



ENERGY AUDIT FINAL POST INSTALLATION REPORT

Results and Recommendations from Energy Audit of Fort Yukon

For EECBG and VEEP Grants City of Fort Yukon, Alaska



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EXECUTIVE SUMMARY AND PREFACE

This Final Post Installation Report summarizes the results of an Ameresco Energy Audit of the Village of Fort Yukon, the initial energy savings measures identified and proposed, and any changes that may have occurred throughout the installation process. The City of Fort Yukon is a recipient of an Alaska Energy Authority (AEA) Whole Village Energy Efficient Retrofit of \$400,000 as well as an Energy Efficiency and Conservation Block Grant (EECBG) of \$33,700.

Ameresco engineers conducted an energy audit of the City of Fort Yukon on December 29-30, 2010. The table below shows the buildings audited and their respective square footages.

City of Fort Yukon - Building Summary		
Building	Category	Square Footage
Addie Shewfelt	Public Building	2,059
City Hall	Public Building	3,120
Power House	Public Facility	5,076
Gwandak Public Broadcasting and CATG	Public Building	2,188
Tribal Hall	Public Building	4,740
Richard C Carroll Community Center	Public Building	1,800
Tribal Office	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 tableS below shows the results of Ameresco’s audit and potential calculation savings, allocated by grant. See *Appendix A* and *Appendix B* for more detailed calculation results. Project costs include costs incurred from the site visit, engineering time, materials cost, and labor cost, as well as Ameresco’s markup. It is important to note that the simple paybacks (SPBs) have been determined according to ECO type. For example, the SPB for an electrical ECO is calculated using only the annual kWh savings, even though the equivalent annual fuel gallon monetary savings is reported.

WHOLE VILLAGE/VEEP ECOS – FORT YUKON			
ECO	Cost	Savings	SPB
B01 - WEATHERSTRIPPING	\$2,368.57	\$161.55	14.66
B02 - THERMAL INSULATION UPGRADE	\$61,270.98	\$4,346.29	14.10
B03 - NEW MAINTENANCE BAY DOORS	\$119,350.09	\$3,549.49	33.62
E01 - STREET LIGHTING UPGRADE	\$99,980.53	\$31,978.39	3.13
E02 - INSTALL OCCUPANCY SENSORS	\$1,874.95	N/A	N/A
E03 - LED LIGHTING UPGRADE	\$23,876.30	\$3,492.17	6.84
M01 - FURNACE UPGRADE	\$42,120.90	\$6,667.26	6.32
M02 - DOMESTIC WATER HEATER UPGRADE	\$43,702.56	\$2,173.68	20.11
AVAILABLE FUNDING	\$ 5,455.13		
<i>* Available funding allocated to Kotlik</i>			
TOTAL GRANT	\$ 400,000.00		
FORT YUKON PROJECT TOTAL	\$ 394,544.87	\$52,368.83	7.53

EECBG - PROJECT COSTS & EXPECTED SAVINGS - FORT YUKON			
ECO	Cost	Savings	SPB
B01 - WEATHERSTRIPPING	\$ 13,036.96	\$ 4,409.70	2.96
C01 - PROGRAMMABLE THERMOSTAT UPGRADE	\$ 1,680.23	\$ 2,519.13	0.67
E02 - INSTALL OCCUPANCY SENSORS	\$ 9,690.23	\$ 2,248.06	4.31
E04 - INSTALL NEW AIR COMPRESSOR SYSTEM	\$ 9,065.38	\$ 1,737.17	5.22
AVAILABLE FUNDING	\$ 227.20		
<i>* Available funding allocated to Kotlik</i>			
TOTAL GRANT	\$ 33,700.00		
FORT YUKON PROJECT TOTAL	\$ 33,472.80	\$10,914.06	3.07

1.0 BUILDING DESCRIPTIONS

1.1 ADDIE SHEWFEELT BUILDING

Description: The Addie Shewfelt Building functions as a youth center for the city of Fort Yukon. The building is open 7 days a week from 1600 to 2000 hours.



General Conditions: The building was constructed in 1974, but is holding up relatively well for its age. The building also has a photovoltaic system with solar panels on the roof. At the time of the audit, these panels were snow-covered and could not be closely inspected. These panels appear to be connected to the main electrical panel and the domestic hot water system, but no batteries were found at the time of the audit.

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

Building Envelope: The building is in good condition overall, although the exterior is showing signs of weathering and age. There is no evidence of this facility being overheated as seen by the condition of the metal roof. Many of the windows have been boarded up with plywood to prevent break-ins because the building is closed for the majority of the day. There are four exterior doors, but three have been sealed to control the building traffic. Interior surfaces are in fair condition; a few drop tiles have been removed, as well as a few plastic floor tiles. The biggest concerns for the condition of the building envelope are several penetrations that have been covered by fiberglass insulation only and are leaking cold air into the building.

Heating: Two Monitor oil stoves provide the building with space heating, models 441 and 442. At the time of the audit, one of the oil heaters had been shut down for an unknown reason.

Controls: There are no additional building controls.

Lighting: Interior lighting consists primarily of T8 fluorescent lamps with electronic ballasts as well as several CFL fixtures.

Domestic Water: The building water pipes are currently not connected to a heat trace system. Because of this, the pipes freeze and remain frozen during the colder months in Fort Yukon. This was the case at the time of the audit. Also because of this, water to the building is turned off once the pipes freeze, and the domestic water heater is turned off as well. This water heater is a General Electric 38 gallon electric water heater.

Building Photos: Addie Shewfelt Building



Exterior Door



Missing Ceiling Tiles and Lighting System



GE Domestic Water Heater



Photovoltaic Panel



Poorly Insulated Penetration



Exterior and Boarded-up Windows

1.2 FORT YUKON CITY HALL

Description: The City Hall building in Fort Yukon is a multi-functional building that is divided into two sections. The first building section is the Fort Yukon City Hall. The second section consists of the Garage, Police Department, and Washeteria. Construction on the building was finished in 1981. Building operational hours are 0800 to 1700, Monday through Friday.



General Conditions: The building is in good condition overall, with no major faults or defects. At the time of the audit, the heating system was not fully functional, leaving only one working furnace.

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

Building Envelope: The structure appears to be in good condition overall with no noticeable concerns. The roof is in good condition, as are the exterior windows and doors. The walls are in good condition, though there is a cosmetic flaw in one of the exterior walls.

Heating: There are a total of 4 fuel oil furnaces that provide the building with space heating. Two Luxaire 126 MBH oil furnaces provide the City Hall area of the building with space heating. At the time of the audit, only one of these furnaces was operational and was running at 73.2% combustion efficiency. Both of these furnaces are old and run down, and two new replacements have already been ordered by the City. Two more warm air furnaces are housed in the Garage section of the building and provide heat to the Garage, Police Station, and Washeteria. A combustion analysis showed these two furnaces to be functioning at 70.3% and 70.9% combustion efficiency at the time of the audit.

Controls: Building heating is controlled by mechanical thermostats. Two mechanical thermostats control the zones of the City Hall section of the building. The thermostat controls for the two zones, however, are placed next to each other in one central location in the City Clerk's office. One mechanical thermostat located in the Garage section of the building controls both furnaces that heat the Garage, Police Station, and Washeteria. Programmable thermostats have been ordered to replace the mechanical thermostats that serve the City Office portion of the building.

Lighting: Interior lighting fixtures are mostly T8 fluorescent with electronic ballasts.

Domestic Water: A 32 gallon Bock fuel oil fired domestic water heater provides hot water to the building. This size domestic water heater is a residential model with an energy factor of 0.63 and a recovery efficiency of 85%. Occupants state that this current water heater does not have enough capacity to serve washers and bathroom fixtures.

Building Photos: Fort Yukon City Hall



Minor Damage to Exterior Façade



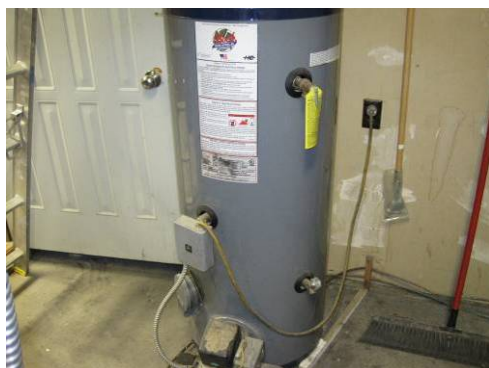
Exterior Lighting Fixture



Defunct Furnace



Side-By-Side Zone Controls



Bock Domestic Water Heater



Attic Insulation

Building Photos: Fort Yukon City Hall



Washeteria Area



Washeteria Area



Garage Lighting System



Heating System in Garage

1.3 FORT YUKON POWER HOUSE

Description: The Fort Yukon Power House building contains the village's generators and serves as a maintenance storage facility. The building was first constructed in the 1940's and has been patched and augmented over the years. It was originally owned by a private company, which then sold the facility to the city. Typical operating hours are 0800 to 1700, Monday through Friday, though the operator is on call during non-working hours.



General Conditions: Overall, the building is in poor condition due to age and weathering. Many parts of the building are falling apart and are in desperate need of repair. This building is not charged for electric use, so any monetary savings will come from fuel use reduction. The operator believes that his load has grown considerably faster than the other villages over the years and most likely will continue to do so. Since the time of the audit, Ameresco has been informed that a renovation project has already been planned for this facility. No ECOs have been identified for this building because of this.

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

Building Envelope: The building is in extremely poor condition. The roof has a plethora of holes through which the sky is visible. There is no insulation either, so when the excess generator heat escapes, this causes the snow to melt and ice to form around the perimeter of the building and create a safety hazard. The walls are in poor condition and have many holes as well. Windows are in poor condition, and many of the single pane fixtures are broken. Exterior door weather-stripping has deteriorated to the point that it is no longer functional.

Heating: When the temperature drops, extra heating is provided by electric and hydronic unit heaters. If the building were repaired and insulated more adequately, the waste heat from the generators could be captured and used to heat the facility.

Controls: Three mechanical thermostats control space heating to the building. One thermostat controls heating to the workshop, while the other two control heating to the garage area.

Lighting: Interior lighting is primarily T8 fluorescent with electronic ballasts as well as several CFL fixtures. There are no occupancy sensors or lighting timers.

Domestic Water: There is not a domestic water system at the Fort Yukon Power House.

Power Equipment and Loading: The Power House holds 4 Caterpillar diesel generators ranging from 500 to 700 kW. These generators are in fair condition, and all 4 were operational at the time of the audit, though only 2 were running. At the time of the audit, Generators 1 and 4 carried no load, Generator 2 had a 290 kW load, and Generator 3 had a 209 kW load. A new generator was being housed in the garage as well. The operator informed Ameresco engineers that one of the older generators will be replaced with this new 445 kW generator, even though it cannot carry as large of a load as the 700 kW generator.

Building Photos: Fort Yukon Power House



Power Lines



Ice Melting From Generator Heat



Electric Unit Heater



Hydronic Unit Heater



Generator Panels



Dilapidated Door

Building Photos: Fort Yukon Power House



Non-insulated Penetrations



Gaps in Structure to Outside Conditions



Deteriorating Insulation



Lighting System



New Generator

1.4 GWANDAK PUBLIC BROADCASTING AND COUNCIL OF ATHABASCAN TRIBAL GOVERNMENTS (CATG) BUILDING

Description: The Gwandak Public Broadcasting building is a multi-functional building that also houses the Council of Athabascan Tribal Governments (CATG). The CATG section is on the ground floor and is used by the city as an income property. The radio station is housed on the upper level of the building. Typical operating hours for the radio station are 0800 to 1900, seven days a week.



General Conditions: The building is an old building and is in relatively poor condition. A single mechanical thermostat controls building heating to both the radio station and the CATG section. There is an equipment room on the top floor of the building that remains warm because of all the transmitters and broadcasting equipment. A window is kept open to keep this room cool because the thermostat is located downstairs.

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

Building Envelope: The building is in poor condition due to weathering and its age. The roof is in poor condition and has a large patch to keep water from leaking in, but the patch is no longer effective. One area of the roof is leaking water near the electrical board, which raises a safety concern. Walls are in fair condition. Most of the windows are in good condition, but one needs to be resealed. Weather-stripping is in poor condition and is no longer adequate.

Heating: A recently replaced Lennox furnace provides the building with space heating. A combustion analysis showed this furnace to be operating at 81.2% combustion efficiency at the time of the audit. There are also several electrical heaters scattered around that tenants and employees use when the temperature drops. Occupants most often use these extra heaters when the temperature drops below zero. Several penetrations remain in the furnace room that have not been adequately insulated and still allow warm air to escape the building.

Controls: One mechanical thermostat controls heating to the whole building.

Lighting: The building is primarily lit by T8 fluorescent fixtures with electronic ballasts as well as several CFL fixtures.

Domestic Water: A 30-gallon American water heater provides the building with domestic hot water.

Building Photos: Gwandak Broadcasting



Exterior Windows in Good Condition



Patched Roof



Lennox Furnace



Sealed Penetration



Thermostat for Entire Building



Electric Heater

1.5 FORT YUKON TRIBAL HALL

Description: The Fort Yukon Tribal Hall was originally constructed in 1982 and is the main meeting area for many of the villagers. This building is where major ceremonies are held such as weddings, traditional dances, and funerals.



General Conditions: The log cabin-style building is in good condition overall, except for two penetrations through the rear wall. No major faults or defects were found during the audit walkthrough.

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

Building Envelope: The structure is in good condition overall. The exterior and interior walls are also in good condition. The roof is in good condition and shows no signs of damage or poor insulation. Windows are in fair condition; several are broken and others have been boarded up for unknown reasons. Weather-stripping is in poor condition and needs to be replaced. Doors are in fair condition and could be upgraded.

Heating: Two Monitor-2400 fuel oil forced air heaters as well as a wood-burning heater supply the building with space heating.

Controls: There are no separate building controls.

Lighting: The building is primarily lit by T8 fluorescent fixtures with electronic ballasts.

Domestic Water: There is not a domestic water heating system in the Tribal Hall.

Building Photos: Fort Yukon Tribal Hall



Wood Stove Vent and Storage Tank



Partially-Boarded Window



Sealed Penetrations



Non-Weather-stripped Door



Wood-Burning Stove



Monitor-2400 Fuel Oil Heater

1.5 OTHER BUILDINGS VISITED

Richard C Carroll Community Hall: At the time of the audit, the Richard C Carroll Community Hall had been shut down by the city to save money. The building appears to be in good condition overall, without any major faults or defects. Ameresco engineers could not fully assess the condition of the mechanical equipment at this facility because it is no longer operational. Lighting is provided by T8 fluorescent fixtures with electronic ballasts.



Tribal Council Office: The Tribal Office is a separate building from the Tribal Council and is in good condition overall. The building is well kept up, but the domestic water heater at this facility is outdated and uses a great deal of electricity.



2.0 UTILITIES

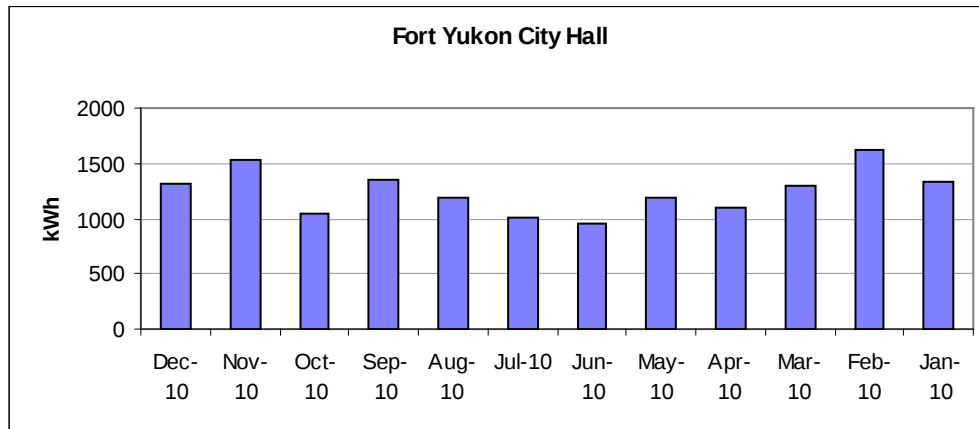
2.1 ELECTRICITY

The City of Fort Yukon produces its own electricity via the Gwitchyaa Zhee Utility Company.

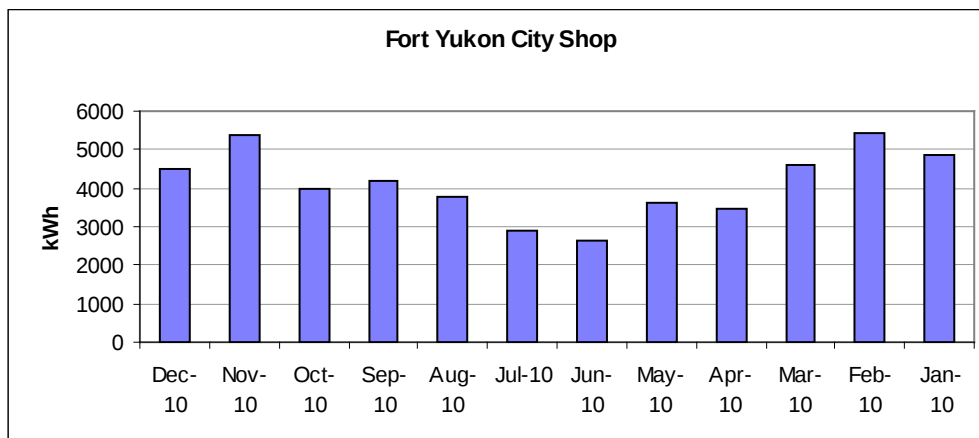
Utility Fuel Charge Per kWh	\$ 0.1900
Rate Per kWh, Fuel Cost Included	\$ 0.6034
State Assistance Rate Per kWh	\$ 0.3211

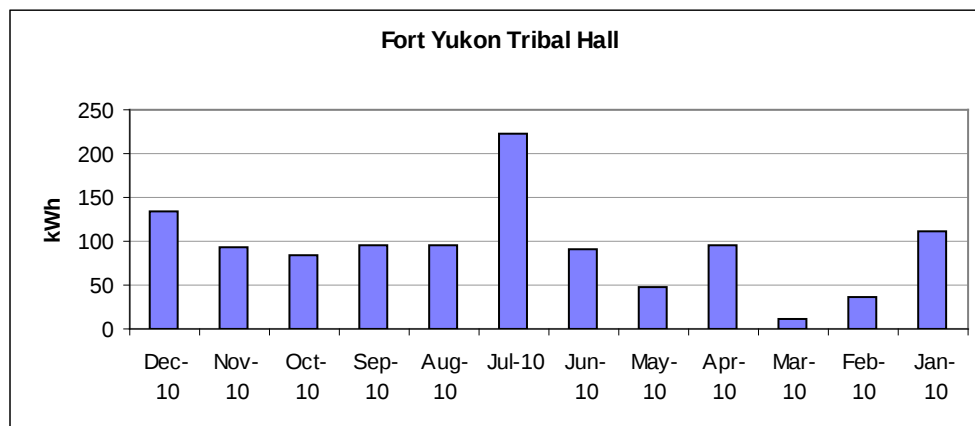
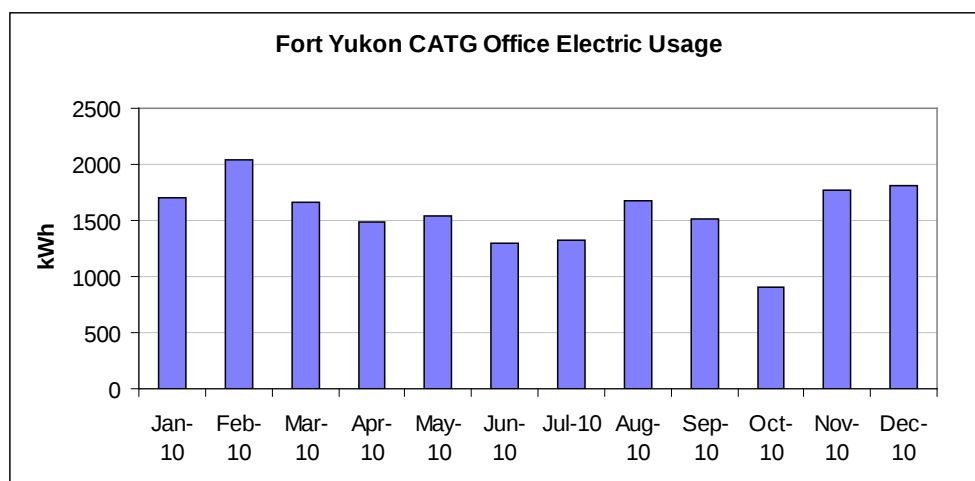
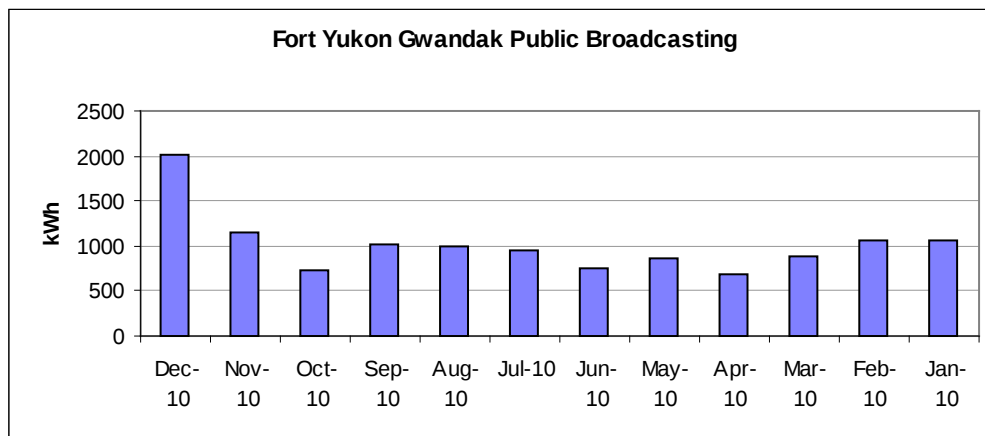
The Fort Yukon City Hall is the only building audited to receive state assistance at this time. The street lighting bill, however, receives state assistance as well.

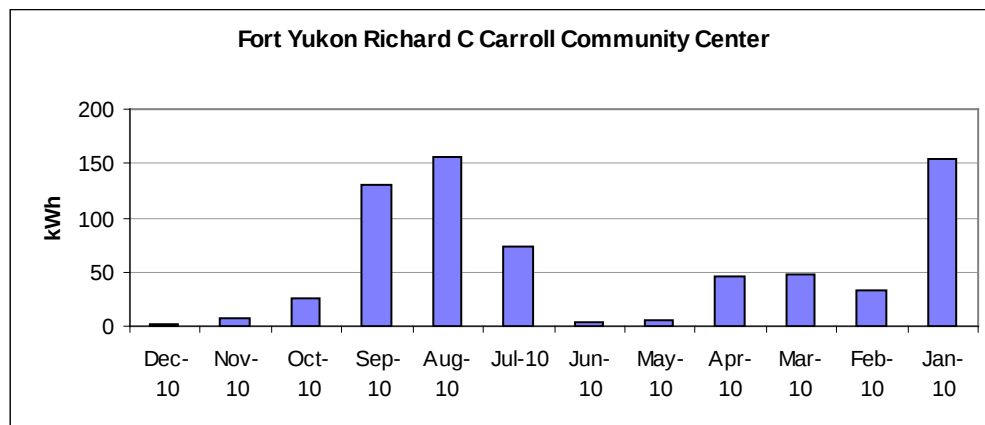
2.1.1 Electricity Usage Profiles



Note: The City Shop is the Garage section of the Fort Yukon City Hall building.



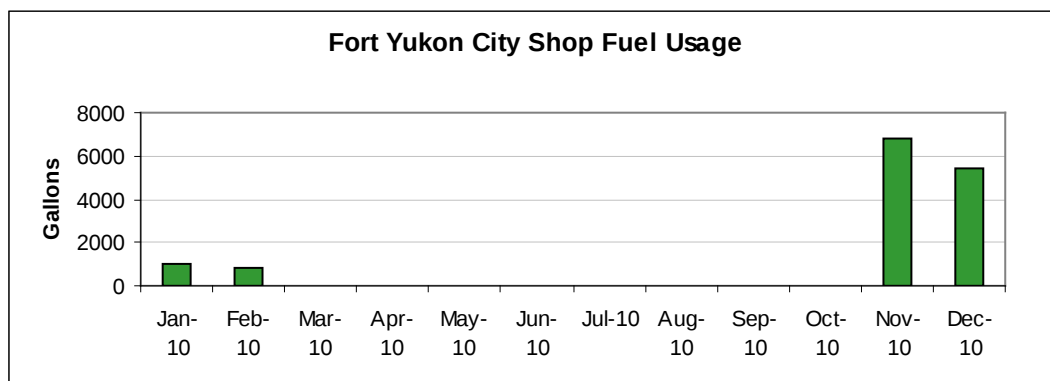


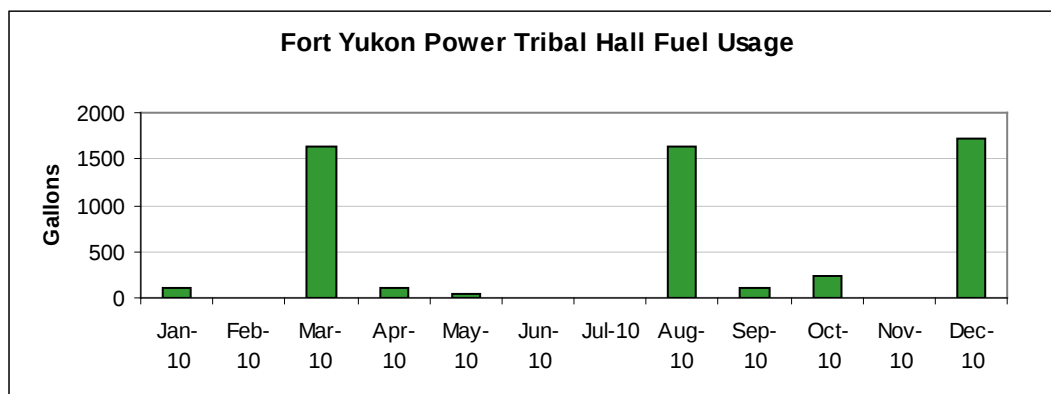
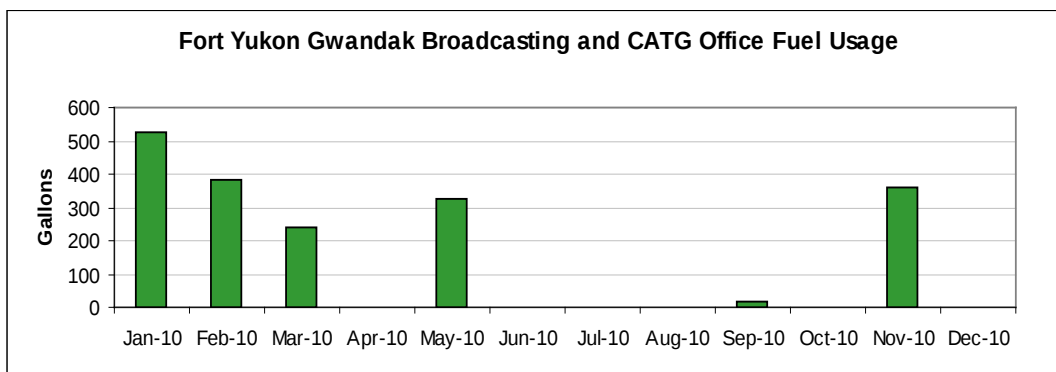
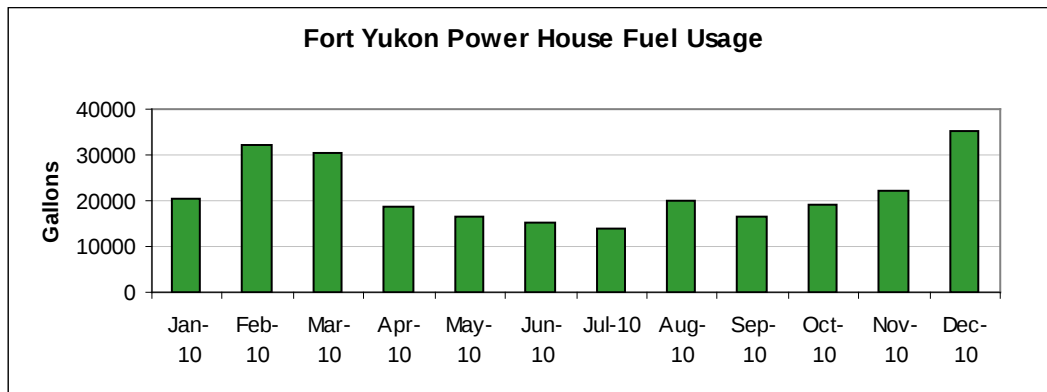


2.2 FUEL

The City of Fort Yukon purchases its fuel from Crowley Petroleum Distribution, Inc. The majority of City buildings paid an average of \$4.449/gallon in 2010. The Gwandak Public Broadcasting building has a separate account and paid an average of \$5.074/gallon in 2010.

2.2.1 Fuel Usage Profiles





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 within the village.

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

4.0 WHOLE VILLAGE AUDIT INITIATIVES

Section 4 details opportunities for the City of Fort Yukon's Whole Village Energy Efficiency Retrofit granted by the Alaska Energy Authority.

4.1 LIGHTING EXCHANGE PROGRAM

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

4.2 STREET LIGHTING UPGRADE

This ECO proposes replaced the existing 150W high pressure sodium (HPS) fixtures with 40W LED fixtures. The City of Fort Yukon has 110 street light fixtures, and this retrofit will lower nighttime demand and electricity consumption considerably.

5.0 ENERGY CONSERVATION OPPORTUNITIES

The ECO matrix below summarizes the energy conservation opportunities identified during the site survey and baseline analysis. A description of each energy conservation opportunity follows the matrix. It is important to note the matrix below does not display Ameresco's recommendations, but only the opportunities analyzed. For Ameresco's implementation recommendations, see the funding table in the Executive Summary.

ECO No.	ECO Description	ECO MATRIX					
	B=Building Envelope; C=Controls; E=Electrical; M=Mechanical; W=Water/Wastewater; R=Renewable	FORT YUKON					
		Addie Shewfelt	City Hall	Gwandak Broadcasting	Tribal Hall	Tribal Office	Whole Village
Building Envelope							
B01	Door Weather-stripping Upgrade	X	X		X		
B02	Insulation Upgrade	X	X	X	X		
B03	Install New Maintenance Bay Doors		X				
Controls							
C01	Thermostat Upgrade		X	X			
Electrical							
E01	Street Lighting Upgrade						X
E02	Occupancy Sensors	X	X	X	X		
E03	Residential Lighting Upgrade						X
E04	Install New Air Compressor System		X				
Mechanical							
M01	Furnace Upgrade		X				
M02	DHW Upgrade	X	X	X		X	
Renewable							
R01	Solar Domestic Hot Water		X				

WHOLE VILLAGE & VEEP ECOS – FORT YUKON – INITIAL PROPOSAL (FINAL AUDIT REPORT)			
ECO	Cost	Savings	SPB
B01 - WEATHERSTRIPPING	\$ 23,856.00	\$ 4,571.25	5.22
B02 - THERMAL INSULATION UPGRADE	\$ 57,097.04	\$ 4,346.29	13.14
C01 - PROGRAMMABLE THERMOSTAT UPGRADE	\$ 1,000.00	\$ 2,519.13	0.40
E01 - STREET LIGHTING UPGRADE - 110 FIXTURES	\$ 131,670.00	\$ 31,978.39	4.12
E02 - INSTALL OCCUPANCY SENSORS	\$ 11,000.00	\$ 4,039.20	2.72
E03 - LED LIGHTING UPGRADE	\$ 20,690.00	\$ 3,492.17	5.92
E04 - INSTALL NEW AIR COMPRESSOR SYSTEM	\$ 10,332.00	\$ 1,737.17	5.95
M01 - FURNACE UPGRADE	\$ 20,000.00	\$ 6,667.26	3.00
M02 - DOMESTIC WATER HEATER UPGRADE	\$ 37,220.40	\$ 2,173.68	17.12
R01 - SOLAR DOMESTIC WATER HEATING	\$ 27,350.40	\$ 1,060.02	25.80
DESIGN/AUDIT	\$ 30,000.00	N/A	N/A
AVAILABLE FUNDING	\$ 63,484.16	N/A	N/A
<i>* Available funding allocated for travel expenses, shipping, additional labor, etc</i>			
TOTAL	\$ 433,700.00	\$ 62,584.56	6.93

5.1 ECO DESCRIPTIONS

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

5.1.1 Building Envelope Opportunities

B01 – Door Weather-stripping Upgrade

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

B02 – Thermal Insulation Upgrade

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

B03 – Energy Efficient Doors – New Maintenance Bay Doors

This ECO proposes installing new insulated doors. The installation would improve U-values of the current hollow metal maintenance bay doors. This ECO would also improve the basic maintenance bay door operation, as the currently installed doors do not open and close properly.

5.1.2 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.

5.1.3 Electrical Opportunities

E01 – Street Lighting Upgrade

See *Section 4.2*.

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 – Residential Lighting Upgrade

See *Section 4.1*.

E04 – Install New Air Compressor System

The existing air compressor system at the Fort Yukon City Hall building is in need of a replacement due to its age and operational limitations. The unit is also left on, even when use is not required. Savings will be realized by shutting off the system when it is not in use via a relay and timer, fixing any system leaks, and installing a higher efficiency air compressor.

5.1.4 Mechanical Opportunities

M01 – 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.

M02 – 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.

5.1.5 Renewable Opportunities

R01 – Solar Domestic Hot Water

This ECO proposes installing solar domestic hot-water heating systems that use solar collection panels to capture solar radiated heat to heat domestic water. Such systems can displace the entire domestic water heating load or serve as a pre-heater and supplement the heating load. The total amount of solar heating is dependent upon the domestic hot-water consumption profile, daily weather conditions, and available solar radiation.

6.0 FINAL COSTING AND CHANGES FROM INITIAL REPORTING

Due to the brief nature of these contracts and the high cost of travel to and from the villages, audits were conducted as 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 for the VEEP projects can be found in *Appendix A*. Final project costs and expected annual savings for the EECBG projects can be found in *Appendix B*. ECOs that were categorized as “Not Funded,” whether in the initial stages of the proposal or during VEEP construction, can be found in *Appendix C*.

6.1 GRANT CHANGES FROM INITIAL REPORTING

In the initial Fort Yukon audit report, the village was documented as receiving a \$33,700 additional VEEP grant, but this grant is actually from EECBG funds. Because of this, some of the ECO cost structure was rearranged due to different program requirements between Whole Village, VEEP, and EECBG initiatives. Where necessary, these requirements are explained further in *Section 6.2*.

6.2 ECO CHANGES FROM INITIAL REPORTING

B01 – Door Weather-stripping Upgrade

Installed as planned in the Tribal Hall building under Whole Village funding and in the City Hall and Addie Shewfelt buildings under EECBG funding. EECBG funding does not allow for upgrades on Tribal owned buildings, therefore, this ECO had to be split between funding pools.

B02 – Thermal Insulation Upgrade

Installed as planned.

B02 – Thermal Insulation Upgrade

Added to scope. This ECO replaced R01 in the Fort Yukon project scope.

C01 – Programmable Thermostat Upgrade

Installed as planned with EECBG funding.

E01 – Street Lighting Upgrade

Installed as planned.

E02 – Occupancy Sensors

Installed as planned in the City Hall under EECBG funding. Removed from Whole Village scope at Tribal Hall building due to grounding issues; two sensors were purchased in this instance, but could not be installed.

E03 – LED Lighting Upgrade

Distributed as planned. A total of 600 LED light bulbs were dispersed during a Village Energy Efficiency Fair.

E04 – Air Compressor Upgrade

Installed as planned with EECBG funding.

M01 – Furnace Upgrade

Installed as planned.

M02 – Domestic Water Heater Upgrade

Installed as planned in the Addie Shewfelt, Gwandak, and Tribal Office buildings. Removed from scope at the City Hall building.

R01 – Solar Hot Water System

Removed from scope due to funding and time constraints. This ECO would have taken significant engineering and development time that was not available in the Village Audit time frame.

6.2 FUNDING ALLOCATION SUMMARY TABLES

WHOLE VILLAGE/VEEP ECOS – FORT YUKON			
ECO	Cost	Savings	SPB
B01 - WEATHERSTRIPPING	\$2,368.57	\$161.55	14.66
B02 - THERMAL INSULATION UPGRADE	\$61,270.98	\$4,346.29	14.10
B03 - NEW MAINTENANCE BAY DOORS	\$119,350.09	\$3,549.49	33.62
E01 - STREET LIGHTING UPGRADE	\$99,980.53	\$31,978.39	3.13
E02 - INSTALL OCCUPANCY SENSORS	\$1,874.95	N/A	N/A
E03 - LED LIGHTING UPGRADE	\$23,876.30	\$3,492.17	6.84
M01 - FURNACE UPGRADE	\$42,120.90	\$6,667.26	6.32
M02 - DOMESTIC WATER HEATER UPGRADE	\$43,702.56	\$2,173.68	20.11
AVAILABLE FUNDING	\$ 5,455.13		
<i>* Available funding allocated to Kotlik</i>			
TOTAL GRANT	\$ 400,000.00		
FORT YUKON PROJECT TOTAL	\$ 394,544.87	\$52,368.83	7.53

EECBG - PROJECT COSTS & EXPECTED SAVINGS - FORT YUKON			
ECO	Cost	Savings	SPB
B01 - WEATHERSTRIPPING	\$ 13,036.96	\$ 4,409.70	2.96
C01 - PROGRAMMABLE THERMOSTAT UPGRADE	\$ 1,680.23	\$ 2,519.13	0.67
E02 - INSTALL OCCUPANCY SENSORS	\$ 9,690.23	\$ 2,248.06	4.31
E04 - INSTALL NEW AIR COMPRESSOR SYSTEM	\$ 9,065.38	\$ 1,737.17	5.22
AVAILABLE FUNDING	\$ 227.20		
<i>* Available funding allocated to Kotlik</i>			
TOTAL GRANT	\$ 33,700.00		
FORT YUKON PROJECT TOTAL	\$ 33,472.80	\$10,914.06	3.07

APPENDIX A

**VEEP & WHOLE
VILLAGE PROJECT
COSTS & EXPECTED
SAVINGS**

APPENDIX A - VEEP & WHOLE VILLAGE PROJECT COSTS & EXPECTED SAVINGS - FORT YUKON

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
Tribal Hall	2	\$1,184.28	\$2,368.57	0.00	5.08	5.08	36.31	\$0.00	\$161.55	\$161.55	14.66

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
Addie Shewfelt	R-19	R-38	\$10,420.17	0.00	19.17	19.17	136.92	\$0.00	\$609.10	\$609.10	17.11
City Hall	R-19	R-38	\$15,789.66	0.00	33.18	33.18	237.00	\$0.00	\$1,054.33	\$1,054.33	14.98
Gwandak	R-19	R-38	\$11,073.01	0.00	34.03	34.03	243.05	\$0.00	\$1,081.27	\$1,081.27	10.24
Tribal Hall	R-19	R-38	\$23,988.14	0.00	50.40	50.40	360.01	\$0.00	\$1,601.59	\$1,601.59	14.98

B03 - NEW MAINTENANCE BAY DOORS

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 Hall	6	Varies w/Size	\$119,350.09	-3.00	111.70	111.70	797.86	-\$0.97	\$3,550.46	\$3,549.49	33.62

E01 - STREET LIGHTING UPGRADE

Number of Fixtures for Retrofit	Existing Fixture	Retrofit Fixture	Total Cost	Electric kWh Savings	Electric kW Savings	Equivalent t mmBtu Savings	Equivalent Fuel Gallons Savings	Annual kWh Cost Savings	Annual Equivalent Fuel Cost Savings	Total Annual Savings	Simple Payback
110	150W HPS	72W LED	\$99,980.53	52,998.00	145.20	180.88	3,846.01	\$31,978.39	\$17,109.89	\$49,088.27	3.13

E02 - INSTALL OCCUPANCY SENSORS

Building	# of Sensors	Price Per Sensor	Total Cost	Electric kWh Savings	Annual Electric kW Savings	Equivalent t mmBtu Savings	Equivalent Fuel Gallons Savings	Annual kWh Cost Savings	Annual Equivalent Fuel Cost Savings	Total Annual Savings	Simple Payback
Tribal Hall	2	\$937.48	\$1,874.95	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Note: The following table is a village-wide energy retrofit initiative. Therefore the savings reported in "Annual kWh Cost Savings" and "Annual Equivalent Fuel Cost Savings" are village-wide savings.

E03 - LED LIGHTING UPGRADE

Number of Bulbs to be Exchanged	Typical Lamp Wattage (kW)	LED Wattage (kW)	Total Cost	Electric kWh Savings	Annual Electric kW Savings	Equivalent t mmBtu Savings	Equivalent Fuel Gallons Savings	Annual kWh Cost Savings	Annual Equivalent Fuel Cost Savings	Total Annual Savings	Simple Payback
600	60	7	\$23,876.30	5,787.60	31.80	19.75	420.00	\$3,492.17	\$1,868.47	\$5,360.64	6.84

M01 - 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 Hall	2	96.00%	\$42,120.90	0.00	209.82	209.82	1,498.69	\$0.00	\$6,667.26	\$2,158.36	6.32

M02 - DOMESTIC WATER HEATER UPGRADE

Building	# of Water Heaters to Replace	New Water Heater	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
Addie Shewfelt	1	Toyotomi O128	\$14,567.52	3,363.23	-12.13	-0.65	157.44	\$2,029.33	\$700.43	\$2,729.76	20.80
Gwandak	1	Toyotomi O128	\$14,567.52	3,475.33	-12.13	-0.27	165.58	\$2,096.98	\$736.62	\$2,833.60	19.78
Tribal Office	1	Toyotomi O128	\$14,567.52	3,475.33	-12.13	-0.27	165.58	\$2,096.98	\$736.62	\$2,833.60	19.78

APPENDIX B

EECBG PROJECT COSTS & EXPECTED SAVINGS

APPENDIX B - EECBG PROJECT COSTS & EXPECTED SAVINGS - FORT YUKON

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
Addie Shewfelt	3	Varies w/Size	\$3,008.53	0.00	8.13	8.13	58.10	\$0.00	\$258.47	\$258.47	11.64
City Hall	10	Varies w/Size	\$10,028.43	0.00	130.60	130.60	932.86	\$0.00	\$4,151.23	\$4,151.23	2.42

C01 - PROGRAMMABLE 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 Hall	1	\$840.12	\$840.12	0.00	47.74	47.74	341.02	\$0.00	\$1,517.12	\$1,517.12	0.55
Gwandak	1	\$840.12	\$840.12	0.00	31.53	31.53	225.23	\$0.00	\$1,002.01	\$1,002.01	0.84

E02 - INSTALL OCCUPANCY SENSORS

Building	# of Fixtures	Price Per Fixture	Total Cost	Electric kWh Savings	Annual Electric kW Savings	Equivalent mmBtu Savings	Equivalent Fuel Gallons Savings	Annual kWh Cost Savings	Annual Equivalent Fuel Cost Savings	Total Annual Savings	Simple Payback
City Hall	14	\$692.16	\$9,690.23	3,725.72	0.00	12.72	270.37	\$2,248.06	\$1,202.81	\$3,450.87	4.31

E04 - INSTALL NEW AIR COMPRESSOR SYSTEM

Building	Air Compressor HP	New Air Compressor Efficiency	Total Cost	Electric kWh Savings	Annual 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 Hall - Shop	3	90%	\$9,065.38	5,410.69	0.00	18.47	392.65	\$1,737.17	\$1,747.28	\$3,484.45	5.22

APPENDIX C

ECO CALCULATION RESULTS – NOT FUNDED

APPENDIX C - ECO CALCULATION RESULTS - NOT FUNDED - FORT YUKON

M02 - DOMESTIC WATER HEATER UPGRADE											
Building	# of Water Heaters to Replace	New Water Heater	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 Hall	1	Toyotomi O128	\$12,406.80	0.00	5.66	5.66	40.42	\$0.00	\$179.83	\$179.83	68.99

R01 - SOLAR HOT WATER SYSTEM											
Building	# Solar Collectors Needed	System Size Needed (kW)	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 Hall	9	14.98	\$27,350.40	0.00	33.36	33.36	238.27	\$0.00	\$1,060.02	\$1,060.02	25.80

APPENDIX D

**EQUATIONS USED IN
CALCULATIONS**

APPENDIX D - EQUATIONS USED IN CALCULATIONS - FORT YUKON

ECO Equations

- B01**
1. Door Leakage Area (in²) = Door Area x Door Leakage Factor
 2. Specific Infiltration (CFM/in²) = [(Stack Coefficient x ΔT) + (Wind Coefficient x [Wind Speed]²)]^{1/2}
 3. ΔT = Heating Setpoint Temp - Bin Temp
 4. Air Infiltration (CFM) = Specific Infiltration x Door Leakage Area
 5. Heat Loss Rate (Btu/hr) = 1.08 x Air Infiltration x ΔT
 6. Heating Load (mmBtu) = Heat Loss Rate x Bin Hours / 1,000,000
 7. Energy Savings = Baseline - Proposed
- Note: This ECO was completed using the RETScreen program.*
- B02** *Note: This ECO was completed using the RETScreen program.*
Inputs are R-values reported in the appendices as well as the insulation square footage.
- B03** *Note: This ECO was completed using the eQuest program.*
Two building models were created and compared using pre- and post-install door upgrade data.
- 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 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. 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)
- E04**
1. $W = m \cdot C_p \cdot T \cdot [(P_2/P_1)^{(k-1)/k} - 1]$, m=mass flow, C_p = specific heat, T = temperature, P = pressure, k = ratio of specific heats
 2. Annual Air Compressor Waste (kWh/yr) = $W / [(3413 \text{ Btu/hr/kW}) \cdot (60 \text{ min/hr}) \cdot (\text{Annual Hours Equipment Operational Without Need})]$
 3. kWh Savings From Higher Efficiency Motor =
 $(\text{Motor hp}) \cdot (0.746 \text{ kW/hp}) \cdot (\text{Annual Hours of Operation}) \cdot [1/(\text{Old Efficiency}) - 1/(\text{New Efficiency})]$
 4. Total Annual kWh Savings = Air Compressor Waste + Savings From New Install
 5. Total Annual Cost Savings = (Total kWh Savings)(\$/kWh)
- M01** *Note: This ECO is based on bin data, occupancy, heating peak loads, and furnace efficiency.*
Baseline Usage = (Peak Load x Occupied Load Profile x All Hours) / (Old Heater Efficiency)
ECM Usage = (Peak Load x Occupied Load Profile x All Hours) / (New Heater Efficiency)
mmBtu Saved = Baseline Usage - ECM Usage
- 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
- R01**
1. RETScreen is used for the energy savings estimate.
 2. Baseline Usage (kWh) = (Baseline Demand) x (Fixture Hours)
 3. Proposed Usage (kWh) = (Proposed Demand) x (Fixture Hours)
 4. Annual Energy Savings = (Baseline Energy Usage) - (Proposed Energy Usage)
 5. 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%

APPENDIX E

**POST INSTALLATION
PHOTOS**

APPENDIX E – POST INSTALLATION PHOTOS – FORT YUKON



Thermal Insulation Upgrade – Addie Shewfelt Building



New Overhead Shop Doors – City Hall



LED Street Lighting Upgrade



Furnace Upgrade – City Hall