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ENERGY AUDIT
POST INSTALLATION REPORT

Results and Recommendations from Energy Audit of Shageluk

For VEEP Grants
Village of Shageluk, Alaska

June 21, 2012

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APPENDICES

EXECUTIVE SUMMARY AND PREFACE

This Post Installation Report summarizes the results of an Ameresco Energy Audit of the Village of Shageluk, the initial energy savings measures identified and proposed, and any changes that may have occurred throughout the installation process. The Village of Shageluk is a recipient of an Alaska Energy Authority (AEA) Village Energy Efficiency Program (VEEP) grant of $100,000.

Ameresco subcontracted this energy audit to Whitney Construction. Eric Whitney conducted the energy audit on December 1-2, 2010.

City of Shageluk - Building Summary		
Building	**Category**	**Square Footage**
City Office	Public Building	3,580
Washeteria	Public Facility	1,504

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 ECOS – PROJECT COSTS & EXPECTED SAVINGS – SHAGELUK			
ECO	**Cost**	**Savings**	**SPB**
E01 - T8 LIGHTING UPGRADE	$ 30,647.99	$ 5,298.42	5.78
E02 - T5 LIGHTING UPGRADE	$ 27,683.03	$ 2,300.95	12.03
E03 - LED STREET LIGHTING UPGRADE	$ 17,664.22	$ 1,362.30	12.97
M01 - BOILER TUNE-UP	$ 7,578.47	$ 4,030.79	1.88
M02 - FURNACE UPGRADE	$ 21,667.81	$ 7,736.77	2.80
TOTAL	**$ 105,241.52**	**$ 20,729.23**	**5.08**
TOTAL GRANT	**$ 100,000.00**		
BUDGET EXCEEDED	**$ (5,241.52)**		

1.0 BUILDING DESCRIPTIONS

1.1 SHAGELUK CITY OFFICE

Description: The City Office building is a two-story log cabin-style building that was originally constructed in the 1980's. This building houses the city offices, rental bedrooms, and a rental office space.

General Conditions: The building is in fair condition, and its structural integrity is currently in question.

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

Building Envelope: The building structure is in fair condition overall. In the summer of 2009, some structural work was completed; two 6 by 6 foot posts were installed in an effort to stabilize the second floor. The floors are not level in some areas, and some of the logs are currently showing signs of rotting.

Heating: Space heating is provided by a Riteway model LF20 fuel oil furnace. This furnace is an old combination wood- and oil-burning furnace, and its estimated efficiency is 70%. Although this furnace can be wood-burning, the village has not used it in this capacity in many years.

Controls: Building heating zones are controlled by mechanical thermostats.

Lighting: Interior lighting consists primarily of T12 fluorescent lamps with magnetic ballasts. There are no occupancy sensors in the building.

Building Photos: Shageluk City Office

Riteway Furnace

1.2 SHAGELUK WASHETERIA

Description: The Washeteria building houses the village's laundering equipment and also serves as the water treatment facility. Aside from the laundering equipment, the Washeteria also houses showers, bathrooms, and a sauna.

General Conditions: The building was originally constructed in 1994 and is in good condition overall.

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

Building Envelope: The building is in good condition overall, though the exterior shows many signs of weathering. It is adequately insulated overall, with engineered foam panel walls and ceiling.

Heating: Heating for the Washeteria is provided by two Burnham model V8 boilers. Whitney Construction noted that these boilers are greatly oversized to meet building heating needs, unless these boilers are also heating the water lines to the Post Office, Clinic, and City Building as well. The mechanical room of the building is usually uncomfortably warm due to the excess heat from the boilers, and occupants frequently leave windows open to remedy this.

Controls: Building heating is controlled by a mechanical thermostat.

Lighting: Interior lighting fixtures are mostly T12 fluorescent with magnetic ballasts. There are no occupancy sensors in the facility.

Domestic Water: The Washeteria has a new solar water heating system, but this system was not operational at the time of the audit. This system has not been in operation long enough to produce any legitimate data for study on the effectiveness of the system.

Building Photos: Shageluk Washeteria

Burnham Boilers

Heliodyne Heat Transfer Appliance and Solar Heat Exchange Tank

Exterior Window with Broken Pane

1.3 SHAGELUK SCHOOL

Description: The Shageluk school houses elementary through high school students. This building was audited for a lighting survey only, though other observations from the walkthrough have been reported.

Lighting: Interior lighting is primarily T12 fluorescent fixtures with magnetic ballasts. The gym area is light by high bay mercury vapor (MV) fixtures.

Windows: During the walkthrough, the auditor found many of the windows at the school are failing and do not shut properly. Upon further investigation, the windows are good quality triple pane fixtures with low-e coatings, but the hardware currently used is inadequate to support the weight of the triple pane glass. The school district should contact the manufacture to remedy this defective product.

2.0 UTILITIES

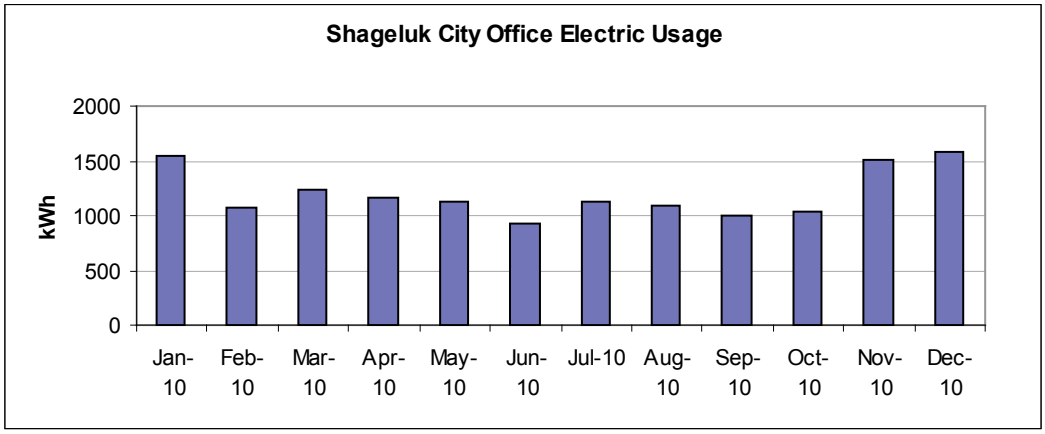
2.1 ELECTRICITY

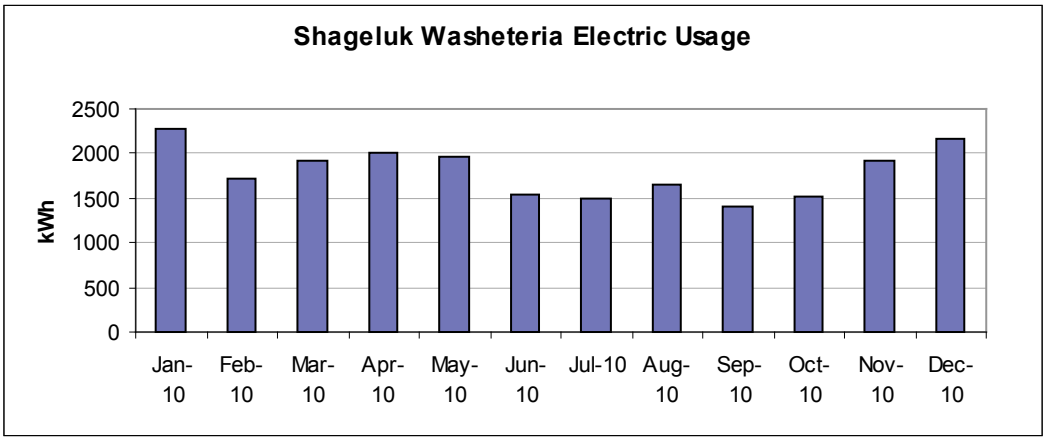
The City of Shageluk purchases its electricity from the Alaskan Village Electric Cooperative (AVEC). Village facilities are billed on an electric use and fuel use to provide the electricity. Some facilities may also qualify for a Power Cost Equalization (PCE) incentive. The AVEC rates for the City of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

Current Rates as of January 2011	
AVEC Cost of Fuel (Added to Customer Electric Bill)	$ 0.2721
Rate Per kWh, Fuel Cost Included (1-700 kWh)	$ 0.5721
Rate Per kWh, Fuel Cost Included (Over 700 kWh)	$ 0.4721
PCE Rate (1-700 kWh)	$ 0.3546
PCE Rate (700+ kWh)	$ 0.3282
Rates August 2010 - December 2010	
AVEC Cost of Fuel (Added to Customer Electric Bill)	$ 0.2634
Rate Per kWh, Fuel Cost Included (1-700 kWh)	$ 0.5634
Rate Per kWh, Fuel Cost Included (Over 700 kWh)	$ 0.4634
PCE Rate (1-700 kWh)	$ 0.3464
PCE Rate (700+ kWh)	$ 0.3195
Rates for Calculations, Including Fuel Cost and PCE Incentive	
Rate for Calculations (1-700 kWh)	$ 0.2175
Rate for Calculations (700+ kWh)	$ 0.1439

The Shageluk School is assumed to have the same utility rates as the rest of the village because the school's utility bills were not readily available. Based on commonalities between the other villages under AVEC, however, a $45/kW charge has been considered for electrical ECOs at the school.

2.1.1 Electricity Usage Profiles





2.2 FUEL

The Village of Shageluk purchases its fuel at a rate of $5.65/gallon. In 2009, the City Office building used 2,000 gallons of fuel. In the same year, the Washeteria used 5,000 gallons of fuel.

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 Beaver 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	ECO MATRIX		
		SHAGELUK		
	B=Building Envelope; C=Controls; E=Electrical; M=Mechanical; W=Water/Wastewater; R=Renewable	City Office	Washeteria	School
Electrical				
E01	T-8 Lighting Upgrade	X	X	X
E02	T-5 Lighting Upgrade			X
Mechanical				
M01	Boiler Tune-Up		X	
M02	Furnace Upgrade	X		

VEEP – INITIAL PROPOSAL (FINAL AUDIT REPORT)			
ECO	**Cost**	**Savings**	**SPB**
E01 - T8 LIGHTING UPGRADE	$ 58,907.80	$ 5,298.42	11.12
E02 - T5 LIGHTING UPGRADE	$ 8,654.00	$ 2,300.95	3.76
M01 - BOILER TUNE-UP	$ 4,200.00	$ 5,374.39	0.78
M02 - FURNACE UPGRADE	$ 19,300.00	$ 7,736.77	2.49
DESIGN/AUDIT	$ 3,500.00		
AVAILABLE FUNDING	$ 5,438.20		
** Available funding allocated for travel expenses, shipping, additional labor, etc*			
TOTAL	**$ 100,000.00**	**$ 20,710.53**	**4.83**

4.1 ECO DESCRIPTIONS - PROPOSED

Below are the descriptions of the Energy Conservation Opportunities (ECOs) that Ameresco analyzed for the Village of Shageluk. Section 4.1 details the ECOs the Ameresco proposes for the Village of Shageluk.

4.1.1 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

4.1.2 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 or subcontractors 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*. 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

E01 – T8 Lighting Upgrade

Installed as planned.

E02 – T5 Lighting Upgrade

Installed as planned.

E03 – LED Street Lighting Upgrade

Newly added ECO. See *Section 5.2* for cost and expected savings information.

M01 – Boiler Tune-Up

Performed as planned.

M02 – Furnace Upgrade

Performed as planned.

5.2 FUNDING ALLOCATION SUMMARY TABLES

VEEP ECOS – PROJECT COSTS & EXPECTED SAVINGS – SHAGELUK			
ECO	**Cost**	**Savings**	**SPB**
E01 - T8 LIGHTING UPGRADE	$ 30,647.99	$ 5,298.42	5.78
E02 - T5 LIGHTING UPGRADE	$ 27,683.03	$ 2,300.95	12.03
E03 - LED STREET LIGHTING UPGRADE	$ 17,664.22	$ 1,362.30	12.97
M01 - BOILER TUNE-UP	$ 7,578.47	$ 4,030.79	1.88
M02 - FURNACE UPGRADE	$ 21,667.81	$ 7,736.77	2.80
TOTAL	**$ 105,241.52**	**$ 20,729.23**	**5.08**
TOTAL GRANT	**$ 100,000.00**		
BUDGET EXCEEDED	**$ (5,241.52)**		

APPENDIX A

VEEP PROJECT COSTS & EXPECTED SAVINGS

APPENDIX A - VEEP PROJECT COSTS & EXPECTED SAVINGS - SHAGELUK

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	Electric kW Savings	Equivalent mmBtu Savings	Equivalent Fuel Gallons Savings	Annual kWh & kW Cost Savings	Annual Equivalent Fuel Cost Savings	Total Annual Savings	Simple Payback
City Office	60	$151.72	$9,103.36	5,203.74	42.89	17.76	377.63	$748.84	$2,133.61	$2,882.45	12.16
Washeteria	25	$151.72	$3,793.07	3,465.28	20.40	11.83	251.47	$498.67	$1,420.82	$1,919.48	7.61
School	117	$151.72	$17,751.56	10,153.13	57.55	34.65	736.80	$4,050.91	$4,162.93	$8,213.84	4.38

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 kWh & kW Cost Savings	Annual Equivalent Fuel Cost Savings	Total Annual Savings	Simple Payback
School	17	$1,628.41	$27,683.03	5,809.65	23.05	19.83	421.60	$2,300.95	$0.00	$2,300.95	12.03

E03 - LED STREET LIGHTING UPGRADE - QTY 13

Building	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	Total Annual Savings	Simple Payback
Streetlights	150W HPS	47W LED	$17,664.22	6,263.40	17.16	21.38	454.53	$1,362.30	$2,568.08	$2,300.95	12.97

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
Washeteria	2	2%	$7,578.47	0.00	99.88	99.88	713.41	$0.00	$4,030.79	$4,030.79	1.88

M02 - FURNACE UPGRADE

Building	# of Furnaces to Replace	New Furnace 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	Total Annual Savings	Simple Payback
City Office	1	83.00%	$21,667.81	0.00	191.71	191.71	1,369.34	$0.00	$7,736.77	$7,736.77	2.80

APPENDIX B

ECO CALCULATION RESULTS – NOT FUNDED

APPENDIX B - ECO CALCULATION RESULTS - SHAGELUK

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 - 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
City Office	R-20	R-39	$7,812.00	0.00	17.45	17.45	124.62	$0.00	$704.09	11.10

APPENDIX C

EQUATIONS USED IN CALCULATIONS

APPENDIX C - EQUATIONS USED IN CALCULATIONS - SHAGELUK

ECO Equations

B01 *Note: This ECO was completed using the RETscreen program.*
Inputs are R-values reported in the appendices as well as the insulation square footage.

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

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 – SHAGELUK

Completed T5 Installation