ENERGY AUDIT FINAL REPORT

Results and Recommendations from Energy Audit of Holy Cross

For VEEP Grants

City of Holy Cross, Alaska

April 29, 2011

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APPENDICES

EXECUTIVE SUMMARY AND PREFACE

This Final Report summarizes the results of an Ameresco Energy Audit of the City of Holy Cross. The intent of this Final Report is to evaluate energy consumption and costs, and to identify city and community projects that could utilize grant money provided by the Alaska Energy Authority (AEA). The City of Holy Cross is a recipient of an AEA Village Energy Efficiency Program (VEEP) grant of $150,000.

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

City of Holy Cross - Building Summary

Building	Category	Square Footage
City Office	Public Building	770
Community Hall	Public Building	2,640
School	School	17,537
Water Treatment Plant	Public Facility	860
Washeteria	Public Facility	330

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. 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

ECO	Cost	Savings	SPB
C01 - THERMOSTAT UPGRADE	$ 2,000.00	$ 7,937.11	0.25
E01 - T8 LIGHTING UPGRADE	$ 60,200.00	$ 10,830.24	5.56
E02 - INSTALL OCCUPANCY SENSORS	$ 13,000.00	$ 5,511.37	2.36
E03 - PREMIUM EFFICIENCY MOTORS UPGRADE	$ 20,000.00	$ 1,102.31	18.14
M01 - BOILER TUNE-UP	$ 8,400.00	$ 17,642.00	0.48
M02 - BOILER UPGRADE	$ 41,000.00	$ 6,164.56	6.65
DESIGN/AUDIT	$ 2,500.00		
AVAILABLE FUNDING	$ 2,900.00		
** Available funding allocated for travel expenses, shipping, additional labor, etc*			
TOTAL	**$ 150,000.00**	**$ 49,187.60**	**3.05**

1.0 BUILDING DESCRIPTIONS

1.1 HOLY CROSS CITY OFFICE

- **Description:** The Holy Cross City Office handles the day to day operations and maintenance issues of the village. The upstairs of the building is used mostly as a storage area. Typical operating hours are from 0900 to 1700 hours, Monday through Friday.

- **General Conditions:** The building is in fair condition overall, with several damaged areas found during the course of the audit, in particular the leaky roof. Much room exists for repair and improvement in energy savings.

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

- **Building Envelope:** The building overall is in fair condition and could use many improvements. The roof is in poor condition and is leaking water into the building. The building exterior is showing many signs of weathering and age but it still holding up. The windows are in fair condition. Weather-stripping, when present, is in poor condition and needs to be replaced; the front entrance door has no weather-stripping at all. There is a potential safety hazard on the second floor of the building; an exterior door exists where there is no staircase or balcony for unknowing occupants to step out on.

- **Heating:** Building heating is provided by a Toyostove Laser 73 oil burning unit heater. A Lennox oil furnace that is no longer used remains in the building. This furnace is kept as a backup in case the Toyostove heater breaks. The Toyostove heater, however, cannot heat the building to the setpoint of 68°F in cold weather.

- **Controls:** The old mechanical thermostats for the furnace remain in the building but are not used at this time.

- **Lighting:** Interior lighting consists primarily of T12 fluorescent lamps with magnetic ballasts as well as several 60-90 watt incandescent fixtures.
- **Domestic Water:** The building does not have a domestic hot water system in place.

Building Photos: Holy Cross City Office

Exterior Door to Nowhere

Melting Snow – Poor Insulation

Run-Down Exterior Window

No Weather-stripping on Front Door

Toyostove Laser 73 Heater

Ceiling Water Damage From Leaky Roof

Old Lennox Furnace

More Water Damage

1.2 HOLY CROSS COMMUNITY HALL

- **Description:** The Holy Cross Community Hall is connected to the City Office building by a shared foyer area. This section of the building is used for special occasions and various community gatherings.

- **General Conditions:** This building is in the same condition as the City Office, but the roof of the Community Hall section of the building is in fair condition with no water leakage issues.

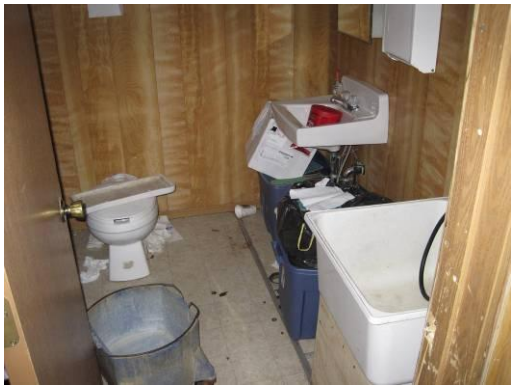
  Pictures of general conditions found during the field audit immediately follow this building description.

- **Building Envelope:** The building envelope of the Community Hall is the same as the City Office, except there is no water leakage, so the roof and dropped-ceiling tiles are in good condition.

- **Heating:** This section of the building has the same setup as the City Office. A new Toyostove Laser 73 supplies the building with space heating, while an old Lennox furnace remains in place as a backup heating system.
- **Controls:** The Toyostove has a building in thermostat, but the old furnace mechanical thermostats remain in place in the facility.
- **Lighting:** Interior lighting fixtures are mostly T12 fluorescent with magnetic ballasts, and there are several 60-90 watt incandescent fixtures as well.
- **Domestic Water:** The building has a men's and women's toilet, but no showers or domestic water heater.

Building Photos: Holy Cross Community Hall

Interior Lighting System



Women's Restroom – No Longer Functional

Unused Furnace

Community Hall Interior

Insulated Exhaust Opening

Toyostove Laser 73 Heater

1.3 HOLY CROSS SCHOOL

- **Description:** The Holy Cross school houses elementary through high school students from the village. School hours are from 0730 to 1700, but there are several after school activities that keep the facility open longer some nights.

- **General Conditions:** Although the building was constructed in 1986, it is in good condition with no major faults or defects found during the course of the audit. Although there is some water damage, it is not certain at this time weather the water damage is due to an issue with the roof or mechanical equipment. The primary concern at this time is the overheating that is currently happening in the facility. Updating the controls system to maintain building temperatures as well as introduce night setbacks will provide ample opportunity for energy savings.

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

- **Building Envelope:** The building is in good condition overall and is well-maintained. The roof appears to be in good condition. In the library, there is evidence of some water damage on the dropped ceiling, but the source of the damage is uncertain. Windows are in fair condition, and some have been recently replaced; many have handles that have been broken off. Weather-stripping is in fair condition, but could be upgraded. Doors are in good condition.

- **Air Distribution:** A Trane Climate Changer air handling unit (AHU) provides the school with its air distribution needs. There is also a second smaller AHU that servers as a boiler room vent fan. At the time of the audit, both of these AHUs were shut down. According to the operator, these pieces of equipment are only used in the fall and spring as backup heat for somewhat milder but cold days, while the boilers operate independently in the winter months.

- **Heating:** Two Burnham PF 504 boilers rated at 80.5% thermal efficiency and 620 MBH each provide the building with space heating. A combustion analysis at the time of the audit showed these boilers to be operating at 78.6 and 82.2% combustion efficiency. The Holy Cross school, however, was clearly overheated at the time of the audit. Although the thermostat was set to 70°F, temperature measurements taken ranged from 75-80°F.
- **Controls:** Building heating is controlled by a series of mechanical thermostats throughout the building. The functionality of these thermostats is uncertain due to the overheating concerns of this building.
- **Lighting:** Interior lighting is primarily T12 fluorescent with magnetic ballasts. There are several 90 watt incandescent fixtures scattered throughout the building as well as several 150 and 175 watt metal halide, high pressure sodium, and mercury vapor fixtures. The gym has T-8 high bay fixtures with motion sensors.
- **Domestic Water:** A Triangle Tube Smart series indirect-fired water heater provides the building with domestic hot water.

Building Photos: Holy Cross School

Burnham Boilers

Circulating Pumps and Smart Indirect Water Heater

Air Handling Unit (AHU-1)

Boiler Room Vent Fan (VF-1)

Gym High Bay Lighting

Water Damage in Library

1.4 HOLY CROSS WASHETERIA

- **Description:** The Holy Cross Washeteria is used by most of the villages to meet their laundering needs. The Washeteria operates from 0900 to 1900 hours, seven days a week.

- **General Conditions:** The building is in fair condition overall due to age and weathering; the facility was originally constructed in 1986.

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

- **Building Envelope:** The building is showing many signs of weathering and age and is in fair condition overall. The roof is in fair condition, but is showing no signs of leakage. There is not enough insulation, however, to prevent building heat from escaping, and this is causing snow on the roof to melt. Additional attic insulation is needed to retain building heat. The exterior walls are in fair condition, but do not have any major structure faults or defects. Weather-stripping is in poor condition and is due to be replaced. Doors are in poor condition and need replacements.

- **Heating:** Building heating is provided by a Toyostove Laser 73 fuel oil forced air heater.
- **Controls:** There are no separate building controls.
- **Lighting:** Interior lighting is primarily T12 fluorescent with magnetic ballasts.
- **Domestic Water:** The water heater for the Washeteria is located in the Water Treatment Plant's office. It is a tankless kerosene-fired Toyotomi model BS-36UFF.
- **Laundry Equipment:** The Washeteria has 3 washers and 2 dryers. The washers run on electricity, while the dryers consume liquid propane for heat and use electricity for the motors. At the time of the audit, one of the dryers was out of order, and two of the washers were out of order. This leaves only one functional washer and dryer for the village Washeteria.

Building Photos: Holy Cross Washeteria

Windows

Roof – Melting Snow Evidence of Poor Insulation

Toyostove Laser 73 Heater

Dryers

Washers

Interior Lighting

1.5 HOLY CROSS WATER TREATMENT PLANT

- **Description:** The Holy Cross Water Treatment Plant provides clean water to the entire city. The plant has a single operator, but receives extra maintenance help when needed. The plant is open 3 hours a day, Monday through Friday, but constantly has an operator on call.

- **General Conditions:** The water treatment plant is in fair condition overall. Having been constructed in 1986, the building is showing many signs of age and weathering. There are several concerns with the heating equipment that should be corrected as soon as possible.

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

- **Building Envelope:** The building's exterior is in fair condition, due to its age and the weathering seen over the years. The metal roof is in fair condition and has been patched. The walls are 2x4 posts with no side insulation according to the operator. Windows appear to be in good condition. Weather-stripping is in poor condition and is due to be replaced. Doors are in poor condition. Roof insulation is in fair condition, but additional insulation could be added.

- **Heating:** Two Burnham V903 fuel oil boilers provide the building with heating; these boilers are rated 80.0% thermally efficient with a combustion efficiency of 85.2%. Combustion analyses of these two boilers showed them to be functioning at combustion efficiencies of 78% and 79.2%. At least one, if not both, of the boilers seems to have a crack in the combustion chamber or diffuser, and the inspection had to be completed with the main entrance doors open to abate the overwhelming fumes in the mechanical room. There are also several hydronic unit heaters and fuel oil forced air heaters in the facility as well.

- **Controls:** Building heating is controlled by mechanical thermostats.

- **Lighting:** The building is primarily lit by T12 fluorescent fixtures with magnetic ballasts as well as several 90 watt incandescent fixtures.
- **Domestic Water:** A tankless kerosene-fired Toyotomi model BS-36UFF water heater provides domestic hot water to the Water Treatment Plant as well as the Washeteria.
- **Vacuum System:** Vacuum sewage systems are installed in bush Alaska due to permafrost and lack of available pitch. The system originates at the treatment facility and is in good operational condition. The vacuum pump motor runs 24/7 to meet village requirements. A higher efficiency motor will result in measurable savings for this system.
- **Heat Trace System:** To prevent system freeze ups, hot water heat trace pumps that run throughout the water distribution system originate from this facility. The system is manually controlled and runs at all times or at operators' discretion. Limiting the operation of the heat trace based on outside air or ground temperatures will provide significant savings to the village.

Building Photos: Holy Cross Water Treatment Plant

Burnham Boilers

Toyotomi Fuel Oil Heater

Water Tank

Doors in Need of New Weather-stripping

Unused Insulation – Not Enough to Cover Attic

Corroded Heat Exchanger

2.0 UTILITIES

2.1 Electricity

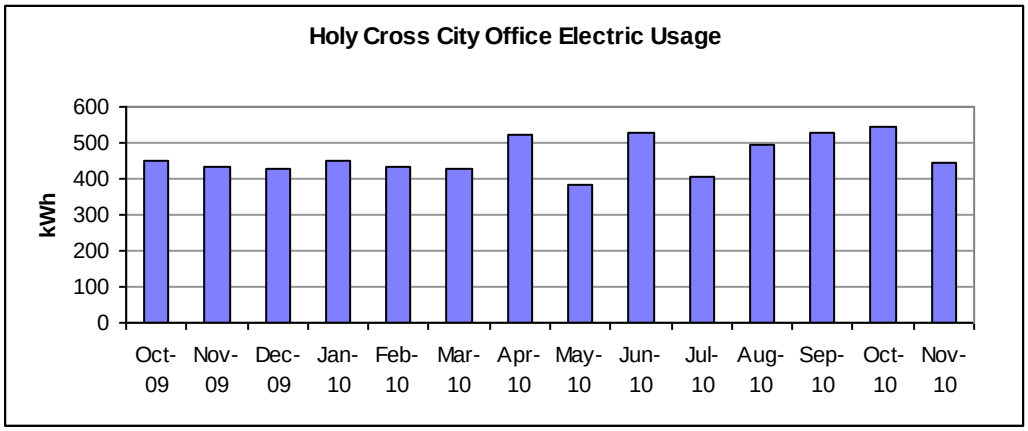
The City of Holy Cross purchases its electricity from the Alaskan Village Electric Cooperative (AVEC). Village facilities are billed on an electric use and fuel use to provide the electricity. Some facilities may also qualify for a Power Cost Equalization (PCE) incentive. The AVEC rates for the City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

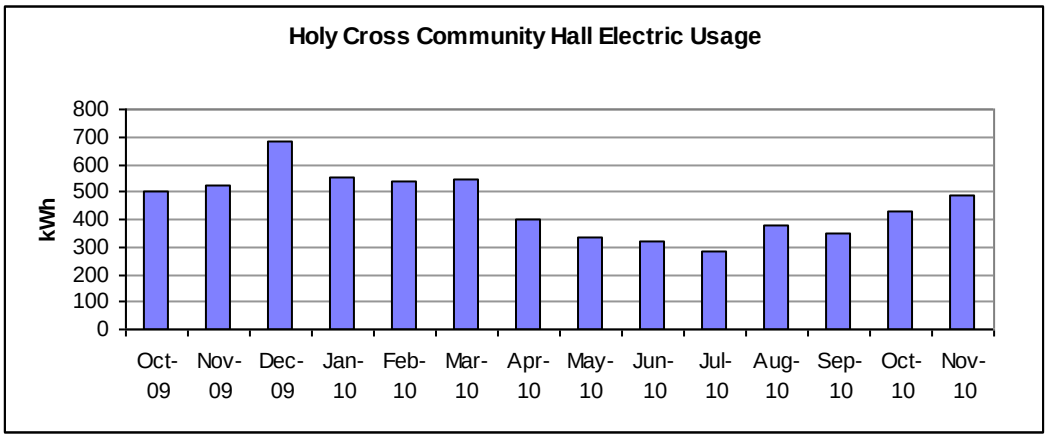
Current Rates as of January 2011		
AVEC Cost of Fuel (Added to Customer Electric Bill)	$	0.2271
Rate Per kWh, Fuel Cost Included (1-700 kWh)	$	0.5271
Rate Per kWh, Fuel Cost Included (Over 700 kWh)	$	0.4271
PCE Rate (1-700 kWh)	$	0.3119
PCE Rate (700+ kWh)	$	0.2839
Rates August 2010 - December 2010		
AVEC Cost of Fuel (Added to Customer Electric Bill)	$	0.2405
Rate Per kWh, Fuel Cost Included (1-700 kWh)	$	0.5405
Rate Per kWh, Fuel Cost Included (Over 700 kWh)	$	0.4405
PCE Rate (1-700 kWh)	$	0.3246
PCE Rate (700+ kWh)	$	0.2966
Rates for Calculations, Including Fuel Cost and PCE Incentive		
Rate for Calculations (1-700 kWh)	$	0.2152
Rate for Calculations (700+ kWh)	$	0.1432

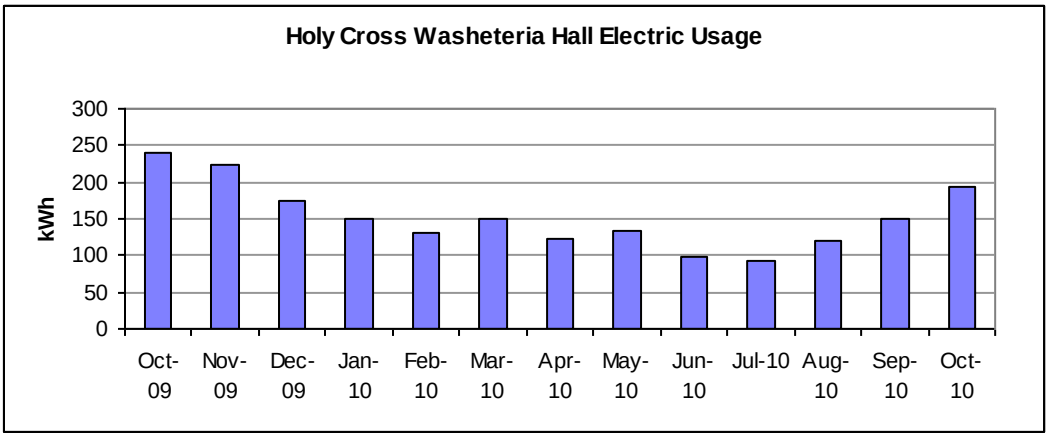
All buildings audited except for the Holy Cross School currently receive PCE funding. The School has its own agreement with AVEC, but bills were not readily available at the time of the audit or reporting process. The school is therefore assumed to pay the same amount per kilowatt-hour as the rest of the village. Most schools that have a contract with AVEC also pay a demand fee of $45/kW, so this has been assumed as well in savings calculations.

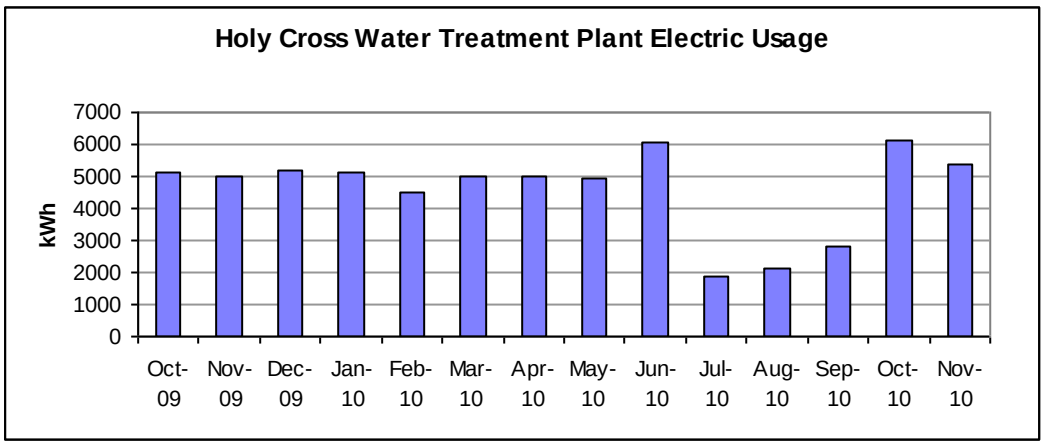
The street light bills show identical usage month to month and, therefore, are most likely billed on a flat rate.

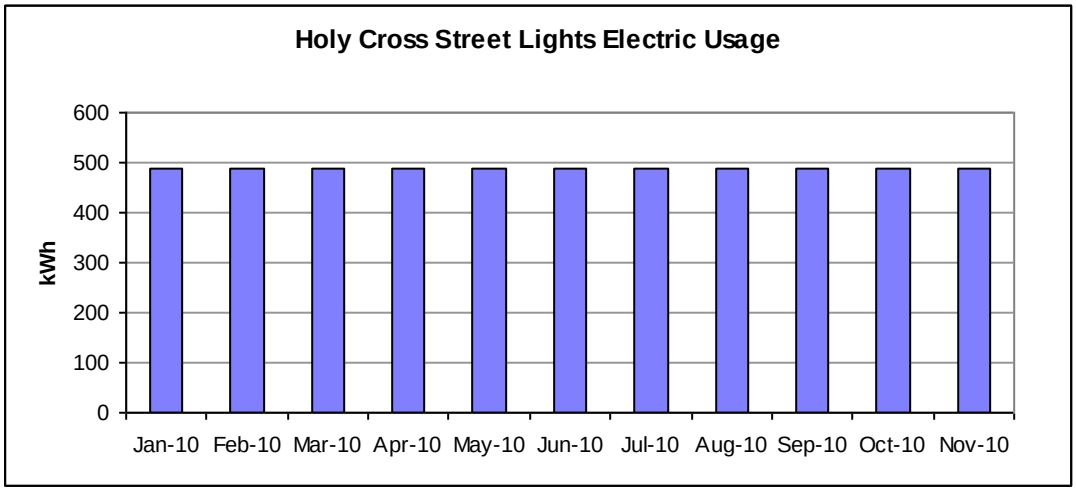
2.1.1 Electricity Usage Profiles








Holy Cross Water Treatment Plant Electric Usage
kWh
7000
6000
5000
4000
3000
2000
1000
0
Oct-09
Nov-09
Dec-09
Jan-10
Feb-10
Mar-10
Apr-10
May-10
Jun-10
Jul-10
Aug-10
Sep-10
Oct-10
Nov-10


Holy Cross Street Lights Electric Usage
kWh
600
500
400
300
200
100
0
Jan-10
Feb-10
Mar-10
Apr-10
May-10
Jun-10
Jul-10
Aug-10
Sep-10
Oct-10
Nov-10

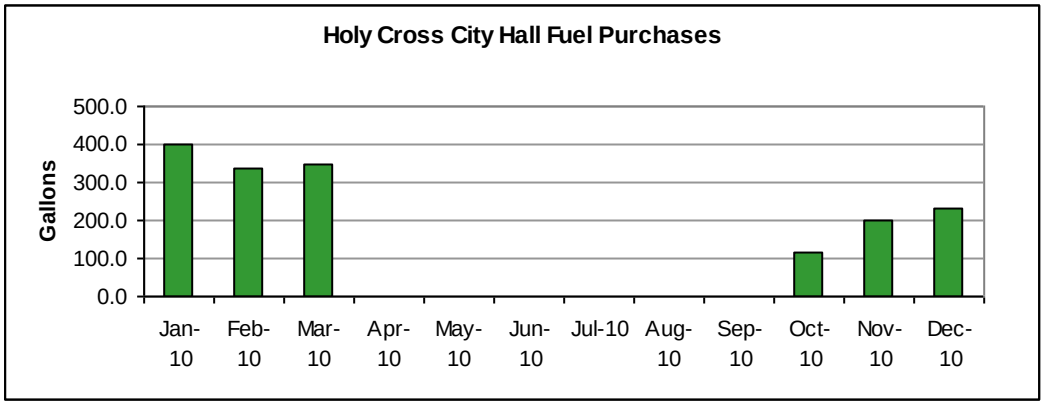
2.2 Fuel

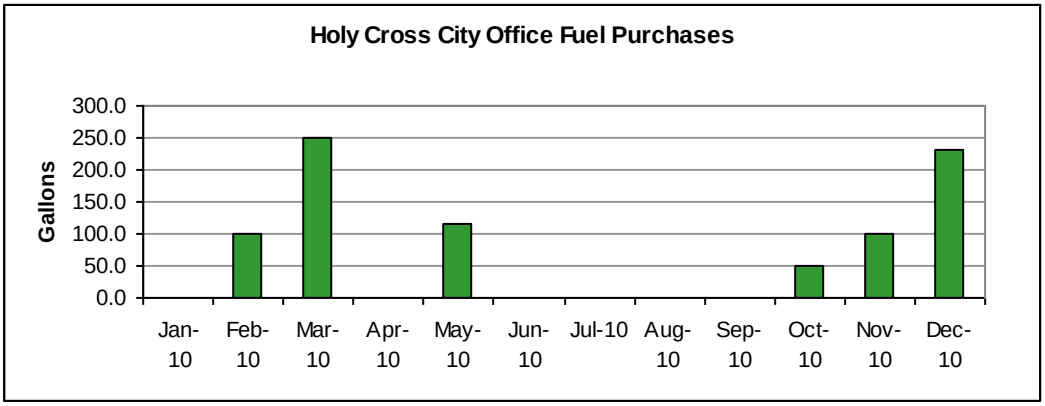
The City of Holy Cross purchases its fuel from Ruby Marine at a rate of $3.12/gallon.

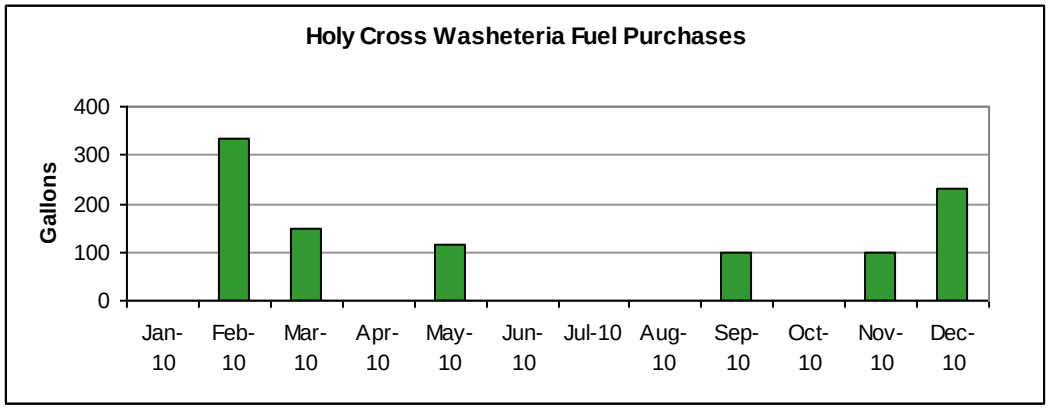
The Holy Cross Washeteria purchases 14 bottles of 100-pound liquid propane from Fairbanks each year at a rate of $223.30/bottle.

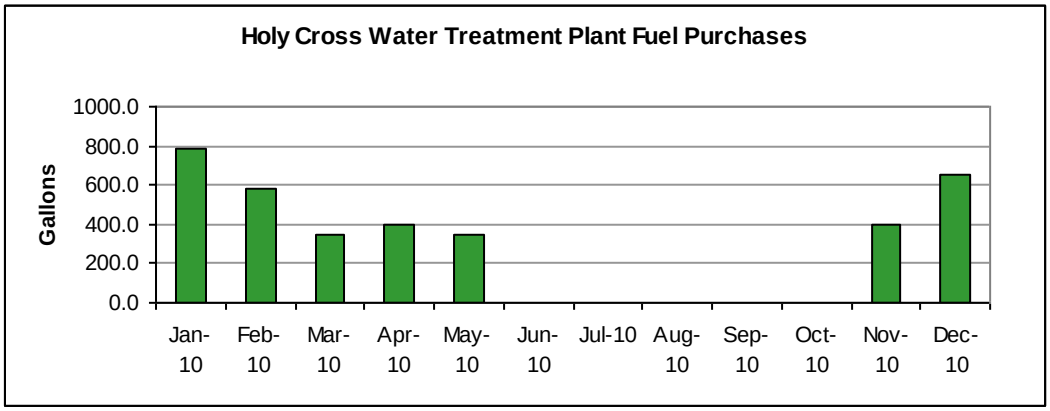
The Holy Cross School has its own fuel contract with Crowley Petroleum Distribution, Inc. Bills were not readily available at the time of the audit, and therefore, the school has been assumed to pay the same fuel rates as the rest of the village in savings calculations.

2.2.1 Fuel Usage Profiles






Holy Cross Washeteria Fuel Purchases
Gallons
400
300
200
100
0
Jan-10
Feb-10
Mar-10
Apr-10
May-10
Jun-10
Jul-10
Aug-10
Sep-10
Oct-10
Nov-10
Dec-10


Holy Cross Water Treatment Plant Fuel Purchases
Gallons
1000.0
800.0
600.0
400.0
200.0
0.0
Jan-10
Feb-10
Mar-10
Apr-10
May-10
Jun-10
Jul-10
Aug-10
Sep-10
Oct-10
Nov-10
Dec-10

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 funded energy conservation opportunities identified during the site survey and baseline analysis. A description of each energy conservation opportunity follows the matrix.

ECO No.	ECO Description B=Building Envelope; C=Controls; E=Electrical; M=Mechanical; W=Water/Wastewater; R=Renewable	ECO MATRIX HOLY CROSS				
		School	City Hall	Washeteria	City Office	Water Treatment
Controls						
C01	Thermostat Upgrade	X				X
Electrical						
E01	T-8 Lighting Upgrade	X				
E02	Occupancy Sensors	X	X	X	X	X
E03	Premium Efficiency Motors					X
Mechanical						
M01	Boiler Tune-Up	X				X
M02	Boiler Upgrade					X

4.1 ECO DESCRIPTIONS

Below are the descriptions of the Energy Conservation Opportunities (ECOs) that Ameresco analyzed for the Village of Holy Cross. For the results of the calculations, refer to *Appendix A.*

4.1.1 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.

4.1.2 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 – Boiler Upgrade

This ECO proposes replacing existing hot-water heating boilers with more energy efficient units. Many of the existing units in the village are original to the buildings they serve and have reached the end of their useful service life. Boilers employing modern technology can be installed to reduce energy consumption, improve system operations, and reduce maintenance costs.

4.2 ECO DESCRIPTIONS – ECOS NOT FUNDED

Below are the descriptions of the Energy Conservation Opportunities (ECOs) that Ameresco analyzed for the Village of Holy Cross, but there was not enough grant funding to cover construction. For the results of the calculations, refer to *Appendix B.*

4.2.1 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

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.

4.2.2 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.