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ENERGY AUDIT
POST INSTALLATION REPORT

Results and Recommendations from Energy Audit of Nikolai

For VEEP Grants

City of Nikolai, 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 Nikolai, the initial energy savings measures identified and proposed, and any changes that may have occurred throughout the installation process. The City of Nikolai is a recipient of an AEA Village Energy Efficiency Program (VEEP) grant of $75,000.

Ameresco engineers conducted an energy audit of the City of Nikolai on October 27, 2010. The table below shows the buildings audited and their respective square footages. Construction was completed in November 2011.

City of Nikolai - Building Summary

Building	Category	Square Footage
City Office	Public Building	4,050
Maintenance Shop	Public Building	N/A

The audit identified existing types, conditions, operating modes, and energy consumption profiles for a variety of buildings, facilities and systems. The audit also identified all cost-effective system and facility modifications, adjustments, alterations, additions, and retrofits. Systems investigated during the audit included heating, ventilation, interior and exterior lighting, process exhaust, domestic hot water, motors, building envelopes, utility metering systems, and energy management control systems (EMCS).

The table below shows the actual costs of the project and expected annual savings. See *Appendix A* for more detailed 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 - NIKOLAI

ECO	Materials	Savings	SPB
B01 - WEATHERSTRIPPING - NOT INSTALLED	$ 739.30	*N/A*	*N/A*
C01 - PROGRAMMABLE THERMOSTAT UPGRADE	$ 8,393.21	$ 982.20	8.55
E01 - T8 LIGHTING UPGRADE	$ 15,128.91	$ 355.21	42.59
E02 - OCCUPANCY SENSORS - NOT INSTALLED	$ 1,683.09	*N/A*	*N/A*
E03 - STREET LIGHTING UPGRADE	$ 48,664.94	$ 1,752.41	27.77
AVAILABLE FUNDING	$ 390.55		
** Available funding covers remaining project close out expenses.*			
TOTAL	**$ 75,000.00**	**$ 3,089.81**	**23.36**

1.0 BUILDING DESCRIPTIONS

1.1 NIKOLAI CITY OFFICE

Description: The Nikolai City Office building is the main city building for the village. All village business is handled at this facility, including utility billing and payment. The building typically operates 8 hours a day, 5 days a week.

General Conditions: The two story building is in good condition overall. Several opportunities for improvement were found during the course of the audit walkthrough.

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

Building Envelope: The building structure overall appears to be in good condition. Existing windows are double-pane, but with a small gap. The roof is in good condition. Doors are in good condition, but weather-stripping is inadequate and is due to be upgraded. The exterior doors to the mechanical room, however, are in poor condition and should be upgraded. There is also a hole in the mechanical room floor that should be patched. Several of the windows have cracked panes and are in fair condition overall.

Heating: A newly installed Lennox oil furnace provides the building with space heating. An additional furnace has not yet been installed. These furnaces are rated at 81.0% AFUE and are in good condition. A combustion analysis was not performed at the time of the audit. Note: These units are horizontal units but have been installed vertically in the facility.

Controls: Mechanical thermostats control building heating.

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

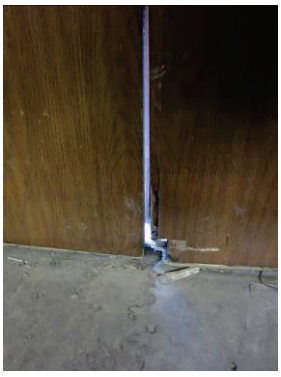
Domestic Water: A Toyotomi model OM-1248 instantaneous water heater provides the building with domestic hot water.

Miscellaneous: The City Office also houses two electric washer and dryer sets for the villagers' laundering needs. Occupants informed Ameresco engineers that these washer and dryers provide 2 washes per day, on average. These units are older Maytag models and are not ENERGY STAR rated.

Building Photos: Nikolai City Office

Installed Lennox Furnace

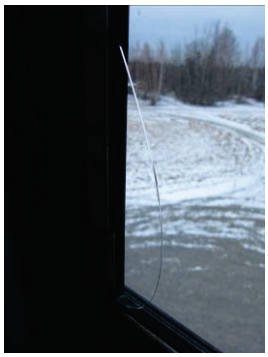
Toyotomi Instantaneous Water Heater



Mechanical Room Doors

Hole in Mechanical Room Floor

Maytag Washer/Dryer Set



Window with Cracked Pane

1.2 NIKOLAI MAINTENANCE SHOP

Description: The building is in poor condition overall and shows many signs of weathering and age. The Nikolai Maintenance Shop is no longer a heated facility. There are several Modine unit heaters in place that formerly operated on waste heat from the generators in the adjacent building. When the old generators were removed, however, this waste heat connection was severed and has not been reconnected. Interior lighting consists of T12 fluorescent fixtures with magnetic ballasts. There are no occupancy sensors in the facility. Exterior doors are in poor condition. Because of the conditions in this building, this facility is rarely used once the temperature drops.

Overhead Door

Modine Unit Heater

Little Attic Insulation

Building Exterior and Overhead Door

2.0 UTILITIES

2.1 ELECTRICITY

The City of Nikolai produces its own electricity. From the time of the audit and throughout the calculation and report writing process, bills were not readily available to Ameresco engineers with kilowatt-hour (kWh) usage and electric rates. Typical electric rates and power cost equalization (PCE) rates have therefore been used in calculations. Data was used from the villages of Kaltag, Holy Cross, and Shageluk.

Rate per kWh	$ 0.5382
PCE Rate	$ 0.3225
Rates for Calculations	$ 0.2158

2.2 FUEL

Fuel bills were not readily obtained from the City of Nikolai. Ameresco's point of contact (POC) for the village informed engineers that the village pays $7.50/gallon for fuel. This rate has been used in calculations.

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 Nikolai 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 NIKOLAI City Office
Building Envelope		
B01	Door Weather-stripping Upgrade	**X**
B02	Insulation Upgrade	**X**
Controls		
C01	Thermostat Upgrade	**X**
Electrical		
E01	T-8 Lighting Upgrade	**X**
E02	Occupancy Sensors	**X**

VEEP – INITIAL PROPOSAL (FINAL AUDIT REPORT)			
ECO	**Cost**	**Savings**	**SPB**
B01 - WEATHERSTRIPPING	$ 8,000.00	$ 766.06	10.44
B02 - THERMAL INSULATION UPGRADE	$ 18,000.00	$ 797.06	22.58
C01 - PROGRAMMABLE THERMOSTAT UPGRADE	$ 1,600.00	$ 982.20	1.63
E01 - T8 LIGHTING UPGRADE	$ 28,000.00	$ 416.16	67.28
E02 - INSTALL OCCUPANCY SENSORS	$ 1,000.00	$ 370.85	2.70
DESIGN/AUDIT	$ 2,500.00		
AVAILABLE FUNDING	$ 15,900.00		
** Available funding allocated for travel expenses, shipping, additional labor, etc*			
TOTAL	**$ 75,000.00**	**$ 3,332.33**	**22.51**

4.1 ECO DESCRIPTIONS

Below are the descriptions of the Energy Conservation Opportunities (ECOs) that Ameresco analyzed for the Village of Nikolai. 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 – 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.

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 *Appendix A*.

5.1 CHANGES FROM INITIAL REPORTING

B01 – Door Weather-stripping Upgrade

Material was purchased and delivered to village but not installed due to lack of funding. An additional EECGB grant has been awarded to Village of Nikolai to upgrade existing doors and windows in City Office per Roger Jenkins and Joe Kimball (mayor).

B02 – Thermal Insulation Upgrade

Upon further investigation, the City Office was found to have a hot roof with no existing attic space. This ECO has not been performed.

C01 – Programmable Thermostat Upgrade

Installed as planned. See *Section 5.2* for updated cost information. Note: The savings on this ECO relies on proper HVAC scheduling. If the settings are tampered with, the savings will not be realized.

E01 – T-8 Lighting Upgrade

Installed as planned in the City Office Building. See *Section 5.2* for updated cost information. This ECO was added to the Maintenance Building later in the engineering process, and variation in fixture sizes was noted during the installation process. Only 2 of the T-8 fixtures were replaced in this building due to unexpected variation in fixture sizes. Additional 4 foot T-8 fixtures have been left in the possession of the City Maintenance Facilitator.

E02 – Occupancy Sensors

Occupancy sensors could not be installed in the Village of Nikolai due to the lack of grounding wires in the City Office Building. Occupancy Sensors require ground wire for operation. The sensors were left in the possession of the City Maintenance Facilitator.

E03 – LED Street Lights

The LED Street Light ECO was added to the project after additional funding was reallocated from the deletion of the Thermal Insulation Upgrade ECO. See *Section 5.2* for cost and expected savings information.

5.2 FUNDING ALLOCATION SUMMARY TABLES

VEEP ECOS - PROJECT COSTS & EXPECTED SAVINGS - NIKOLAI			
ECO	**Materials**	**Savings**	**SPB**
B01 - WEATHERSTRIPPING - NOT INSTALLED	$ 739.30	*N/A*	*N/A*
C01 - PROGRAMMABLE THERMOSTAT UPGRADE	$ 8,393.21	$ 982.20	8.55
E01 - T8 LIGHTING UPGRADE	$ 15,128.91	$ 355.21	42.59
E02 - OCCUPANCY SENSORS - NOT INSTALLED	$ 1,683.09	*N/A*	*N/A*
E03 - STREET LIGHTING UPGRADE	$ 48,664.94	$ 1,752.41	27.77
AVAILABLE FUNDING	$ 390.55		
** Available funding covers remaining project close out expenses.*			
TOTAL	**$ 75,000.00**	**$ 3,089.81**	**23.36**

APPENDIX A

VEEP PROJECT COSTS & EXPECTED SAVINGS

APPENDIX A - VEEP PROJECT COSTS & EXPECTED SAVINGS - NIKOLAI

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 - DELIVERED, NOT INSTALLED

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	5	Varies w/Size	$739.30	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*

**Note: This ECO was not installed, so only materials cost information has been reported.*

C01 - PROGRAMMABLE 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	Total Annual Savings	Simple Payback
City Office	2	$4,196.60	$8,393.21	0.00	18.33	18.33	130.96	$0.00	$982.20	$982.20	8.55

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	Total Annual Savings	Simple Payback
City Office	51	Varies w/# of lamps	$14,558.01	1,633.63	13.46	5.58	118.55	$352.54	$889.13	$1,241.67	41.29
Maintenance	2	Varies w/# of lamps	$570.90	12.38	0.27	0.04	0.90	$2.67	$6.74	$9.41	213.76

E02 - INSTALL OCCUPANCY SENSORS - NOT INSTALLED

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
City Office	2	Varies w/Type and Location	$1,683.09	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*

**Note: This ECO was not installed, so only materials cost information has been reported.*

E03 - STREET LIGHTING UPGRADE - QTY 18

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
Whole Village	150W HPS	47W LED	$48,664.94	8,120.52	22.25	27.72	589.30	$1,752.41	$4,419.73	$6,172.14	27.77

APPENDIX B

EQUATIONS USED IN CALCULATIONS

APPENDIX B - EQUATIONS USED IN CALCULATIONS - NIKOLAI

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)

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)

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%

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

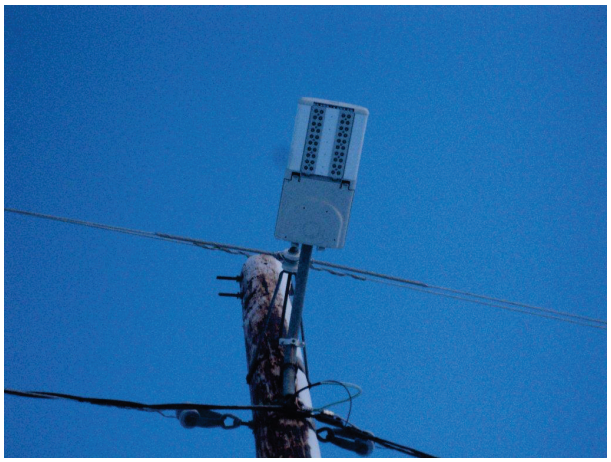
Tables 2A and 2B - 1995 Commercial Building Energy Consumption
2003 ASHRAE Applications Handbook, Chapter 35

	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

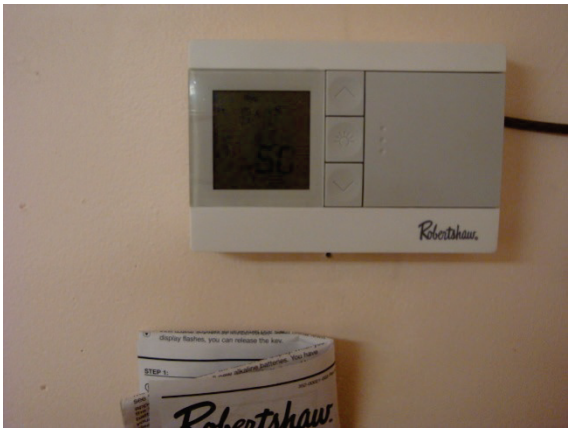
POST INSTALLATION PHOTOS

APPENDIX C – POST INSTALLATION PHOTOS - NIKOLAI



LED Street Light Installation

LED Street Light Installation – Second View



Programmable Thermostat Installation