Sustainable Priorities for Alaska Rural Communities

Anvik, Alaska

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City of Anvik

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Alaska Native Tribal Health Consortium

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Cold Climate Housing Research Center

Acknowledgements

This comprehensive energy efficiency retrofit project began in 2005 with an energy audit of the power plant in Anvik, Alaska. Additional community buildings were audited in 2012 and 2013. In the following years, many people and organizations came together to perform retrofits, measure energy savings, and document the process from audit through project completion. Many thanks to the Denali Commission and the State of Alaska for providing funding for the final stages of the energy retrofit process, including energy retrofits and their documentation and the biomass boiler facilities, respectively. These organizations, their programs, and their dedicated employees help many entities in Alaska realize energy savings, through projects with outcomes that improve buildings and decrease costs for so many residents. Additionally, the report authors would like to thank the following:

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Photo credits

Photos not credited in the caption were taken by members of the project team, including:

Jonathan Pierson, ANTHC

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Abstract

The Sustainable Priorities for Alaska Rural Communities (SPARC) project originated with energy audits of community buildings in Anvik and Hughes. In 2015, several agencies, led by the Alaska Native Tribal Health Consortium (ANTHC), joined to implement the recommendations from the energy audits and realize energy savings for the building occupants and owners. The Denali Commission funded energy efficiency retrofits in each community. This report documents the SPARC project phases in Anvik, and includes descriptions of the nine buildings that participated in the project, the recommendations in their respective audits, the retrofit construction, and the resulting energy savings.

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Acronyms

AC	Air Conditioning
ANTHC	Alaska Native Tribal Health Consortium
AVEC	Alaska Village Electric Cooperative
BTU	British Thermal Unit
CCHRC	Cold Climate Housing Research Center
CHP	Combined Heat & Power
DHW	Domestic Hot Water
ECM	Energy Conservation Measure
EEM	Energy Efficiency Measure
EOL	End of Life
°F	Degrees Fahrenheit
GCI	General Communication Inc.
HRV	Heat Recovery Ventilator
HVAC	Heating, Ventilation, and Air-Conditioning
kWh	Kilowatt-hour
LED	Light Emitting Diode
MBTU	1 Million BTUs
O&M	Operations and Maintenance
PC	Personal Computer
RurAL CAP	Rural Alaska Community Action Program, Inc.
SPARC	Sustainable Priorities for Alaska Rural Communities
TCC	Tanana Chiefs Conference
VPSO	Village Public Safety Officer

Motivation

The Sustainable Priorities for Alaska Rural Communities (SPARC) project aimed to advance community energy efficiency in Anvik and Hughes. The goal of the project was to implement energy efficiency improvements in those two communities. In addition, SPARC worked with a concurrent project to install district biomass heating systems in both locations. Ultimately, the outcome of the project would be lower energy use in the buildings and a resulting cost savings.

This is one of two final reports for the SPARC project. This report summarizes the background, procedure, and results of the energy efficiency audits and improvements in Anvik. It covers project partners and timeline, energy audit summaries, documentation of retrofit construction, and data on energy savings.

Project partners

The Alaska Native Tribal Health Consortium (ANTHC) initiated the Sustainable Priorities for Rural Alaska Communities (SPARC) project. Their Rural Energy Initiative department managed the project, including collecting the energy audits, planning the retrofit construction, soliciting funding, and overseeing the retrofits and reporting. ANTHC regularly engages in energy efficiency projects to meet its mission of providing the highest quality health services for Alaska Native people. For this project, they brought together multiple partners in Alaska to complete the retrofits outlined in the energy audits, making buildings in Anvik and Hughes more comfortable and reducing energy costs.

The Denali Commission provided the majority of the funding for the retrofit projects. The Denali Commission provides critical utilities, infrastructure, and economic support throughout Alaska, encouraging energy efficiency and local energy solutions whenever possible. In the SPARC project, they funded the energy efficiency retrofits for the buildings as well as the operational costs of the project.

The State of Alaska Renewable Energy Fund provided the majority of the funding for an upgrade to a biomass boiler in the water treatment plant building in Anvik. The Renewable Energy Fund has a goal of bringing technically and economically viable renewable energy projects online to decrease the reliance of Alaska communities on fossil fuels and encourage local energy solutions. For this project, the funding allowed Anvik to switch to the local, renewable resource of biomass in selected buildings to decrease the amount of fuel oil purchased each year. The Alaska Department of Commerce and Economic Development and the Environmental Protection Agency Safe Drinking Water Act also contributed funds to the biomass project.

The Tanana Chiefs Conference (TCC) and Rural Alaska Community Action Program, Inc. (RurAL CAP) managed and completed the majority of the construction in both communities. TCC is a nonprofit organization advancing Tribal self-determination and regional unity among the Tribes in Interior Alaska. Anvik and Hughes both lie within TCC's region. RurAL CAP is a nonprofit organization that works to improve quality of life for low-income Alaskans. Many programs recognize the importance of safe, comfortable, and energy efficient buildings. They provided the weatherization crew for the SPARC project to address retrofits comprehensively during the summers of 2016 and 2017.

Finally, the Cold Climate Housing Research Center (CCHRC) analyzed energy savings and authored the final report. CCHRC promotes the development of healthy, durable, and sustainable shelter for Alaskans and circumpolar people and regularly participates in energy efficiency projects throughout the state.

Project timeline

The SPARC project addressed energy projects within the communities of Anvik and Hughes, both of which have leadership that recognized the importance of lowering energy use and improving buildings. After obtaining energy audits, the communities worked with ANTHC's Rural Energy Initiative department to form a plan to fund and complete the retrofits suggested by energy audits of various community buildings. SPARC officially began in July 2015 with funding from the Denali Commission and the State of Alaska with the objective to perform retrofits and monitor energy costs to identify the resulting savings. The project is nearing completion with the publication of this report, which summarizes each component of the project: the energy audits, retrofit construction, and energy savings.

Table 1: The SPARC project to improve the condition and energy efficiency of buildings in Anvik spanned several years.

Date	Milestone
December 2005	Energy audit of AVEC power plant and recovered heat facilities
July 2012	Energy audit of Blackwell School
June 2013	Energy audits of: City office Deloy Ges Corporation office Health clinic Tribal community hall Tribal Council office Wireless network building
May 2015	Energy audit of water treatment plant & washeteria
July 2015	SPARC project start
Summers 2016-2017	Retrofit construction
Fall 2017	Installation of district biomass heating system
2018	Energy bill analysis
April 2019	SPARC project conclusion

Project tasks

The Anvik component of the SPARC project originated with the publication of nine energy audits of community buildings, beginning in 2005. The energy audits, summarized in this report, catalogued the current condition and baseline energy usage of the buildings and listed recommendations for retrofits to increase the energy efficiency of each building.

Anvik, partnering with the City of Hughes and ANTHC, obtained funding to act on the energy audit recommendations in 2015. ANTHC worked with TCC and RurAL CAP to manage and complete the various components of the construction.

Figure 1: Anvik is located on the Yukon River.

At the conclusion of 2018, researchers worked with building owners to collect post-retrofit energy usage of each building from utilities and building owners. Project staff compared this data to the baseline conditions of each building to determine the energy savings that resulted from the SPARC project.

Building descriptions

Nine buildings, many serving central roles in the community of Anvik, participated in the SPARC project. For instance, the water treatment plant serves as the watering point for community members; the tribal community hall hosts special events; the health clinic and school provide essential services; and the wireless network building provides internet and telephone services. While some SPARC buildings are relatively new and in good condition, such as the tribal community hall and the Deloy Ges Corporation office, others had serious issues identified in the building audits. According to the audits, the health clinic consumed excessive energy and was uncomfortable for occupants. The old Tribal Council office had health and safety concerns due to an aged and failing structure. The descriptions below, listed by building energy audit date, provide details on the status of the buildings when the audits occured and also showcase why the buildings are important to the community.

Alaska Village Electric Cooperative (AVEC) power plant and recovered heat facilities

Alaska Village Electric Cooperative (AVEC) operates the electric utility in Anvik. The local power plant is a 540 square-foot insulated metal building on a wood post and pad foundation. AVEC completed the original construction of this building in the mid-1970s and relocated the building to its present site in the late 1990s. Three diesel generators within the power plant provide power

Figure 2: The storage containers for the power plant did not have insulation prior to the SPARC retrofit project, and used the vast majority of the heat available from the heat recovery system.

to the community. Waste heat from the diesel generator cooling system heats both the power plant facility and a nearby school building boiler module. A heat recovery system installed in 1999 provides heat to the school, which has lowered its annual heating fuel usage. However, circa 2004, the plant cooling system was modified to provide heat to un-insulated storage containers and crew living quarters. Due to the high heat demand of the storage containers, recovered heat delivery to the school is no longer available.

Blackwell School (Iditarod School District)

Blackwell School, a single-story wood-framed building constructed in 1979, overlooks the town of Anvik. The school provides K-12 education and is built on an all-weather wood frame foundation. Since the original construction, several additions have included a new kitchen, cafeteria, storage space, and an apartment for the school principal. In 1999, an out building was constructed to contain new oil-fired boilers. The two boilers provide heating and indirect domestic hot water (DHW) to the building through baseboards and heating coils. Air handlers control ventilation and deliver additional heat to the building. One indirect hot water heater serves the locker rooms and two separate electric hot water heaters serve the principal's residence and kitchen.

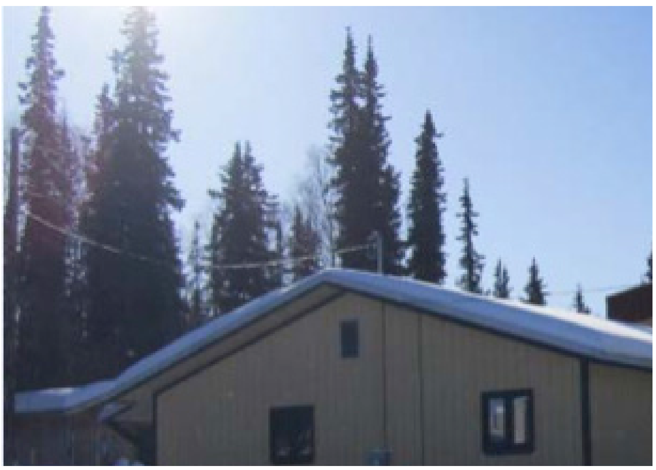

Figure 3: Blackwell School serves the students of Anvik. Photo courtesy of Nortech.

Figure 4: The city office in Anvik, built in 1985, has space for both offices and community events. Photo courtesy of Energy Audits of Alaska.

City office

The city office in Anvik is a 3,856 square-foot, two-story log structure built in 1985. At the time of the building audit, the office had low overall occupancy as the new tribal community hall now hosts many of the events previously held at the city office. The first floor occasionally hosts fundraising activities, bingo, or special events, and many city offices comprise the second floor. The washeteria, located next-door, provides heat for the building. There is no cooling, ventilation, or domestic hot water. The interior lighting is uneven and inconsistent.

Deloy Ges Corporation office

The Deloy Ges Corporation office, completed in 2012, is one of the more recently constructied buildings in Anvik. This 1,500 square-foot modular unit contains the Deloy Ges Corporation office and one of the two village stores. A single oil-fired Toyostove provides heat to the building, a heat recovery ventilator (HRV) provides ventilation, and an electric 30-gallon hot water heater provides domestic hot water. The building is in excellent condition.

Figure 5: The Deloy Ges Corporation office. Photo courtesy of Energy Audits of Alaska.

Figure 6: The health clinic contains an exam room, a lab, and itinerant quarters. Photo courtesy of Energy Audits of Alaska.

Health clinic

Constructed in 1998, the health clinic is a 1,000 square-foot single-story building that contains a lobby, an office, an exam room, a lab used for storage, and itinerant quarters. At the time of the audit, the building's malfunctioning heating and ventilation system, an oil-fired boiler and HRV, was causing excessive energy consumption and occupant discomfort. A 50-gallon electric water heater provides domestic hot water to the sinks and showers.

Tribal community hall

A one-story log structure built in 2009 is home to Anvik's tribal community hall. Its 3,888 square-foot space is home to a community hall, childcare center, community kitchen, and the village public safety officer (VPSO). The building, which is in excellent condition, rests on an insulated crawlspace. Heat is provided by multiple sources, including oil-fired boilers, a wood stove, and two Toyo stoves. A 30-gallon hot water heater provides domestic hot water, and there is no cooling or ventilation.

Figure 7: The tribal community hall serves many purposes, housing a community hall, childcare center, community kitchen, and the local VPSO.

Tribal Council office

The Tribal Council office in Anvik is a 1,338 square-foot, 50-year-old log structure located outside the main part of the village. At the time of the audit, the building housed the Tribal Council office year-round in the west wing. The east wing serves as a museum during the summer. Overall, the building is in exceptionally poor condition and has considerable health and safety concerns, including uncovered line voltage wires, a lack of plumbing and ventilation, an uncovered basement floor, and structural logs that are deteriorating from dry rot. An oil-fired heater in the basement provides heat to the building. There is no cooling.

Figure 8: The Tribal Council office is in very poor condition. Photo courtesy of Energy Audits of Alaska.

Wireless network building

The Wireless network building, with an area of just 240 square feet, houses the village's internet server and GCI communication equipment. The building is relatively new and remains in good condition. In 2012, General Corporations Inc. (GCI) added a rack of equipment, ductless air conditioner, and sub-meter to the building, which led to a more than five-fold increase in electrical consumption. A baseboard electric heater generates heat while an air-conditioning (AC) unit controls cooling. Four exhaust fans coupled with a gravity vent provide ventilation.

Figure 9: The wireless network building contains equipment for local internet and telephone services. Photo courtesy of Energy Audits of Alaska.

Water treatment plant and washeteria

The water treatment plant and washeteria building, constructed in 1986, serves as the water gathering point, laundromat, and shower services for community residents. The building is 1,300 square feet and contains four clothes washers and three dryers for public use. Residents collect their own water supply through a single watering point. Three unit heaters supply heat to the building and water comes from a ground source well inside the plant. The building shell is in poor condition, with damaged insulation and broken windows.

Figure 10: The water treatment plant and washeteria building contains water distribution, a laundromat, and showers for community members.

Energy efficiency recommendations

Energy audits document a building at a moment in time, describing everything from its size and construction details to the mechanical systems to typical occupancy. Audits also document the amount of fuel and electricity the building requires for space conditioning and power. Finally, audits address how to improve the energy efficiency and safety of buildings. Each audit contains a list of recommended retrofits accompanied by an estimate of their installation costs and resulting annual energy savings. The recommendations are typically ranked according to simple payback, or the amount of time it takes to earn back the installation price through energy savings. Low simple payback periods, indicating retrofits that are quickly cost-effective, appear at the top of the list of recommendations.

A summary of the audits performed on the buildings in Anvik during the period from 2005 to 2015 is shown in Table 2. More complete descriptions of the audit contents can be found following the table. Most audit recommendations include both energy efficiency measures (EEMs) and energy conservation measures (ECMs). EEMs are generally building and equipment upgrades that could be accomplished through a retrofit project. ECMs are methods to avoid costs by preventing excess consumption and are often suggestions for building occupants to follow to reduce energy use. The energy savings and estimated implementation costs listed in the table come directly from these audits, so do not always reflect 2019 prices accurately. Many of the buildings had similar recommendations, including lighting upgrades, installation of more efficient electrical appliances, and use of setback thermostats.

Table 2: The audits of Anvik community buildings recommended a variety of strategies to reduce energy use.

Building	Audit date	Baseline energy use	Audit recom-mendations by category	Estimated annual energy savings (ECMs & EEMs)	Cost of implement-ing recom-mendations	Simple payback
AVEC power plant & re-covered heat facilities	Dec 2005	Fuel oil #1: 1,967 MBTU	Building envelope	3,200 gallons fuel oil #1	N/A	N/A
Blackwell School	July 2012	Fuel oil #1: 489 MBTU Electricity: 196 MBTU Total: 685 MBTU Dollars: $58,302	Appliances Building envelope Heating system Lighting Operations & Maintenance (O&M)	$12,270	$41,950	3.4 years
City office	June 2013	Fuel oil #1: 198 MBTU Electricity: 26 MBTU Total: 224 MBTU Dollars: $10,610	Appliances Building envelope Heating system Lighting O&M	$2,162	$26,003	12 years

Deloy Ges Corporation	June 2013	Fuel oil #1: 43 MBTU Electricity: 38 MBTU Total: 81 MBTU Dollars: $4,217	Appliances Building envelope Heating system Lighting O&M	$316	$1,680	5.3 years
Health clinic	June 2013	Fuel oil #1: 220 MBTU Electricity: 77 MBTU Total: 279 MBTU Dollars: $15,130	Appliances Building envelope Heating system Lighting O&M	$6,102	$58,902	9.6 years
Tribal community hall	June 2013	Fuel oil #1: 304 MBTU Electricity: 30 MBTU Total: 334 MBTU Dollars: $19,555	Appliances Building envelope Heating system Lighting O&M	$1,409	$8,855	6.2 years
Tribal Council office	June 2013	Fuel oil #1: 158 MBTU Electricity: 17 MBTU Total: 175 MBTU Dollars: $10,462	Appliances Building envelope Heating system Lighting O&M	$2,972	$38,970	13.1 years
Wireless network building	June 2013	Electricity: 41 MBTU Dollars: $7,323	O&M	$3,774	$0	N/A
Water treatment plant & washeteria	May 2015	Fuel oil #1: 507 MBTU Electricity: 22 MBTU Total: 529 MBTU Dollars: $27,357	Appliances Building envelope Heating system Lighting	$18,484	$159,453	8.6 years

Alaska Village Electric Cooperative (AVEC) power plant and recovered heat facilities

Audit date: December 2005
Audit by: U.S. Department of Energy Combined Heat and Power (CHP) Technical Assistance Partnerships – Northwest

The energy audit of the power plant recommended only one energy efficiency measure, which was to insulate the building envelope of the storage containers. This would reduce heating needs of the storage units and allow for more recovered heat to be provided to the nearby school. If this EEM was performed, an estimated total of 3,200 gallons of diesel fuel will be saved each year. There are no recommended ECMs.

Blackwell School

Audit date: July 2012
Audit by: Nortech

The energy audit for the Blackwell School outlines six different EEMs based on priority and adjusted baselines. The measure with highest priority is the installation of three programmable thermostats and setting the unoccupied and nighttime temperature to 60°F. At an installation cost of $1,500 and a simple payback period of half a year, an estimated annual energy savings of $4,130 will be achieved. Next on the priority list is cleaning out and unplugging the refrigerators and freezers at the end of each school year, rather than leaving the appliances running through the summer. This is expected to save $80 per year at a cost of $50, paying back in less than a year. Upgrading the HVAC system with more efficient components will cost $6,500 with a simple payback period of just over two years and will save $2,860 in annual energy costs. Through a combination of better temperature control and pipe insulation, the temperature of the building's crawlspace would be reduced from approximately 80°F to 60°F, saving $2,000 in annual energy after an installation cost of $10,000. It will take five years for this measure to be paid back. By replacing the building's lamps with more efficient lighting, $2,000 in annual energy would be saved at a cost of $6,900. Installing insulation within the crawlspace is also expected to achieve annual energy savings of $1,200. This measure comes at a more expensive cost of $17,000 with a payback period of 14 years.

Table 3: Six energy efficiency measures could result in annual savings of over $12,000 for the Blackwell School.

Recommendation	**Estimated annual energy & maintenance savings**	**Estimated installation cost**	**Simple payback (years)**
Install (3) programmable thermostats and implement unoccupied setbacks to 60°F	$4,130	$1,500	0.4
Clean out refrigerators and consolidate freezer, unplug at end of school year	$80	$50	0.6
Upgrade HVAC circulation pump and replace fan motor	$2,860	$6,500	2.3
Reduce crawlspace temperature to 60°F	$2,000	$10,000	5
Install insulation on crawlspace wall	$1,200	$17,000	14
Replace lamps with efficient lighting, install electronic ballasts	$2,000	$6,900	3.5
Total	**$12,270**	**$41,950**	**3.4**

The energy audit indicates that the Blackwell School is a good candidate for energy conservation measures; however, there is not a detailed description of these ECMs within the audit report.

If all EEMs are performed, an estimated total of $12,270 in energy savings will be achieved annually.

City office

Audit date: June 2013
Audit by: Energy Audits of Alaska

The energy audit outlines recommended EEMs based on priority and adjusted baselines. Ranked as the most important measure, the implementation of a programmable thermostat for the second and ground floor is expected to be cost-effective with a fast payback period. A programmable thermostat will save energy when the spaces are not in use by setting the unoccupied setback temperature. This measure would cost $200 per floor and save approximately $901, paying back in a little less than half a year. This energy efficiency measure would be beneficial as the building typically has a low occupancy. The only other EEM is to perform a lighting upgrade, replacing interior and exterior lighting with more efficient LED bulbs and adding occupancy sensors to the interior lights. This measure would save approximately $1,000 per year and pay back in roughly 13 years.

Table 4: Two energy efficiency measures could result in annual savings of over $2,000 for the city office.

Recommendation	**Estimated annual energy & maintenance savings**	**Estimated installation cost**	**Simple payback (years)**
Install setback thermostats	$901	$400	0.4
Upgrade lighting with LED bulbs and occupancy sensors	$1,261	$16,935	13.4
50% for logistics including		$8,668	
Total	**$2,162**	**$26,003**	**12 years**

The auditors also recommended several ECMs, including installing a cumulative fuel oil flow meter,designating an “energy champion” to monitor building energy use and perform a monthly energy checklist walkthrough, turning off plug loads, maintaining weather stripping, scheduling lamp replacement, servicing HVAC equipment annually, reducing temperature and ventilation in unoccupied spaces, and maintaining a safety inventory.

If all the recommended EEMs and ECMs were performed an estimated total of $5,852 in energy costs will be saved annually.

Deloy Ges Corporation office

Audit date: June 2013
Audit by: Energy Audits of Alaska

Similar to many other buildings, the energy efficiency measure with the highest priority in the Deloy Ges Corporation office is temperature control. Programmable thermostats are an easy and inexpensive upgrade that results in a high return on investment. At an installation cost of $5 to program each existing thermostat, the total payback period is just under two years and would save $133 per year. In order to fully achieve energy savings, the unoccupied setback temperature within the corridor, store space, storage, office, and toilet room should be set to 64°F. Another recommended EEM would be to install a CoolingMiser to the beverage display cooler. This installation adds a seasonal shutdown control setting to the refrigeration and would reach an energy savings of $87 annually. Lastly, upgrading the exterior lighting to more efficient LED blubs is estimated to save $96 a year. This measure would cost $1,060 in installation and pay back in roughly 11 years.

Table 5: The Deloy Ges Corporation office could achieve an annual savings of $316 if three energy efficiency measures are implemented.

Recommendation	Estimated annual energy & maintenance savings	Estimated installation cost	Simple payback (years)
Install (4) setback thermostats	$133	$20	0.2
Add CoolingMister to beverage display cooler	$87	$280	3.2
Upgrade lighting with LED bulbs and occupancy sensors	$96	$1,060	11
8 hrs @ $40/hr logistics		$320	
Total	**$316**	**$1,680**	**5.3 years**

The auditors also recommend several ECMs, including designating an ”energy champion” to monitor building energy use and perform a monthly energy checklist walkthrough, properly maintaining doors, windows, and weather stripping, adding plug load management devices, scheduling lamp replacements, servicing HVAC equipment annually, installing a cumulative fuel oil meter, and maintaining a safety inventory.

If all the recommended EEMs and ECMs were performed, an estimated total of $1,835 in energy costs will be saved annually.

Figure 11: Upgrading to LED bulbs and adding occupancy sensors would reduce electrical costs by close to $100 annually.

Health clinic

Audit date: June 2013
Audit by: Energy Audits of Alaska

Figure 12: The top audit recommendation for the clinic is to replace existing thermostats with programmable versions.

Although the health clinic is well maintained, auditors still recommend four EEMs to reduce annual energy costs. First, programmable thermostats for the building's ten heating zones will save an estimated $552 in annual energy costs by setting the unoccupied setback temperature. Second, a lighting retrofit will increase efficiency and save $2,519 annually. The building's HVAC system was malfunctioning at the time of the audit, and as a result, the auditor recommended repairing and maintaining the controls to achieve $2,386 in annual energy savings. Finally, adding insulation in the walls and ceiling will reduce the amount of energy to heat or cool the building and save $645 per year. After an installation cost of $21,674, the payback period is just over 33 years.

Table 6: To achieve an annual energy savings of $6,102, auditors recommend four EEMs to be performed in the health clinic.

Recommendation	Estimated annual energy & maintenance savings	Estimated installation cost	Simple pay-back (years)
Retrofit setback thermostats in all appropriate zones	$552	$600	1.1
Lighting upgrade and controls upgrade	$2,519	$11,994	4.8
HVAC controls repair and maintenance	$2,386	$5,000	2.1
Envelope improvements: Additional insulation in walls and ceiling	$645	$21,674	33.6
50% markup for logistic: sourcing, ordering, shipping, receiving, staging, etc.		$19,634	
Total	**$6,102**	**$58,902**	**9.6 years**

The auditors also recommend several ECMs, including installing a cumulative fuel oil flow meter, designating an "energy champion" to monitor building energy use and perform a monthly energy checklist walkthrough, maintaining weather stripping, adding plug load management devices, reducing temperature and ventilation in un-occupied spaces, replacing lamps, servicing HVAC equipment annually, and maintaining a safety inventory.

If all the recommended EEMs and ECMs were performed an estimated total of $8,720 in energy costs will be saved annually.

Tribal community hall

Audit date: June 2013
Audit by: Energy Audits of Alaska

Figure 13: Installing and using programmable thermostats and a lighting upgrade were the top two energy audit recommendations for the community hall in Anvik.

Although the tribal community hall is in excellent condition, the audit lists several EEMs that can decrease energy consumption and result in annual energy savings of over $1,000 per year. At the time of the audit, the building had six manual low-voltage thermostats to control each heating zone. While the installation of programmable thermostats within each specific heating zone has varying priority, all are conducive to saving $675 in energy costs per year. At $200 per thermostat, this EEM will have a simple payback period of just over two years. A programmable thermostat should be placed in the main part of the building, the childcare area, two of the offices, two restrooms, and the kitchen. Another recommended EEM would be conducting a lighting retrofit and updating the manual lighting controls to occupancy sensors. For example, installing 28-watt fixtures in place of the current 32-watt fixtures along with occupancy sensors will cost $4,014 and save $222 per year. Installing a CoolingMister as a control setting to the beverage cooler would generate an estimated $404 in annual savings as well. The final recommended EEM would be the replacement of the desktop computer with a laptop at an additional cost per computer of $201. The new laptop would pay back in approximately two years and produce $108 in annual savings.

Table 7: The tribal community hall could achieve an annual savings of $1,409 if four energy efficiency measures are implemented.

Recommendation	Estimated annual energy & maintenance savings	Estimated installation cost	Simple pay-back (years)
Retrofit setback thermostats in all appropriate zones	$675	$1,400	2.1
Lighting upgrade and controls upgrade	$222	$4,014	18.1
Add “CoolingMister” to TURE reach-in beverage cooler	$404	$240	0.6
Desktop PC replaced with laptops at EOL (incremental cost difference between desktop and laptop is $100 each)	$108	$201	1.9
Markup for logistic: sourcing, ordering, shipping, receiving, staging, etc.		$3,000	
Total	**$1,409**	**$8,855**	**6.2 years**

The auditors also recommend several ECMs, including installing a cumulative fuel oil flow meter, designating an “energy champion” to monitor building energy use and perform a monthly energy checklist walkthrough, maintaining weather stripping, adding plug load management devices, reducing temperature and ventilation in unoccupied spaces, replacing lamps, servicing HVAC equipment annually, and maintaining a safety inventory.

If all the recommended EEMs and ECMs were performed, an estimated total of $6,074 in energy costs will be saved annually.

Tribal Council office

Audit date: June 2013
Audit by: Energy Audits of Alaska

The energy use of the Tribal Council office is near average for similar buildings and there are only a few cost-effective recommendations to improve energy efficiency. First, a programmable thermostat will save energy when the spaces are not in use. Five zones within the building are recommended for this installation at a total cost of $200. An annual energy savings of $252 is estimated for this EEM with a simple payback period of just under a year. Another recommended EEM would be conducting a lighting upgrade and updating the manual lighting controls to occupancy sensors to save $382 annually. At an installation cost of $4,001, this EEM has a payback period of 10.5 years. With a similar payback period, adding insulation to the attic and walls will result in an annual energy savings of $1,975. Although this measure has the highest predicted savings for the Tribal Council office, it comes at a higher cost of $21,479. The fourth and final recommended measure would be the replacement of desktop computers with laptops at an additional cost per computer of $300. The new laptops would pay back in less than a year and would produce $363 in annual savings.

Table 8: Four energy efficiency measures are recommended for the Tribal Council office to achieve a total annual energy savings of $2,972.

Recommendation	Estimated annual energy & maintenance savings	Estimated installation cost	Simple pay-back (years)
Retrofit setback thermostats in all appropriate zones	$252	$200	0.8
Lighting upgrade and controls upgrade	$382	$4,001	10.5
Add insulation to attic and walls	$1,975	$21,479	10.9
Desktop PC replaced with laptops at EOL (incremental cost difference between desktop and laptop is $100 each)	$363	$300	0.8
50% markup for logistic: sourcing, ordering, shipping, receiving, staging, etc.		$12,990	
Total	**$2,972**	**$38,970**	**13.1 years**

The auditors also recommend several ECMs, including installing a cumulative fuel oil flow meter, designating an "energy champion" to monitor building energy use and perform a monthly energy checklist walkthrough, maintaining weather stripping, adding plug load management devices, reducing temperature and ventilation in un-occupied spaces, replacing lamps, servicing HVAC equipment annually, and maintaining a safety inventory.

If all recommended EEMs and ECMs were performed, an estimated total of $6,295 in energy costs will be saved annually.

Wireless network building

Audit date: June 2013
Audit by: Energy Audits of Alaska

In 2012, GCI added a rack of equipment, a ductless air conditioner, and a sub-meter to the wireless network building. Upon evaluation of the electrical consumption benchmark data, it became clear that with the addition of the GCI equipment, electric consumption was greatly increased. Because this building audit is a special case, it is abbreviated and narrowly focused on two ECMs. First, an invoice should be given to GCI for incremental costs since the installation of its equipment, and second, establish a practice of charging GCI for the extra energy consumption. Both ECMs come at no cost and together would save over $3,000 annually for the building owner.

Table 9: Within the wireless network building, only two ECMs are recommended to achieve $3,774 in annual savings.

Recommendation	**Estimated annual energy & maintenance savings**	**Estimated installation cost**
Invoice GCI for incremental costs since installation of its equipment	$1,110	$0
Set up billing procedure for charging GCI for incremental consumption	$2,664	$0
Total	**$3,774**	**$0**

If both ECMs were performed, an estimated total of $3,774 in energy costs will be saved annually.

Water treatment plant and washeteria

Audit date: May 2015
Audit by: ANTHC Division of Environmental Health and Engineering

Many community members rely on the washeteria for laundry services, so energy efficiency measures in this high-use building will quickly be noticed as the potential energy savings is almost $20,000 per year. Replacing the electric dryers with hydronic units is at the top of the priority list. This would achieve an annual energy savings of over $4,000. The installation cost of the electric dryers would be $10,000 with a simple payback period of a little over two years. Ranked lower on the priority list is the installation of a new biomass and oil-fired boiler along with a new hot water heater and controls. This control system would initiate a cold start for the new oil-fired boiler only when needed. Although this measure has the highest installation cost at $125,000 and a payback period of 10 years, it is estimated to create the highest annual energy saving for the building at $12,090.

Table 10: Seven energy efficiency measures could result in annual savings of over $18,000 for the water treatment plant and washeteria.

Recommendation	Estimated annual energy & maintenance savings	Estimated installation cost	Simple payback (years)
Install two hydronic dryers and turn off electric dryers	$4,671	$10,000	2.1
Replace exterior entrance and arctic entry lighting with LED lighting	$41	$160	3.9
Install setback thermostat	$478	$2,000	4.2
Install new biomass boiler, new oil-fired boiler, and new hot water heater and controls	$12,090	$125,000	10.3
Re-pipe mechanical room and re-commission controls in City Office	$1,075	$20,000	18.6
Insulating doorways, caulking windows, and reducing air infiltration	$75	$1,000	13.4
Replace existing window with triple paned window	$54	$1,293	24.1
Total	**$18,484**	**$159,453**	**8.6 years**

The auditors also recommend several ECMs, including retrofitting a setback thermostat, re-piping the mechanical room, increasing insulation, and replacing several windows.

If all the recommended EEMs and ECMs were peformed, an estimated total of over $18,000 in energy costs would be saved annually.

Figure 14: The top audit recommendation for the Anvik washeteria is to replace the electric dryers with hydronic versions.

Construction documentation

In October 2016, RurAL CAP completed a scope of work assessment, reviewing the energy audits and noting changes to the buildings that had occurred post-audit. This allowed them to slightly modify the scope of work from the original audits to reflect the current conditions of the buildings. RurAL CAP's weatherization crew began retrofit work that same fall, and another crew came back to finish the majority of the work in Spring 2017. The weatherization crew was able to retrofit all of the audited buildings in Anvik with the exception of the wireless network building. The majority of the retrofits involved installing programmable thermostats, upgrading lighting to LED bulbs, and a blower door-guided air-sealing effort. However, as noted in the tables for each building, the crew also completed tasks specific to certain buildings.

In this section, the tables underneath each building list the completed scope of work. The completed tasks are divided into those included in the audit recommendations, and those that were added to the scope of work during the retrofit effort.

Anvik also received a biomass district heating system. TCC, contracting Jim Chowaniec, commissioned the system in late 2017. It is currently providing heat to four buildings, the community hall, the city office, the clinic, and the water treatment plant and washeteria building.

Figure 15: The AVEC storage containers received insulation to reduce their heat load and free up waste heat for use in Blackwell School.

Alaska Village Electric Cooperative (AVEC) power plant and recovered heat facilities

The two storage containers for the AVEC power plant use recovered waste heat from AVEC's electric generators. The energy auditor recommended that the two storage containers be insulated because at the time of the audit, they used the majority of the recovered heat, leaving very little for the school, which also is on the heat recovery loop. The crew completed this recommendation in Spring 2017, and has planned additional work for Spring 2019.

Table 11: A crew completed the only recommended EEM for the AVEC power plant in 2017.

Completed audit recommendations	Date completed	Contractor
Insulate the building envelope of the storage containers	Spring 2017	RurAL CAP
Additional work		
Heat recovery system improvement, including: • Replacing pumps; • Providing air relief; • Replacing thermostats; • Flushing the heat exchanger; and • Other maintenance upgrades.	Spring 2019	ANTHC TUS

Blackwell School

RurAL CAP completed retrofits to Blackwell School in Fall 2016 and Spring 2017. In addition to addressing many of the audit recommendations, as shown in the table below, the crew completed a blower door-guided air-sealing in Spring 2017 that included adding door sweeps to exterior doors. One remaining recommendation, to install programmable thermostats, will be addressed in 2019. There is also an ongoing effort to improve the heating system controls.

Figure 16: Crawlspace retrofits included insulating the walls and adding a vapor barrier to the floor.

Table 12: The RurAL CAP crew upgraded lighting and insulated the crawlspace wall at the school.

Completed audit recommendations	Date completed	Contractor	Notes
Install (3) programmable thermostats and implement unoccupied setbacks to 60°F	March 2019	ANTHC Tribal Utility Support	ANTHC installed programmable thermostat
Replace lamps with efficient lighting, install electronic ballasts	Fall 2016 & Spring 2017	RurAL CAP	
Install insulation on crawlspace wall	Spring 2017	RurAL CAP	Installed R14 XPS insulation and laid down a vapor barrier of 6 mil polyethylene.
Additional work			
The crew completed a blower door-guided air-sealing that included: • Adding door sweeps to exterior doors; • Air-sealing a conex at the school.	Spring 2017	RurAL CAP	

City office

The city office is now part of the district biomass heating loop and is tied directly to the water treatment plant. There is an underground pipe that brings heat from the biomass boilers and back-up oil boilers to the building. In addition to this heating upgrade, the RurAL CAP crew upgraded the building's lighting to LED bulbs.

Table 13: The weatherization crew completed retrofit work by mid-2017.

Completed audit recommendations	Date completed	Contractor	Notes
Upgrade lighting with LED bulbs and occupancy sensors	Spring 2017	TCC	
Weather stripping installation	Spring 2017	RurAL CAP	The crew completed a blower door-guided air-sealing that included: • window hardware, • foam socket / switch gaskets, • adjusting and installing a door sweep to the front double doors, and • air-sealing and insulating the attic.
Annual HVAC equipment service	Spring 2017	RurAL CAP	The crew installed a bath fan.
Additional work			
Added building to biomass heating loop	Fall 2017	Jim Chowaniec	

Figure 17: A crew air-sealed and insulated the city office building attic.

Deloy Ges Corporation office

RurAL CAP modified the scope of work for the Deloy Ges Corporation office slightly, after discovering that the current building had different features than at the time of the audit. However, they were able to address recommendations to upgrade the exterior lighting and to install weather stripping.

Table 14: Retrofits to the Deloy Ges office building included LED lights and weather stripping.

Completed audit recommendations	Date completed	Contractor	Notes
Upgrade lighting with LED bulbs and occupancy sensors	Spring 2017	RurAL CAP	The crew replaced exterior bulbs with LEDs. They found that the interior bulbs had already been upgraded.
Weather stripping installation	Spring 2017	RurAL CAP	The crew completed air-sealing guided by a blower door.

Health clinic

In 2017, RurAL CAP addressed some of the audit recommendations, including installing programmable thermostats and air-sealing the building envelope. The building is included in the biomass district heating loop.

Table 15: Work at the clinic is ongoing, and retrofits should be complete in 2019.

Completed audit recommendations	Date completed	Contractor	Notes
Retrofit setback thermostats in all appropriate zones	Summer 2017	RurAL CAP	
HVAC controls repair and maintenance	March 2019	ANTHC Tribal Utility Support	
Weather stripping installation	Spring 2017	RurAL CAP	The crew completed air-sealing guided by a blower door that included insulating the access hatch.

Figure 18: A blower door test helped identify air leaks for the weatherization crew to seal at the health clinic.

Figure 19: The weatherization crew replaced thermostats in the clinic with programmable versions to facilitate temperature setbacks to reduce energy use when the building is unoccupied.

Tribal community hall

RurAL CAP completed almost all audit recommendations for the tribal community hall, including the integration of the building into the biomass community system to reduce heating costs. Staff at the tribal hall declined the occupancy sensor because the lights in the main hall stay off unless room is occupied.

Also, the community hall staff increased because Tribal Council staff moved into community hall building. Due to this move, the council office did not receive retrofits in 2016 or 2017 while the other buildings did.

Table 16: The community hall received several upgrades through the SPARC project.

Completed audit recommendations	**Date completed**	**Contractor**	**Notes**
Retrofit setback thermostats in all appropriate zones	Spring 2017	RurAL CAP	
Lighting upgrade and controls upgrade	Fall 2016 & Spring 2017	RurAL CAP	Replaced existing lighting with LEDs.
Adding occupancy sensors to lighting	Spring 2019	ANTHC TUS	Declined by staff because lights stay off unless room is occupied
Weather stripping installation	Spring 2017	RurAL CAP	The crew completed a blower door-guided air-sealing that included: • installing door sweeps.
Annual HVAC equipment service	Summer 2017	TCC	The crew upgraded the HVAC system and integrated it into the biomass community system as part of the biomass integration project.

Wireless network building

Anvik Village owns the wireless network building, and in the past has used it to house its internet equipment. In 2012, the electric use of the building increased more than five-fold when GCI added a rack of equipment and a ductless air conditioner to the building. The audit recommended that the Tribe perform the ECM of billing GCI for this additional energy usage. As of the publication of this report, the Tribe is still working to implement an agreement between Anvik Village and GCI that would accomplish this (Alyssa Wolf, Anvik Tribal Office, personal communication, January 14, 2019).

Water treatment plant and washeteria

In 2016 and 2017, RurAL CAP completed many audit recommendations for the building housing the water treatment plant and the washeteria. The crew also rebuilt a well-head arctic box and replaced inoperable bath fans.

In 2017, TCC completed on-site operator training for water treatment plant staff. The operator had participated in retrofit upgrades performed by ANTHC through a separate energy efficiency project, and received training on maintaining operating standards and how to efficiently operate the water treatment plant. The training included learning to operate the controls, how to lower the temperature on thermostats and heat adds, and turning off heat tape except for use in freeze-up recovery.

Figure 20: RurAL CAP rebuilt the well-head arctic box at the washeteria in 2017.

Table 18: In addition to the installation of a biomass heating system, the water treatment plant and washeteria building received many energy efficiency upgrades.

Completed audit recommendations	Date completed	Contractor	Notes
Replace exterior door	Fall 2016	RurAL CAP	
Replace arctic entry lighting with LED lighting	Fall 2016	RurAL CAP	
Install setback thermostat	To be completed March 2019	ANTHC Tribal Utility Support	This was not completed by RurAL CAP due to an issue with the system design that requires an electrician to install the thermostat.
Install new biomass boiler, new oil-fired boiler, and new hot water heater and controls	Fall 2017	Jim Chow-aniec	
Insulating doorways, caulking windows, and reducing air infiltration	Spring 2017	RurAL CAP	The crew completed a blower door-guided air-sealing that included: • front door replacement, and • foam socket / switch gaskets.
Window replacement			This was already completed when the RurAL CAP crew arrived at the building.
Additional work			
Well pump modification to a drainback system	Spring 2017	RurAL CAP	

Biomass integration project

In Anvik, the city office, washeteria and water treatment plant, clinic, and tribal community hall are integrated into the district biomass heating system. TCC, contracting Jim Chowaniec, installed the boilers and commissioned the system in the fall of 2017. At the time of this report, the system has been operational for just over one year.

At the heart of the district system are two GARN 2000 boilers, each with a maximum heating output of 350,000 BTU/hour. They are housed in a centrally-located building, built as part of the SPARC project. The City and Tribe share operation of the boilers; each employs one operator who works every other two weeks, up to 3 hours each day. Tasks include splitting the wood, operating the boiler, and performing maintenance. The wood is supplied by community members, and the current price is $350/cord. In 2018, the first full year of operation, the boilers used 30 cords of wood and this is expected to increase as the operators become more familiar with the system (Devany Plentovich, personal communication, January 18, 2019). Also, ANTHC's Tribal Utility Support department will optimize the system.

Additional work

In addition to the energy efficiency work completed on the Anvik community buildings, SPARC funds were used to upgrade Anvik street lights to LED bulbs in summer 2017. In March 2019, ANTHC TUS used SPARC funds to optimize the biomass heating system. Biomass optimization included several improvements to increase the efficiency, reliability, and safety of the system, such as relocating the air intake ducts to above the snowline, rewiring the combustion air intake damper on one of the GRAN units, reconfiguring various controllers to improve functionality and efficiency, treating boilers with biological growth inhibitors, and replacing a circulation fan.

Energy savings

The purpose of an energy retrofit is to decrease a building's energy use while improving safety and comfort. An important check on whether or not the audit and retrofit process worked as intended is to look at the energy use and see if it dropped as predicted. This section reports on the pre- and post-retrofit energy usage obtained for many of the buildings in the SPARC project in the units in which it is typically purchased: Electric usage is reported in kilowatt-hours (kWh). Fuel usage is reported in gallons of fuel.

The baseline energy usage, or pre-retrofit energy use, comes from the energy audits, which typically contain an estimate of the building's energy use either from fuel records that the auditor was able to access, or from the energy model of the building. The report authors gathered the post energy use with help from building occupants and the local electric utility, the Alaska Village Electric Cooperative (AVEC). These are only initial reports. For more a more accurate

Figure 21: Two GARN boilers (above left) are providing heat to Anvik buildings. They are housed in a centrally located building (above) that was built in 2017 (below left). Photos courtesy of Rebecca Garrett.

understanding of the energy saving effects of the EEMs that were installed in Anvik, a longer reporting period is recommended.

All the buildings, with the exception of the tribal community hall, saw a decrease in energy use post retrofit. The community hall experienced an increase in staff, thus accounting for the corresponding increase in energy use.

AVEC power plant and recovered heat facilities

No post-retrofit electricity or fuel information was available for the AVEC power plant and recovered heat facilities at the time of this report.

Blackwell School

The Blackwell School complex includes both the school building itself and an outbuilding. In the baseline electricity use for the Blackwell School, taken from the audit report, it is not clear if the electrical data includes both the school and the outbuilding, or only the school – most likely both are included. An intermediate set of electrical data, for 2015-2016, included both buildings separately. The 2016-2018 set of data, from AVEC, only includes the school itself.

The school, without the outbuilding, has realized a savings of a 4,000-6,000 kWh per year from 2015 to 2016-2018, with an average savings of 13%. The electric usage was nearly 39,000 kWh in 2015, and decreased to 33,800 kWh used on average each year in the 2016-2018 time period.

The fuel usage for the school has decreased 12% from the academic year ending in summer 2011 to that ending in 2016, a savings of 1,000 gallons of fuel per year.

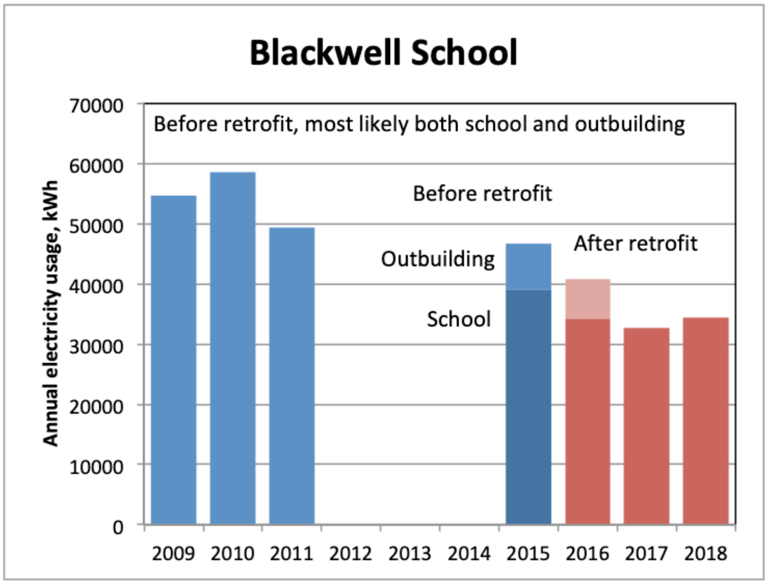

Figure 22: The electric energy use of Blackwell School has decreased with the installation of LED bulbs in 2016 and 2017.

City office

The city office saw a decrease in electrical usage of 20%, from an average of approximately 7,500 kWh / year for 2011-2012, to a post-retrofit value of approximately 6,000 kWh/year. This amounts to a savings of 1,500 kWh each year. The retrofit consisted of upgrading lighting to LED bulbs and air-sealing the building.

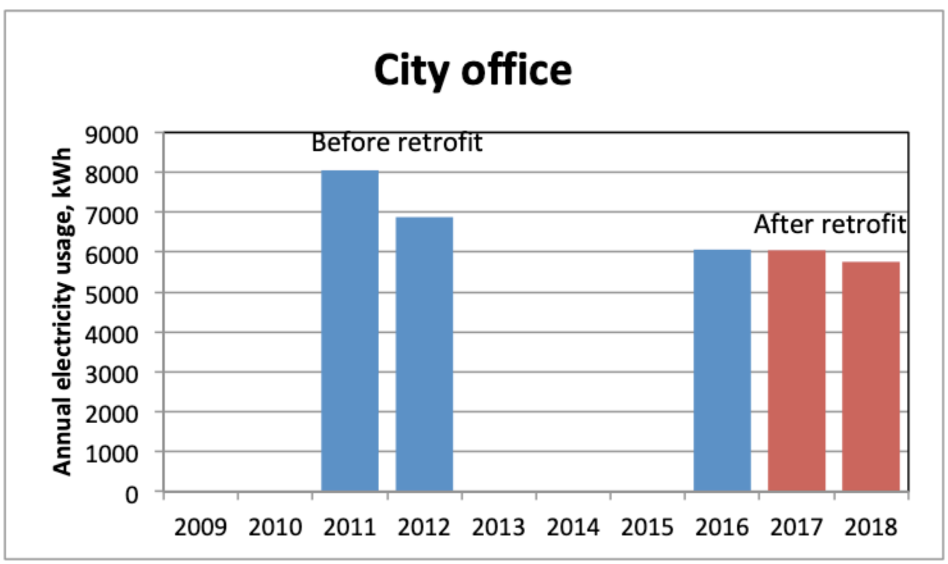

Figure 23: A lighting upgrade helped the city office decrease its electrical energy use.

Deloy Ges Corporation office

The Deloy Ges Corporation office electricity usage decreased an average of 14% from the first full year of operation ending in 2013 to the 2017-2018 season, from roughly 11,000 kWh used in 2013 to an average of 9,600 kWh used per year in 2017 and 2018. The retrofit of the office consisted of a lighting upgrade.

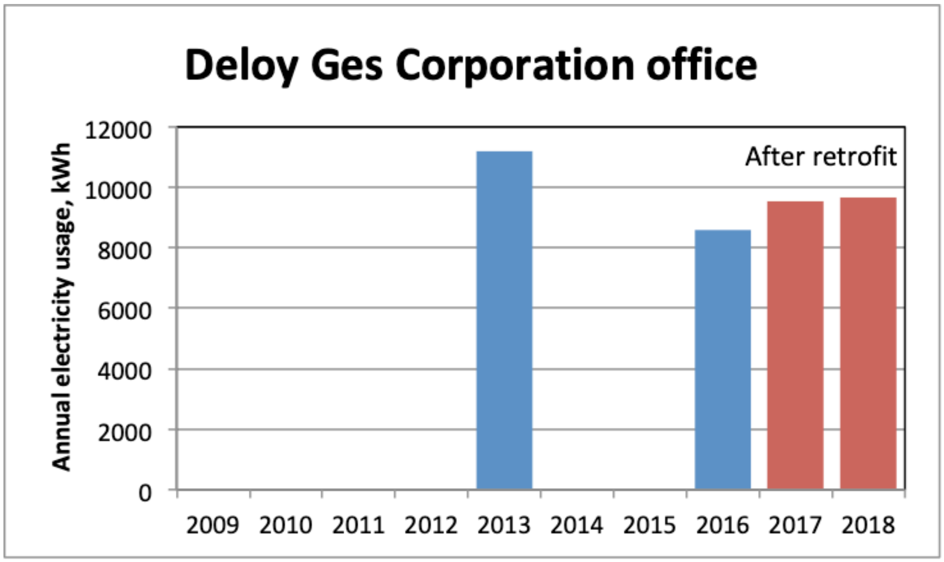

Figure 24: A lighting upgrade helped the office to decrease its electrical energy use.

Health clinic

The health clinic average electricity usage has decreased by more than a third (40%) between the years ending in 2012-2013, and the 2017-2018 time period. From the first year of data, 2011, to the last, 2018, electricity usage has nearly halved, resulting in savings of more than 6,000 kWh. The building's retrofit is ongoing. In 2017, the building joined the district biomass heating loop, was air-sealed, and received programmable thermostats. At the time of this report, there are plans to upgrade the HVAC controls in 2019 to increase the comfort level of building occupants and decrease the energy use further.

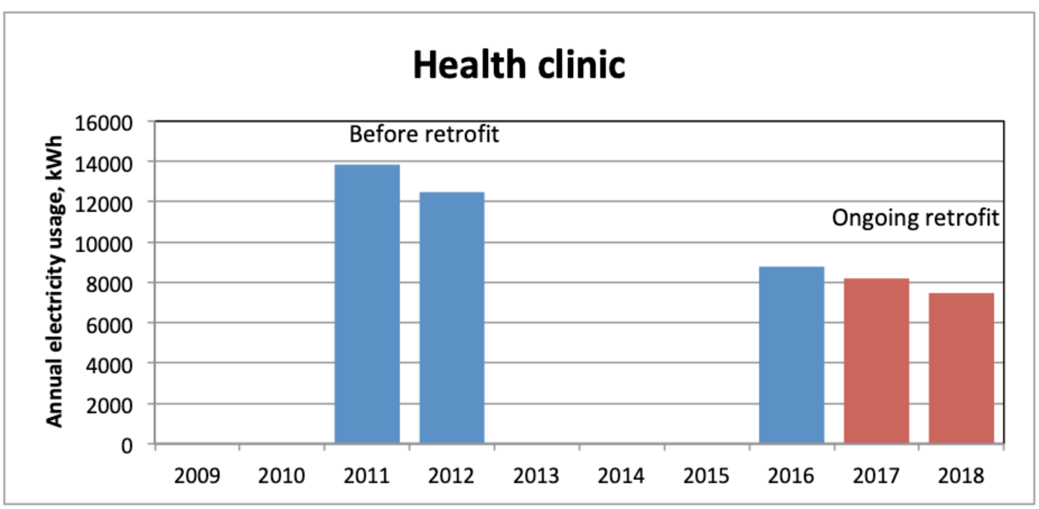

Figure 25: The electrical use of the health clinic is decreasing during its ongoing retrofit.

Tribal community hall

Approximately three years ago, tribal staff members moved their offices from the Tribal Council office building to the newer and more spacious tribal community hall (Alyssa Wulf, personal communication, January 16, 2019). This has resulted in increase of usage compared with the electric data from the audit years 2011-2012.

The community hall received a lighting upgrade and air-sealing in 2016-2017. It also joined the district biomass heating loop. The electric usage in 2018, after the retrofit, was 16% lower than in 2016, when the offices were already relocated, a savings of roughly 2,000 kWh per year.

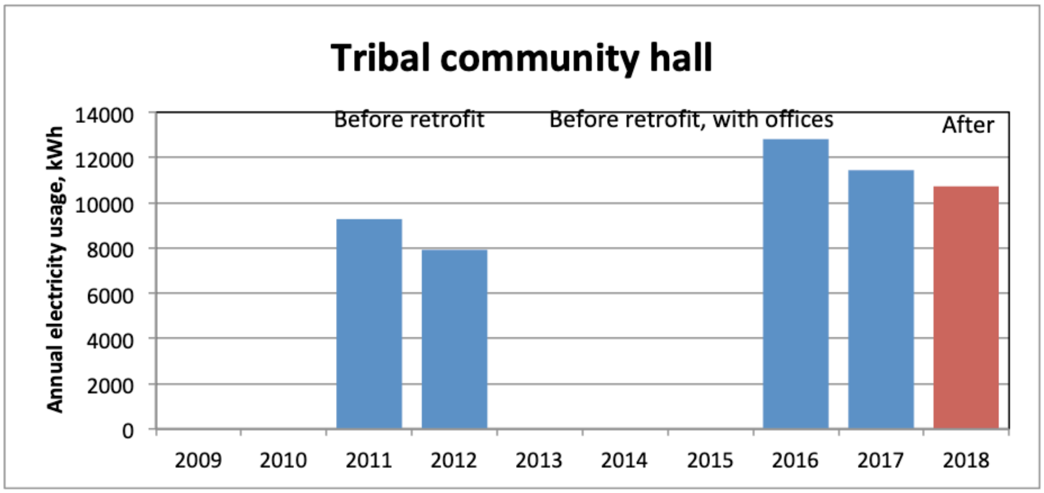

Figure 26: The electrical use of the community hall decreased after a lighting upgrade.

Tribal Council office

Tribal Council office electricity use has decreased by approximately 70% from the 2012-2013 time period to 2016-2018 time frame. Per the note in the tribal community hall section in the preceding section, the staff moved their offices out of this building roughly three years ago, decreasing the electric usage in the building without an energy retrofit.

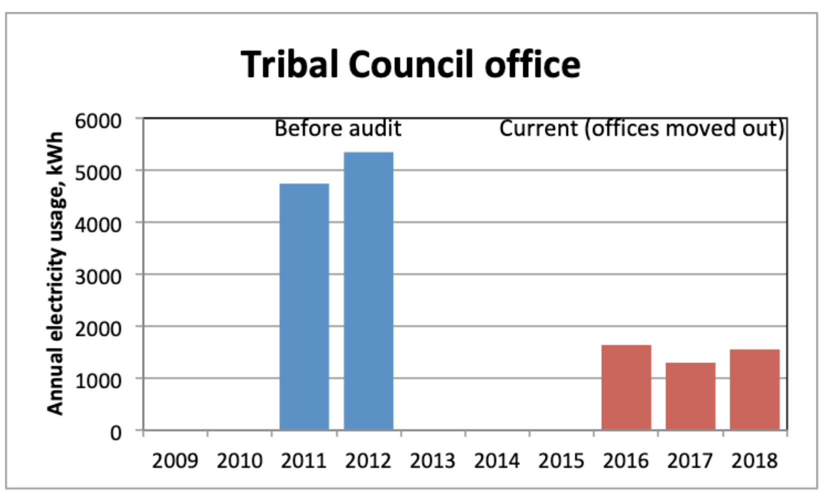

Figure 27: The electrical use of the Tribal Council office decreased due to its staff relocating to the tribal community hall.

For a better comparison of electricity usage given that the offices moved between two buildings, the following chart illustrates a comparison of the electricity used in both buildings, the Tribal Council office and the Tribal community hall. The overall electricity usage has decreased slightly.

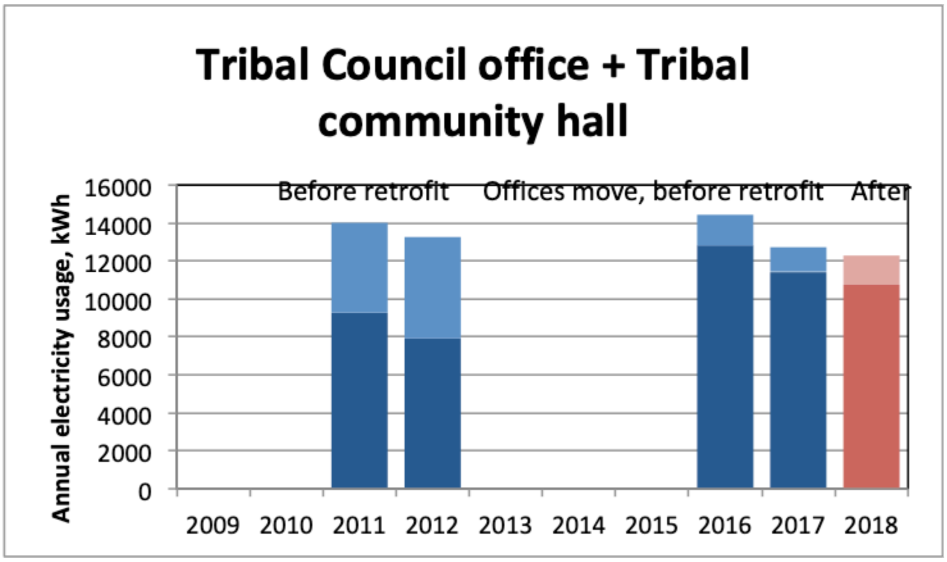

Figure 28: The electrical use of the Tribal Council office and community hall decreased slightly post-retrofit which included a lighting retrofit in the community hall.

Wireless network building

The only recommendation for the wireless network building was to pass the cost of energy use to GCI, for their usage that started in December 2012. The audit did not include any recommendations to decrease the energy use of the building.

Water treatment plant and washeteria

The water treatment plant and washeteria electricity use has decreased by an average of almost 10% from the initial audit period (2012-2013) to the only full year of data after a retrofit that included a lighting upgrade, 2018. The decrease is of almost 2,000 kWh per year from the initial audit.

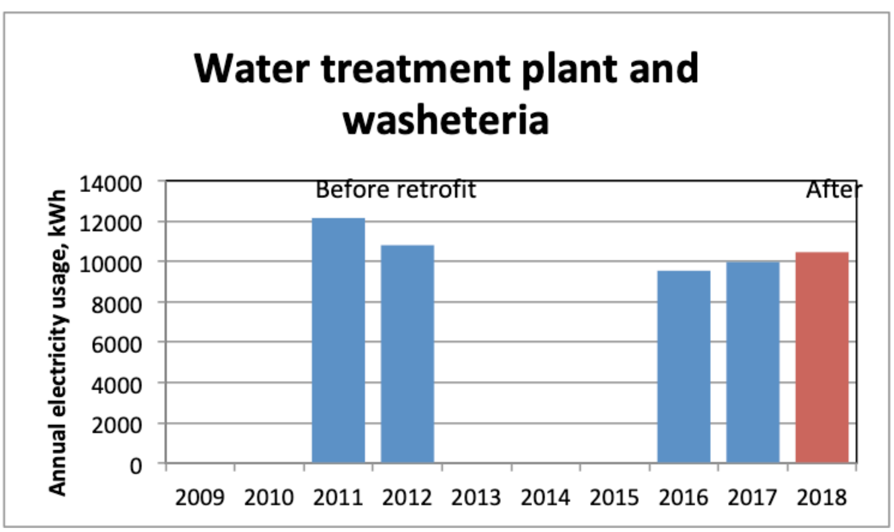

Figure 29: The electrical use of the water treatment plant decreased after a lighting upgrade.

Conclusion

The SPARC project goal was to improve community buildings in rural Alaska and create energy savings for residents. SPARC was a comprehensive retrofit project, achieving energy efficiency improvements alongside the installation of biomass heating systems in the Alaska community of Anvik. Beginning with energy audits of community buildings, SPARC project leaders and staff identified and secured funding from the Denali Commission and the State of Alaska to complete the audit recommendations. Construction crews, led by the Tanana Chiefs Conference and RurAL CAP, implemented the majority of the audit recommendations and installed a district biomass heating system in Anvik in 2016-2017 with a few remaining tasks to be completed in early 2019. The final year of the project, 2018, was dedicated to documenting the project procedure and verifying energy savings resulting from the retrofits.

In Anvik, nine buildings received energy audits prior to 2015. These buildings, all central to community needs and events, serve the majority of the village's population. The SPARC construction crew implemented energy efficiency retrofits in eight of these buildings, as well as connecting four of the buildings to a district biomass heating system. All buildings for which data were available experienced a decrease in energy use, with the exception of the tribal community hall, which increased its staff during the retrofit period.

Alaska's cold climate too often results in high energy costs and uncomfortable buildings. Energy audits are a useful tool for pointing the way toward energy savings; however, the energy audit recommendations must be implemented for energy use to decrease. The SPARC project, in addition to improving buildings and reducing energy costs in Anvik and Hughes, has also provided a template for how such a community energy project can occur, and, for some participating buildings, a verification of the energy savings predictions from energy audits. It also serves as an important example of how community leadership and motivation, as well as agency cooperation, can result in better buildings, lower costs, and more resilent communities.