior and standing seam metal roof show few signs of age and weathering. The doors seal well and have adequate weatherstripping. The building does not have any windows.

Heating: Two Burnham V907 boilers provide the building with heating and appear to be in good condition. These boilers are rated at 82.6% thermally efficient.

Controls: Building zones are controlled by a series of mechanical thermostats.

Lighting: Interior lighting consists of mainly T12 fluorescent fixtures with magnetic ballasts.

Domestic Water: The Water Treatment Plant does not have a domestic water heater.

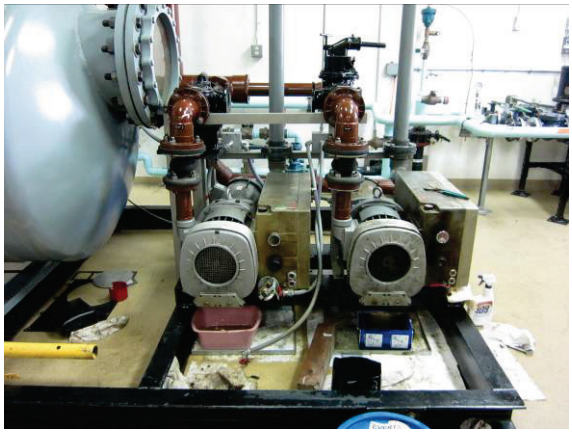
Vacuum System: There are a total of 2 vacuum pumps (10 hp each) at the water treatment plant. Vacuum sewage systems are installed in bush Alaska due to permafrost and lack of available pitch. The system originates at the treatment facility and is in good operational condition. The vacuum pump motor

runs 24/7 to meet village requirements. A higher efficiency motor will result in measurable savings for this system.

Heat Trace: 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. According to the plant operator, some of the heat trace pumps are running continuously. The system pumps hot water from the boilers through out the village water and sewer distribution system to minimize freeze ups in below freezing weather. When the outside temperatures are above freezing the system should be shut down. Automatically controlling the pumps to run only when temperatures drop in a range where freeze ups of the distribution system are possible will decrease overall energy usage by reducing pump operation as well as hot water generation.

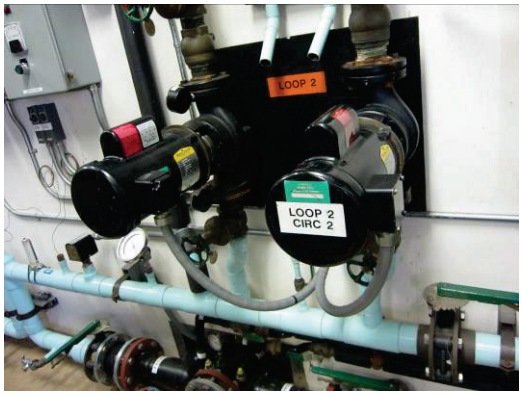
Building Photos: Kotlik Water Treatment Plant

Burnham Boilers



Vacuum Pumps

Water Pumps



Circulating Pumps

2.0 UTILITIES

2.1 ELECTRICITY

The City of Kotlik 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 Kotlik are listed below.

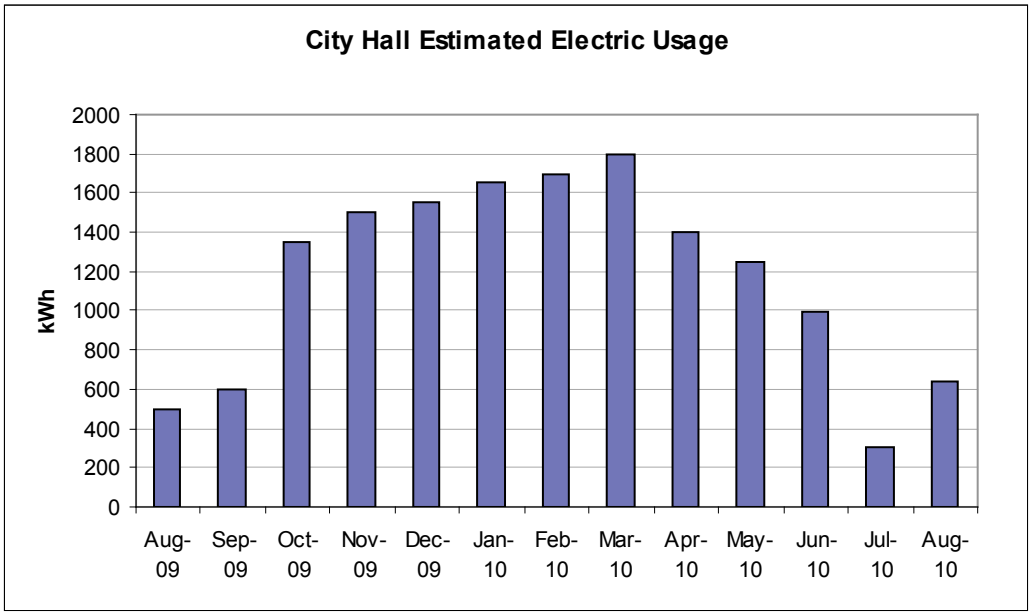
AVEC Cost of Fuel (Added to Customer Electric Bill)	$	0.2717
Rate Per kWh, Fuel Cost Included (1-700 kWh)	$	0.5717
Rate Per kWh, Fuel Cost Included (Over 700 kWh)	$	0.4717
PCE Rate (1-700 kWh)	$	0.3543
PCE Rate (Over 700 kWh)	$	0.3278

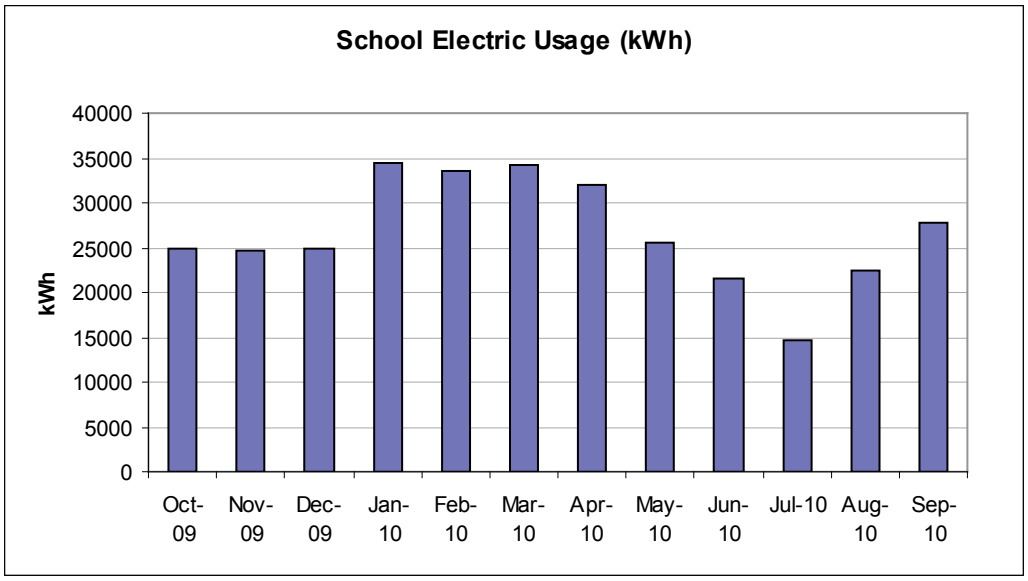
All audited buildings in Kotlik receive PCE funding, except for the Kotlik School.

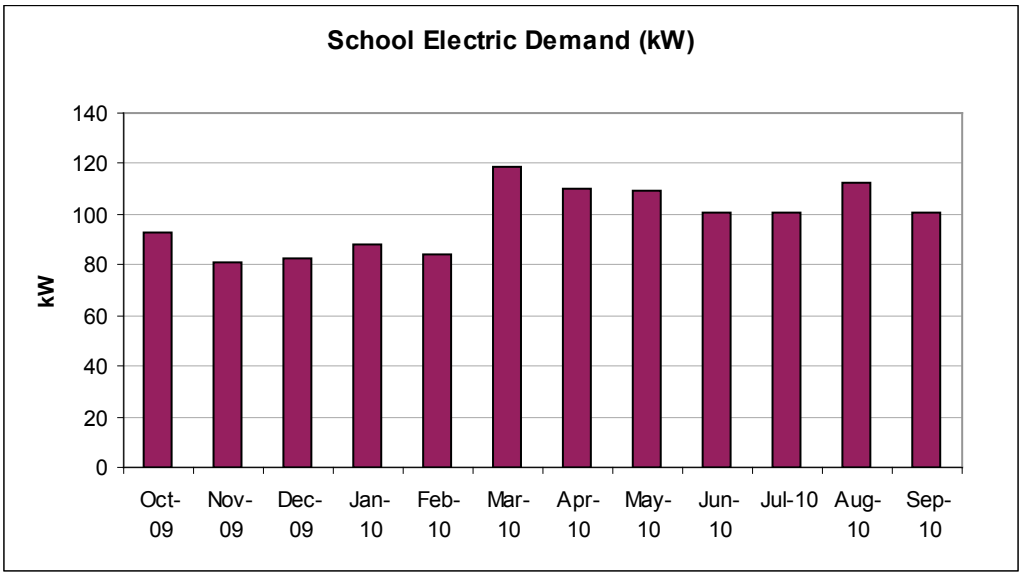
The Lower Yukon School District has its own agreement with AVEC and does not receive PCE funding. The AVEC rates for the Kotlik School are listed below. The school is also the only facility in the village to be charged for demand.

AVEC Average Cost of Fuel	$	0.2289
Demand Cost, Per kW	$	45.00
Rate Per kWh, Fuel Cost Included (1-1,500 kWh)	$	0.3489
Rate Per kWh, Fuel Cost Included (Over 1,500 kWh)	$	0.2689

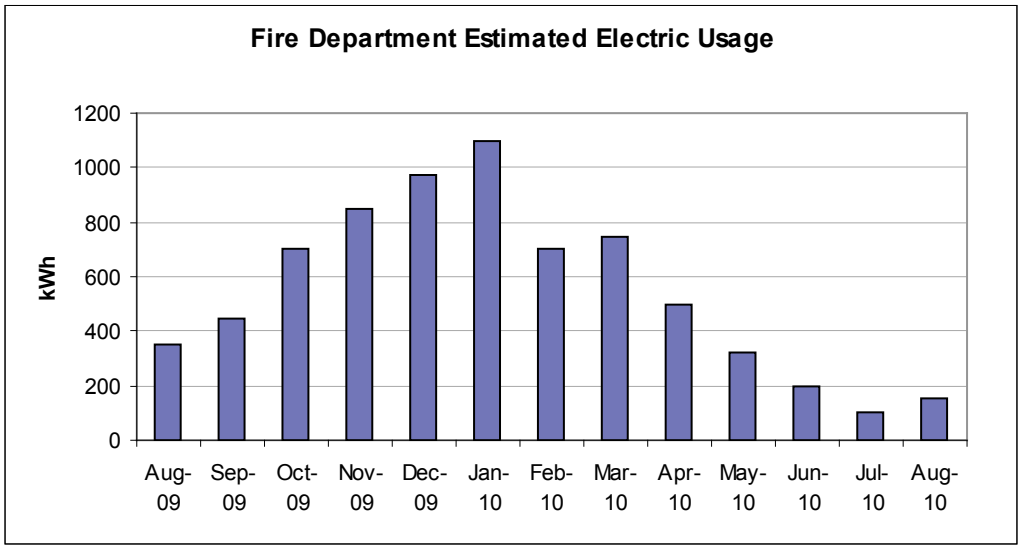
2.1.1 Electricity Usage Profiles

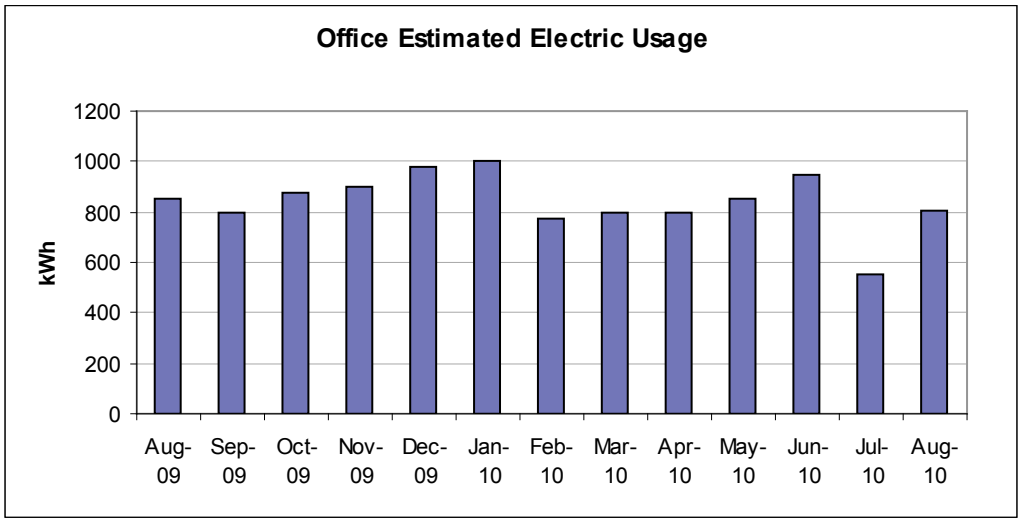






The next two charts are data gathered by Ameresco from bills but do not coincide with buildings visited at the time of the audit. These are for informational reporting purposes only.





2.2 FUEL

The City of Kotlik typically purchases its fuel in two bulk shipments each year. In 2010, Kotlik was unable to receive its second shipment in time, so the City "borrowed" fuel from AVEC at the rate listed below.

Diesel Rate Per Gallon	$	5.54
Fuel Rate Per Gallon (From AVEC – Emergency Fuel Needed)	$	3.3478

The Kotlik School has its own fuel contract with Crowley Petroleum Distribution, Inc. The school purchases its fuel from Crowley at a rate of $2.99705/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 skill 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 KOTLIK City Office	Community Center	Water Treatment
Building Envelope				
B01	Door Weather-stripping Upgrade	X	X	
B02	Insulation Upgrade	X	X	
B03	Install Access Panel to Ceiling	X		
B04	Energy Efficient Door Upgrade	X	X	
Electrical				
E01	T-8 Lighting Upgrade	X	X	X
E02	Occupancy Sensors	X	X	
E03	Premium Efficiency Motors			X
Mechanical				
M01	Boiler Tune-Up			X
M02	Furnace Upgrade		X	

VEEP – INITIAL PROPOSAL (FINAL AUDIT REPORT)			
ECO	**Cost**	**Savings**	**SPB**
B01 - WEATHERSTRIPPING	$ 4,704.00	$ 521.88	9.01
B02 - THERMAL INSULATION UPGRADE	$ 39,060.00	$ 2,631.00	14.85
B03 - INSTALL ACCESS DOOR TO ATTIC	$ 490.00	$ 37.45	13.09
B04 - ENERGY EFFICIENT DOOR UPGRADE	$ 26,880.00	$ 210.12	127.92
E01 - T8 LIGHTING UPGRADE	$ 28,163.80	$ 1,552.26	18.14
E02 - INSTALL OCCUPANCY SENSORS	$ 3,857.00	$ 669.02	5.77
E03 - PREMIUM EFFICIENCY MOTORS UPGRADE	$ 17,838.80	$ 4,146.78	4.30
M01 - BOILER TUNE-UP	$ 4,200.00	$ 16,361.44	0.26
M02 - FURNACE UPGRADE	$ 15,799.00	$ 564.08	28.01
DESIGN/AUDIT	$ 2,500.00		
AVAILABLE FUNDING	$ 6,507.40		
** Available funding allocated for travel expenses, shipping, additional labor, etc*			
TOTAL	**$ 150,000.00**	**$ 26,694.04**	**5.62**

4.1 ECO DESCRIPTIONS – INITIAL REPORTING

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).

B03 – Install Access Panel to Attic

This ECO proposes installing an access panel to a building's attic. Without this access panel, building heating is allowed to escape into the attic and is wasted. An access panel to the attic would further insulate heated building spaces and reduce heating costs.

B04 – 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.

4.1.2 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 – 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.

E03 – 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%.

4.1.3 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 – Furnace Upgrade

This ECO proposes replacing existing fuel oil furnaces 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. Furnaces employing modern technology can be installed to reduce energy consumption, improve system operations, and reduce maintenance costs.

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*.

5.1 CHANGES FROM INITIAL REPORTING

B01 – Door Weather-stripping Upgrade

Material was delivered to the village but not installed. Doors purchased for B04 included a weather-stripping upgrade. Savings for B01 and B04 have been combined to realize total savings from a door and weather-stripping upgrade.

B02 – Thermal Insulation Upgrade

Installed as planned. Removed from the scope at the City Office.

B03 – Install Access Door to Attic

Installed as planned.

B04 – Energy Efficient Door Upgrade

Installed as planned.

E01 – T8 Lighting Upgrade

Installed as planned.

E02 – Occupancy Sensors

Installed as planned.

E03 – Premium Efficiency Motors

Only 2 of the originally identified
motors were installed due to various reasons including stripped isolation valves, altered motor shafts, and some previously installed upgrades.

E04 – Street Lighting Upgrade

Newly added ECO. This ECO was completed with additional funding from other villages within the scope of the VEEP grant. This funding reallocation was pre-approved by the AEA during the VEEP construction process.

M01 – Boiler Tune-Up

Performed as planned.

M02 – Furnace Upgrade

Installed as planned.

5.2 FUNDING ALLOCATION SUMMARY TABLES

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	Cost	**Savings**	**SPB**
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** Remaining funding applied to other VEEP projects that exceeded their initial budget constraints.*

APPENDIX A

VEEP PROJECT COSTS & EXPECTED SAVINGS

APPENDIX A - VEEP PROJECT COSTS & EXPECTED SAVINGS - KOTLIK

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	Simple Payback
City Office	4	$162.50	$649.98	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*
Community Center	2	$162.50	$324.99	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*

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
Community Center	R-17	R-36	$24,067.25	0.00	33.82	33.82	241.56	$0.00	$1,338.25	17.98

B03 - INSTALL ACCESS DOOR TO ATTIC

Building	# of Access Doors	Access Door Size	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	1	~ 2x2 feet	$1,881.21	0.00	0.95	0.95	6.76	$0.00	$37.45	50.24

B04 - 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
City Office	4	$6,665.34	$26,661.35	0.00	11.58	11.58	82.72	$0.00	$458.25	58.18
Community Center	2	$6,665.34	$13,330.67	0.00	6.92	6.92	49.41	$0.00	$273.75	48.70

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 kWh Cost Savings	Annual Equivalent Fuel Cost Savings	Simple Payback
City Office	22	Varies w/# of lamps	$6,086.38	1,505.50	12.41	5.14	109.25	$327.30	$605.26	18.60
Community Center	41	Varies w/# of lamps	$11,342.80	921.84	10.82	3.15	66.90	$200.41	$370.61	56.60
Water Treatment	34	Varies w/# of lamps	$9,406.22	4,712.78	27.74	16.08	342.00	$1,024.56	$1,894.69	9.18

E02 - INSTALL OCCUPANCY SENSORS

Building	# of Sensors	Price Per Sensor	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
City Office	9	$250.84	$2,257.56	1,913.18	0.00	6.53	138.84	$415.93	$769.16	5.43
Community Center	4	$250.84	$1,003.36	1,164.20	0.00	3.97	84.49	$253.10	$468.05	3.96

E03 - 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	Simple Payback
Water Treatment	2	Varies w/HP	$25,601.56	2,384.30	0.81	8.14	173.03	$518.35	$958.57	49.39

E04 - STREET LIGHTING UPGRADE

Number of Fixtures for Retrofit	Existing Fixture	Retrofit 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
32	150W HPS	47W LED	$34,617.48	14,436.48	39.55	49.27	1,047.64	$2,077.41	$5,803.93	16.66

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
Water Treatment	2	2.60%	$7,344.19	0.00	310.10	310.10	2,215.00	$0.00	$12,271.08	0.60

M02 - FURNACE UPGRADE

Building	# of Furnaces to Replace	New Furnace 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
Community Center	1	84.50%	$19,066.74	0.00	14.25	14.25	101.82	$0.00	$564.08	33.80

APPENDIX B

EQUATIONS USED IN CALCULATIONS

APPENDIX B - EQUATIONS USED IN CALCULATIONS - KOTLIK

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 RETscreen program.*
This calculation was completed by varying the air change rate (ac/h) in pre- and post-installation circumstances.

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 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)

E03 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)

E04 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)

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. Heat Loss Rate (mmBtu/hr) = MBLC x (Heating Temp Setpoint - Mean Bin Temp)
2. Heat Load (MBH) = Heat Loss Rate x 1000
3. MBH-hr = Heat Load x Bin Heating Hours / (kW/ton)
4. Fuel Used (mmBtu) =[(MBH-hr) / Efficiency] / 1000
5. mmBtu Saved = (mmBtu)Existing - (mmBtu)Proposed

FOR E02 - 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 E03

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 C

POST INSTALLATION PHOTOS

APPENDIX C – POST INSTALLATION PHOTOS - KOTLIK

New Attic Access Door

New Exterior Door

T8 Lighting Upgrade

New Furnace and Stack