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ENERGY AUDIT
POST INSTALLATION REPORT

Results and Recommendations from Energy Audit of Beaver

For VEEP Grants
City of Beaver, Alaska

June 20, 2012

Prepared By:
Ameresco, Inc.
6643 Brayton Drive
Anchorage, AK 99507

Prepared For:
Alaska Energy Authority
City of Beaver

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EXECUTIVE SUMMARY AND PREFACE

This Post Installation Report summarizes the results of an Ameresco Energy Audit of the City of Beaver, the initial energy savings measures identified and proposed, and any changes that may have occurred throughout the installation process. The City of Beaver is a recipient of an Alaska Energy Authority (AEA) Village Energy Efficiency Program (VEEP) grant of $75,000.

Ameresco engineers conducted an energy audit of the City of Beaver on December 27-28, 2010. The table below shows the buildings audited and their respective square footages.

City of Beaver - Building Summary

Building	Category	Square Footage
Multipurpose Building	Public Building	5,440
Power Plant & Garage	Public Building	1,880
Water Plant, Washeteria, & Lift Station	Public Facility	1,620

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 - BEAVER

ECO	Cost	Savings	SPB
B01 - WEATHERSTRIPPING	$ 1,279.64	*N/A*	*N/A*
C01 - THERMOSTAT UPGRADE	$ 7,125.52	$ 5,105.43	1.40
E01 - INSTALL OCCUPANCY SENSORS	$11,305.06	$ 3,420.21	3.31
M02 - BOILER UPGRADE	$52,368.66	$ 2,425.21	21.59
AVAILABLE FUNDING	$ 2,921.12		
** Available funding allocated to Kotlik.*			
TOTAL	**$75,000.00**	**$10,950.84**	**6.58**

1.0 BUILDING DESCRIPTIONS

1.1 BEAVER MULTIPURPOSE BUILDING (CLINTON VICTOR WEIHL BUILDING)

Description: The Clinton Victor Weihl Building is the village's multipurpose building. This building houses a variety of city offices including the clinic, city hall, utility company, hotel, native council and a Game Management Unit of the Alaska Department of Fish and Game. Typical operating hours are 0900 to 1700 hours, Monday through Friday.

General Conditions: The building is in good condition overall, with no major faults or defects found during the course of the walkthrough. The biggest concern is the inadequate single zone controls system, which could be reworked to generate energy savings.

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

Building Envelope: The building envelope components are in good condition. The roof appears to be in good condition, with no signs of leakage or major damage. Exterior windows are in good condition, with no broken panes. Doors are in good condition, but exterior weather-stripping is in poor condition and needs to be replaced.

Heating: Two Weil-McLain fuel oil WTGO-7 boilers provide heating to the building. These boilers are listed as 85% AFUE. Only one of the boilers was functioning at the time of the audit. A combustion analysis found the operational boiler to be performing at 83.8% combustion efficiency.

Controls: A single mechanical thermostat controls heating for the entire building. Because of this, much of the heat rises to the top floor, and occupants keep the windows open to regulate the temperature. Reworking the building zoning pattern would create energy savings as well as increase occupant comfort.

Lighting: Interior lighting consists primarily of T8 fluorescent lamps with electronic ballasts. No occupancy sensors are present in the building.

Domestic Water: A Weil-McLain indirect fired water heater provides the building with domestic hot water. At the time of the audit, the water had been shut off due to frozen pipes and because of problems at the lift station. Several other pipes were disconnected for unknown reasons. None of the hydronic pipes are insulated.

Building Photos: Beaver Multipurpose Building

Weil-McLain Boilers

Weil-McLain Indirect-fired Water Heater

Uninsulated Hydronic Piping System

Tramont System 2000 Day Tank

Exterior Windows in Good Condition

Makeshift Weatherization

1.2 BEAVER POWER PLANT AND GARAGE

Description: The Beaver Power Plant and Garage houses the village's electrical generators as well as several facility vehicles. The building typically operates 3 hours a day, 7 days a week; the operator is then on call for emergencies and shut downs.

General Conditions: The building is in excellent condition, having been constructed in 2008.

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

Building Envelope: All building envelope components are in good condition due to the age of the building – the roof, walls, windows, doors, and weather-stripping all appear to be in good condition.

Heating: The majority of building heating is provided by waste heat from the generators; these generators also provide waste heat to the Water Treatment Plant. There are also several unit heaters to provide additional heating during the colder months of the winter.

Controls: The unit heaters are controlled by mechanical thermostats.

Lighting: Interior lighting fixtures are mostly T8 fluorescent with electronic ballasts. There are also several incandescent fixtures scattered throughout the facility. Exterior lighting fixtures are high pressure sodium (HPS) lamps. There are no occupancy sensors in the building.

Domestic Water: There is not a domestic hot water system in the building.

Power Equipment and Loading: Three Marsh Creek Energy Systems generators power the village. One of these generators is a 110 kW unit, while the other two have a capacity of 67 kW. At the time of the audit, the 110 kW capacity generator carried a load of 55 kW. The other two generators carried no

load. There are also several solar panels on the roof of the building, but the photovoltaic system does not include any batteries for energy storage.

Building Photos: Beaver Power Plant and Garage

Generator Panel

High-Bay Lighting System

Generators

Garage Area

Radiators

Building Exterior – Solar Panels on Roof

1.3 BEAVER WATER TREATMENT PLANT, WASHETERIA, AND LIFT STATION

Description: The Beaver Water Treatment Plant is a multipurpose facility that also houses the village's Washeteria and lift station. Typical operating hours are 0900 to 1700, Monday through Friday.

General Conditions: The building overall is in fair condition and has seen much wear over the years, having originally been built sometime in the 1970's. The Washeteria section of the building is in poor condition and is in need of many improvements. Several of the washers and dryers are currently inoperable due to broken or missing parts. The lift station is currently inoperable.

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

Building Envelope: The building exterior is in fair condition and is showing signs of weathering and age. The roof is in fair condition and has poor insulation. Windows are in fair condition. Doors are in fair condition and have inadequate weather-stripping; the front door is in need of replacement.

Heating: Building heating is provided by two Burnham PV905 boilers, a waste heat loop, and several hydronic unit heaters. These boilers are rated as 82.4% thermally efficient with a combustion efficiency of 85.5%. At the time of the audit, a combustion analysis showed one boiler to be functioning at 84.3% combustion efficiency, while the other was operating at 82.8%. The dryers in the Washeteria operate on the hot water produced from these boilers.

Controls: Building heating is controlled by mechanical thermostats located in the boiler room. There is one thermostat for each section of the building, for a total of three.

Lighting: Interior lighting is primarily T8 fluorescent with electronic ballasts. There are also several incandescent fixtures scattered throughout the facility.

Domestic Water: An indirect-fired water heater provides the building with domestic hot water. Existing showers are rated at 2.5 gpm, and toilets are rated at 1.6 gpf.

Laundry Equipment: Three Hoyt Windsor dryers and two Maytag washers satisfy the Washeteria's laundering requirements. At the time of the audit, one of the dryers was out of order. The washers are older and are not ENERGY STAR rated. An ENERGY STAR rating does not currently exist for dryers, but these are older models as well, and newer more efficient models could generate energy savings.

Building Photos: Beaver Water Plant, Washeteria, and Lift Station

Lift Station Panel

Water Storage and Treatment Tanks

Hoyt Windsor Dryers

Hydronic Heating System for Dryers

Unit Heater

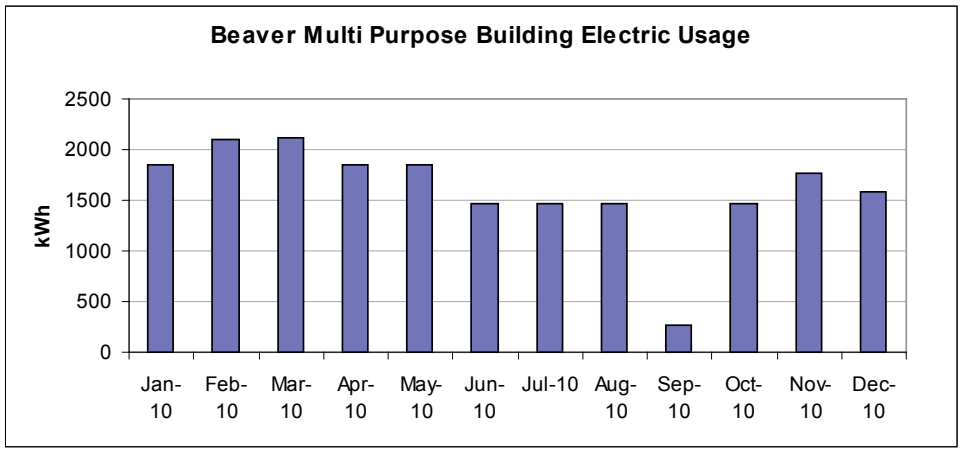
Maytag Washers

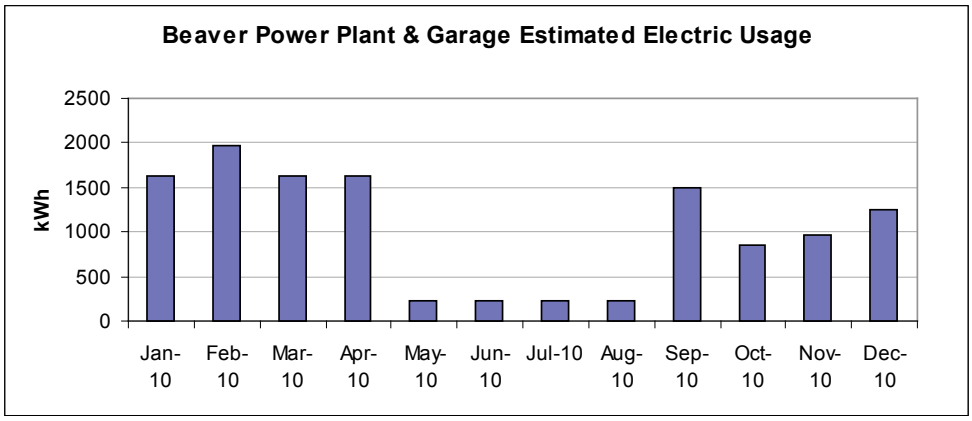
2.0 UTILITIES

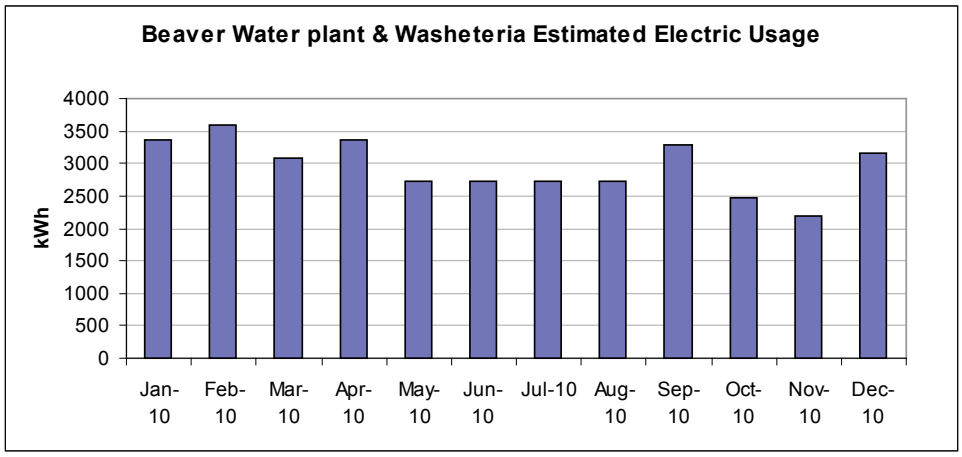
2.1 ELECTRICITY

The City of Beaver produces its own electricity via the Beaver Joint Utilities Company (BJU). Village buildings are charged a rate of $0.65/kWh with no Power Cost Equalization (PCE) assistance.

2.1.1 Electricity Usage Profiles



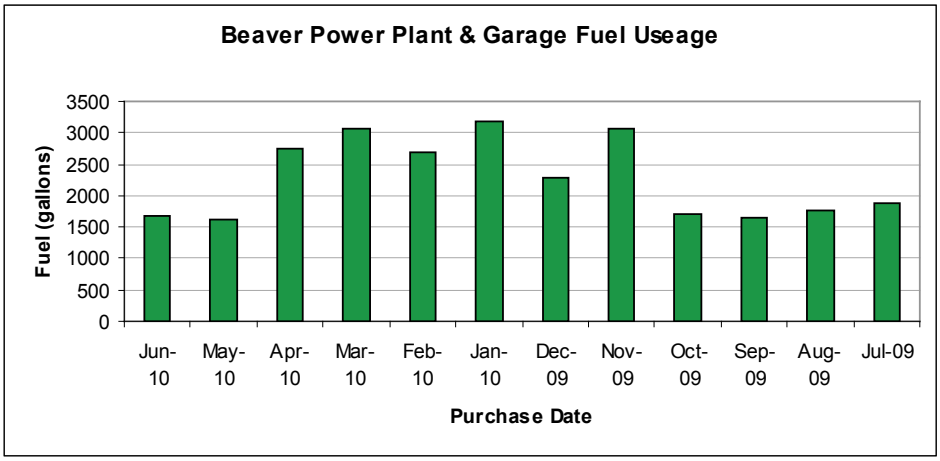




2.2 FUEL

The City of Beaver purchases its fuel from Crowley Petroleum Distribution at a rate of $3.73/gallon.

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 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		
	B=Building Envelope; C=Controls; E=Electrical; M=Mechanical; W=Water/Wastewater; R=Renewable	BEAVER		
		Multipurpose Building	Power Plant & Garage	Water Plant, Washeteria, & Lift Station
Building Envelope				
B01	Weather-stripping Upgrade	X		X
Controls				
C01	Thermostat Upgrade	X	X	X
Electrical				
E01	Occupancy Sensors	X	X	X
E02	Premium Efficiency Motors			X
Mechanical				
M01	Boiler Tune-Up	X		X
M02	Boiler Upgrade	X		

VEEP – INITIAL PROPOSAL (FINAL AUDIT REPORT)			
ECO	**Cost**	**Savings**	**SPB**
B01 - WEATHERSTRIPPING	$ 5,500.00	$ 576.18	9.55
C01 - THERMOSTAT UPGRADE	$ 2,400.00	$ 5,105.43	0.47
E01 - INSTALL OCCUPANCY SENSORS	$ 12,100.00	$ 3,420.21	3.54
E02 - PREMIUM EFFICIENCY MOTORS UPGRADE	$ 4,000.00	$ 886.30	4.51
M01 - BOILER TUNE-UP	$ 8,000.00	$ 4,556.99	1.76
M02 - BOILER UPGRADE	$ 40,000.00	$ 6,185.12	6.47
DESIGN/AUDIT	$ 2,500.00		
AVAILABLE FUNDING	$ 500.00		
** Available funding allocated for travel expenses, shipping, additional labor, etc*			
TOTAL	**$ 75,000.00**	**$ 20,730.22**	**3.62**

4.1 ECO DESCRIPTIONS – INITIAL REPORTING

Below are the descriptions of the Energy Conservation Opportunities (ECOs) that Ameresco analyzed for the Village of Beaver in the Final Audit Report. 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.

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 – 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.

E02 – 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%.

4.1.4 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 ECOs Not Funded – Initial Reporting

Below are the descriptions of the ECOs that Ameresco analyzed for the Village of Beaver but were not recommended in the initial reporting stages.

4.2.1 Building Envelope Opportunities

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 Windows

This ECO proposes installing new windows with improved heat transfer resistivity. This ECO would improve insulating values of the fenestration and reduce the negative energy effects of insolation.

B04 – Energy Efficient Doors

This ECO proposes installing new insulated doors. The installation would improve U-values of the current hollow metal doors, single pane glass doors, and un-insulated bay doors connected to conditioned spaces.

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*. 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

B01 – Door Weather-stripping Upgrade

Material was purchased and delivered to village but not installed due to lack of funding.

C01 – Programmable Thermostat Upgrade

Installed as planned. See *Section 5.2* and *Appendix A* 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 – Occupancy Sensors

Installed as planned. See *Section 5.2* and *Appendix A* for updated cost information.

E02 – Premium Efficiency Motors

Rejected due to lack of funding.

M01 – Boiler Tune-Up

Rejected due to lack of funding.

M02 – Boiler Upgrade

Installed as planned, but project costs exceeded initial projections.

5.2 FUNDING ALLOCATION SUMMARY TABLES

VEEP ECOS - PROJECT COSTS & EXPECTED SAVINGS - BEAVER			
ECO	**Cost**	**Savings**	**SPB**
B01 - WEATHERSTRIPPING	$ 1,279.64	*N/A*	*N/A*
C01 - THERMOSTAT UPGRADE	$ 7,125.52	$ 5,105.43	1.40
E01 - INSTALL OCCUPANCY SENSORS	$11,305.06	$ 3,420.21	3.31
M02 - BOILER UPGRADE	$52,368.66	$ 2,425.21	21.59
AVAILABLE FUNDING	$ 2,921.12		
** Available funding allocated to Kotlik.*			
TOTAL	**$75,000.00**	**$10,950.84**	**6.58**

ECOS NOT FUNDED - INITIAL PROPOSAL			
ECO	**Cost**	**Savings**	**SPB**
B02 - THERMAL INSULATION UPGRADE	$ 27,000.00	$ 1,323.65	20.40
B03 - ENERGY EFFICIENT WINDOW UPGRADE	$ 8,100.00	$ 46.09	175.73
B04 - ENERGY EFFICIENT DOOR UPGRADE	$ 4,500.00	$ 66.87	67.29
TOTAL	**$ 39,600.00**	**$ 1,436.61**	**27.56**

ECOS NOT FUNDED - REJECTED IN CONSTRUCTION PHASE			
ECO	**Cost**	**Savings**	**SPB**
E02 - PREMIUM EFFICIENCY MOTORS UPGRADE	$ 4,000.00	$ 886.30	4.51
M01 - BOILER TUNE-UP	$ 4,000.00	$ 1,323.38	3.02
TOTAL	**$ 8,000.00**	**$ 2,209.68**	**3.62**

APPENDIX A

VEEP PROJECT COSTS & EXPECTED SAVINGS

APPENDIX A - VEEP ECOS - AKIACHAK

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.

C01 - 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
Clinic	2	$457.42	$914.85	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*
Day Care	1	$457.42	$457.42	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*
IRA New Office	2	$457.42	$914.85	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*
Washeteria	2	$457.42	$914.85	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*

E01 - INSTALL OCCUPANCY SENSORS

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
Clinic	17	$283.17	$4,813.97	1,289.60	0.00	4.40	93.58	$456.39	$331.29	$787.68	10.55
Community Hall	3	$283.17	$849.52	781.24	0.00	2.67	56.69	$276.48	$200.69	$477.17	3.07
Day Care	10	$283.17	$2,831.75	1,670.14	0.00	5.70	121.20	$591.06	$429.05	$1,020.11	4.79
Early Education*	2	$283.17	$566.35	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*
IRA New Office	9	$283.17	$2,548.57	1,923.69	0.00	6.57	139.60	$680.79	$494.18	$1,174.98	3.74
Washeteria*	12	$283.17	$3,398.10	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*
Police Station	1	$283.17	$283.17	218.40	0.00	0.75	15.85	$77.29	$56.11	$133.40	3.66
Tribal Council Office*	9	$283.17	$2,548.57	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*
Water Treatment*	7	$283.17	$1,982.22	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*
Youth Center	5	$283.17	$1,415.87	240.34	0.00	0.82	17.44	$85.06	$61.74	$146.80	16.65

**Material delivered to these buildings but not installed by Ameresco.*

E02 - PREMIUM EFFICIENCY MOTORS UPGRADE

Building	# of Motors	Price Per Motor	Total Cost	Electric kWh Savings	Electric kW Savings	Equivalent mmBtu Savings	Equivalent Fuel Gallons Savings	Annual kWh Cost Savings	Annual Equivalent Fuel Cost Savings	Total Annual Savings	Simple Payback
Water Treatment	2	Varies w/HP	$30,838.20	1,990.23	0.51	6.79	144.43	$704.34	$511.28	$1,215.62	43.78

E03 - CFL LIGHTING UPGRADE (90w Incandescent to 23w CFL)

Building	Existing Lamp Wattage	Number of Lamps	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
All Over Village	90	18	$2,588.84	2,422.96	1.21	8.27	175.83	$857.49	$655.85	$1,513.34	3.02

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
IRA New Office	1	3%	$1,676.88	0.00	37.61	37.61	268.61	$0.00	$950.87	$950.87	1.76
School	3	3%	$5,030.65	0.00	474.42	474.42	3,388.70	$0.00	$12,639.87	$12,639.87	0.40
Water Treatment	2	2%	$3,353.77	0.00	391.20	391.20	2,794.30	$0.00	$9,891.84	$9,891.84	0.34

M02 - BOILER UPGRADE

Building	# of Boilers to Replace	New Boiler 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
Day Care	1	88.00%	$32,110.94	0.00	146.88	146.88	1,049.17	$0.00	$3,714.04	$3,714.04	8.65
Washeteria	1	88.00%	$10,389.40	0.00	351.65	351.65	2,511.76	$0.00	$8,891.65	$8,891.65	1.17
Clinic	1	88.00%	$32,110.94	0.00	153.41	153.41	1,095.78	$0.00	$3,879.06	$3,879.06	8.28

APPENDIX B

ECO CALCULATION RESULTS – NOT FUNDED

APPENDIX B - ECO CALCULATION RESULTS - NOT FUNDED - BEAVER

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.

ECOS NOT FUNDED - INITIAL PROPOSAL

B02 - THERMAL INSULATION UPGRADE

Building	Current Insulation	Proposed Insulation	Total Cost	Electric kWh Savings	Fuel mmBtu Savings	Total mmBtu Savings	Equivalent Fuel Gallons Savings	Annual kWh Cost Savings	Annual Equivalent Fuel Cost Savings	Simple Payback
Multipurpose Building	R-20	R-39	$11,800.00	0.00	22.66	22.66	161.84	$0.00	$603.66	19.55
Power Plant, etc	R-20	R-39	$8,100.00	0.00	13.53	13.53	96.64	$0.00	$360.45	22.47
Water Plant, etc	R-20	R-39	$7,100.00	0.00	13.49	13.49	96.39	$0.00	$359.53	19.75

B03 - ENERGY EFFICIENT WINDOW UPGRADE

Building	# of Windows	Price Per Window	Total Cost	Electric kWh Savings	Fuel mmBtu Savings	Total mmBtu Savings	Equivalent Fuel Gallons Savings	Annual kWh Cost Savings	Annual Equivalent Fuel Cost Savings	Simple Payback
Water Plant, etc	11	$525.00	$8,100.00	0.00	1.73	1.73	12.36	$0.00	$46.09	175.73

B04 - ENERGY EFFICIENT DOOR UPGRADE

Building	# of Doors	Price Per Door	Total Cost	Electric kWh Savings	Fuel mmBtu Savings	Total mmBtu Savings	Equivalent Fuel Gallons Savings	Annual kWh Cost Savings	Annual Equivalent Fuel Cost Savings	Simple Payback
Water Plant, etc	1	Varies w/Type and Size	$4,500.00	0.00	2.51	2.51	17.93	$0.00	$66.87	67.29

ECOS NOT FUNDED - REJECTED IN CONSTRUCTION PHASE

E02 - PREMIUM EFFICIENCY MOTORS UPGRADE

Building	# of Motors	Price Per Motor	Total Cost	Electric kWh Savings	Electric kW Savings	Equivalent mmBtu Savings	Equivalent Fuel Gallons Savings	Annual kWh Cost Savings	Annual Equivalent Fuel Cost Savings	Simple Payback
Water Treatment	3	Varies w/HP	$4,000.00	1,363.53	0.33	4.65	98.95	$886.30	$369.08	4.51

M01 - BOILER TUNE-UP

Building	Number of Boilers	Increase in Efficiency	Total Cost	Electric kWh Savings	Fuel mmBtu Savings	Total mmBtu Savings	Equivalent Fuel Gallons Savings	Annual kWh Cost Savings	Annual Equivalent Fuel Cost Savings	Simple Payback
Water Plant, etc	2	2.00%	$4,000.00	0.00	49.67	49.67	354.79	$0.00	$1,323.38	3.02

APPENDIX C

EQUATIONS USED IN CALCULATIONS

APPENDIX C - EQUATIONS USED IN CALCULATIONS - BEAVER

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.
B04	*Note: This ECO was completed using the eQuest program.*
	Two building models were created and compared using pre- and post-install insulated floor.
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 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)
E02	1. Existing/Proposed Motor Demand (kW) = (Motor HP) x (Load Factor) x (0.746 kW/HP)/ Motor Efficiency
	2. Existing/Proposed Motor Consumption (kWh) = (Motor Demand) x (Diversity Factor) x (Annual Hours)
	3. kW Savings = [(Baseline kW) - (Proposed kW)] x (12 Months)
	4. kWh Savings = (Baseline kWh) - (Proposed kWh)
	5. Energy Cost Savings = Energy Savings (kW or kWh) x (Energy Unit Cost)
M01	Savings (MBtu) = (Boiler Input Rating) x ((1/Tested Efficiency)-(1/Desired Efficiency)) x (Hours per Year)
	Savings ($) = (MBtu Savings) x (Energy Cost)
M02	Savings (MBtu) = (Boiler Input Rating) x ((1/Old Boiler Efficiency)-(1/New Boiler Efficiency)) x (Hours per Year)
	Savings ($) = (MBtu Savings) x (Energy Cost)

FOR E01 - Hours Reduced

From the Energy Management Handbook, Turner, 4th Edition Table 13.8 p361
Savings from installing occupancy sensors are as follows:

Offices (Private)	25-50%
Offices (Open Spaces)	20-25%
Rest Rooms	30-75%
Corridors	30-40%
Storage Areas	45-65%
Meeting Rooms	45-65%
Conference Rooms	45-65%
Warehouses	50-75%

FOR E02

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

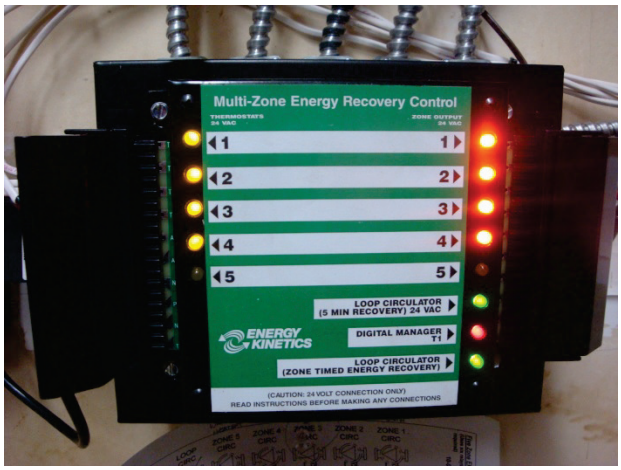
	Energy End-Use (1,000 Btu/ft^2-yr)		
Building Characteristics	**Space Heat**	**Cool**	**Ventilation**
Education	32.8	4.8	1.6
Food sales	27.5	13.4	4.4
Food service	30.9	19.5	5.3
Health care	55.2	9.9	7.2
Lodging	22.7	8.1	1.7
Mercantile and service	30.6	5.8	2.5
Office	24.3	9.1	5.2
Public assembly	53.6	6.3	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 D

POST INSTALLATION PHOTOS

APPENDIX D – POST INSTALLATION PHOTOS - BEAVER

New Energy Kinetics Boilers



Energy Kinetics Zone Control

Installed Occupancy Sensor

Programmable Thermostat Installation