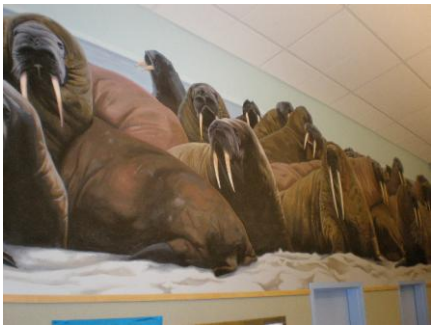
Village End Use Energy Efficiency Measures Program

AEA Grant # 2195225 Administered by Alaska Building Science Network

Brevig Mission Final Report



Community Summary

11 community buildings and 7 teacher housing units received energy efficiency upgrades as follows:

City Offices / Washeteria, Community Hall, Construction Camp, Auxiliary Office, Clinic, Water Plant Garage I (On Coast), VPSO, Store, Welding Shop, BSSD Old School Complex

Lighting Retrofits Completed: June 2008

Village-Wide Lighting Retrofit Summary:

- Retrofitted 180 light fixtures with electronic ballasts & T8 lamps
- Installed 181 compact fluorescent light bulbs
- Pre-retrofit energy use for all lighting: 33.643 Kilowatts
- Post-retrofit energy use for all lighting: 14.506 Kilowatts
- Energy savings projection: 19.137 Kilowatts
- Pre-retrofit to post retrofit energy reduction: 57%

- Estimated Annual Savings:

kWh Rate (as of Fall 2008): $0.53 Fuel Cost (FY 2007 Ave): $1.88

Hours Per Day/ 250 Days Per Year	Electrical Savings	Comparative Avoided Diesel Use (gal)	Comparative Avoided Diesel Costs
4 Hours/day	$10,188.50	1444.30	$2,715.29
7 Hours/day	**$17,829.90**	2527.53	$4,751.75
10 Hours/day	$25,471.30	3610.75	$6,788.22

- Total project cost for all measures: $37,775
- Simple Payback (lighting measures only, using 7 hours/day lighting use run-time): 2.12 years
- Total village wide in-kind contribution: 13,967.47
  (includes BSSD in kind labor for new low-mass boilers - extended grant capacity by 37%)

Additional Energy Efficiency Measures:

- Ten programmable thermostats installed in the City Office/Washeteria and BSSD teacher housing units.
- Two EK3 low-mass boilers installed in BSSD teacher housing and storage building

City of Brevig Mission Owned Buildings

8 buildings owned by the City of Brevig Mission received energy efficient lighting upgrades as follows:

City Offices / Washeteria, Community Hall, Construction Camp, Auxiliary Office, Clinic, Water Plant Garage I (On Coast), VPSO,

- Lighting upgrades completed in June 2008
- Retrofitted 89 light fixtures with electronic ballasts & T8 lamps
- Installed 45 compact fluorescent light bulbs
- Pre-retrofit energy use for all lighting: 13.62 Kilowatts
- Post-retrofit energy use for all lighting: 6.564 Kilowatts
- Energy savings projection: 7.056 Kilowatts
- Pre-retrofit to post retrofit energy reduction: 52%
- Estimated Annual Savings:

Hours Per Day / 250 Days Per Year	Electrical Savings	Comparative Avoided Diesel Use (gal)	Comparative Avoided Diesel Costs
Locally Estimated	$7,544.74	1069.52	$2,010.70
4 Hours/day	$3,756.61	532.53	$1,001.15
7 Hours/day	$6,574.08	931.92	$1,752.02
10 Hours/day	$9,391.54	1331.32	$2,502.88

ABSN Field Manager Geoff Butler conducts maintenance worker training.

Programmable thermostat installed in City Office.

Geoff Butler arrives in Brevig Mission.

Washeteria / City Offices



Materials Installed	Quantity
2-lamp electronic ballast, (2) 25 watt T8 lamps	14
4-lamp electronic ballast, (3) 25 watt T8 lamps	7
4-lamp electronic ballast, (4) 25 watt T8 lamps	9
CFL-14 W	8

- Pre-retrofit energy use: 3636 watts
- Post-retrofit energy use: 2105 watts
- Energy savings projection: 1531 watts
- Pre-retrofit to post retrofit energy reduction: 42%
- Estimated annual savings:

Hours Per Day / 250 Days Per Year	Electrical Savings	Comparative Avoided Diesel Use (gal)	Comparative Avoided Diesel Costs
2100 Hours/year (Est.)	$1,711.72	242.65	$456.18
4 Hours/day	$815.10	115.55	$217.23
7 Hours/day	$1,426.43	202.21	$380.15
10 Hours/day	$2,037.76	288.87	$543.07

Notes: Sixteen, 4-lamp fixtures de-lamped to three 25 watt T-8 lamps.

Community Hall



Materials Installed	Quantity
2-lamp electronic ballast, (2) 25 watt T8 lamps	7
4-lamp electronic ballast, (3) 25 watt T8 lamps	15
CFL-14 W	1
CFL-20 W	2
CFL-23 W	2

- Pre-retrofit energy use: 3414 watts
- Post-retrofit energy use: 1554 watts
- Energy savings projection: 1860 watts
- Pre-retrofit to post retrofit energy reduction: 54%
- Estimated annual savings:

Hours Per Day / 250 Days Per Year	Electrical Savings	Comparative Avoided Diesel Use (gal)	Comparative Avoided Diesel Costs
2852 Hours/year (Est.)	$2,824.23	400.36	$752.67
4 Hours/day	$990.26	140.38	$263.91
7 Hours/day	$1,732.96	245.66	$461.84
10 Hours/day	$2,475.66	350.94	$659.77

Notes: Fifteen, 4-lamp fixtures de-lamped to three 25 watt T-8 lamps.

Construction Camp

Materials Installed	Quantity
2-lamp electronic ballast, (2) 25 watt T8 lamps	8
CFL-14 W	6
CFL-20 W	5
CFL-23 W	8
CFL-27 W	2

- Pre-retrofit energy use: 2111 watts
- Post-retrofit energy use: 798 watts
- Energy savings projection: 1313 watts
- Pre-retrofit to post retrofit energy reduction: 62%
- Estimated annual savings:

Hours Per Day / 250 Days Per Year	Electrical Savings	Comparative Avoided Diesel Use (gal)	Comparative Avoided Diesel Costs
900 Hours/year (Est.)	$629.14	89.18	$167.67
4 Hours/day	$699.04	99.09	$186.30
7 Hours/day	$1,223.32	173.42	$326.02
10 Hours/day	$1,747.60	247.74	$465.74

Auxiliary Office Building

Materials Installed	Quantity
CFL-14 W	2

- Pre-retrofit energy use: 120 watts
- Post-retrofit energy use: 28 watts
- Energy savings projection: 92 watts
- Pre-retrofit to post retrofit energy reduction: 77%

- Estimated annual savings:

Hours Per Day / 250 Days Per Year	Electrical Savings	Comparative Avoided Diesel Use (gal)	Comparative Avoided Diesel Costs
2000 Hours/year (Est.)	$97.96	13.89	$26.11
4 Hours/day	$48.98	6.94	$13.05
7 Hours/day	$85.72	12.15	$22.84
10 Hours/day	$122.45	17.36	$32.63

Clinic



Materials Installed	Quantity
2-lamp electronic ballast, (2) 25 watt T8 lamps	7
4-lamp electronic ballast, (3) 25 watt T8 lamps	16

- Pre-retrofit energy use: 3180 watts
- Post-retrofit energy use: 1529 watts
- Energy savings projection: 1651 watts
- Pre-retrofit to post retrofit energy reduction: 52%
- Estimated annual savings:

Hours Per Day / 250 Days Per Year	Electrical Savings	Comparative Avoided Diesel Use (gal)	Comparative Avoided Diesel Costs
2160 Hours/year (Est.)	$1,898.62	269.14	$505.99
4 Hours/day	$878.99	124.60	$234.26
7 Hours/day	$1,538.24	218.06	$409.95
10 Hours/day	$2,197.48	311.51	$585.64

Notes: Two 4-lamp fixtures reduced to 2-lamp T-8 fixtures and sixteen, 4-lamp fixtures de-lamped to three 25 watt T-8 lamps.

Water Plant

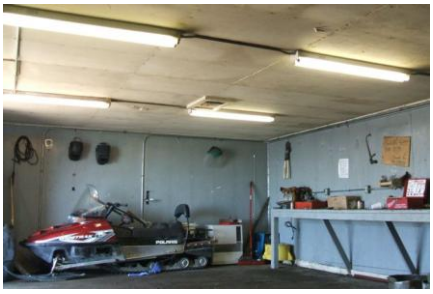
Materials Installed	Quantity
CFL-14 W	2
CFL-20 W	1
CFL-27 W	1

- Pre-retrofit energy use: 300 watts
- Post-retrofit energy use: 75 watts
- Energy savings projection: 225 watts
- Pre-retrofit to post retrofit energy reduction: 75%
- Estimated annual savings:

Hours Per Day / 250 Days Per Year	Electrical Savings	Comparative Avoided Diesel Use (gal)	Comparative Avoided Diesel Costs
1900 Hours/year (Est.)	$227.60	32.26	$60.66
4 Hours/day	$119.79	16.98	$31.92
7 Hours/day	$209.63	29.72	$55.87
10 Hours/day	$299.48	42.45	$79.81

Garage I (On Coast)





Materials Installed	Quantity
2-lamp electronic ballast, (2) 32 watt T8 lamps	6
CFL-20 W	1
• Pre-retrofit energy use:	564 watts
• Post-retrofit energy use:	380 watts
• Energy savings projection:	184 watts
• Pre-retrofit to post retrofit energy reduction:	33%

• Estimated annual savings:

Hours Per Day / 250 Days Per Year	Electrical Savings	Comparative Avoided Diesel Use (gal)	Comparative Avoided Diesel Costs
500 Hours/year (Est.)	$48.98	6.94	$13.05
4 Hours/day	$97.96	13.89	$26.11
7 Hours/day	$171.43	24.30	$45.69
10 Hours/day	$244.90	34.72	$65.27

VPSO


Materials Installed	Quantity
CFL-14 W	1
CFL-27 W	3
• Pre-retrofit energy use:	295 watts
• Post-retrofit energy use:	95 watts
• Energy savings projection:	200 watts
• Pre-retrofit to post retrofit energy reduction:	68%

• Estimated annual savings:

Hours Per Day / 250 Days Per Year	Electrical Savings	Comparative Avoided Diesel Use (gal)	Comparative Avoided Diesel Costs
1000 Hours/year (Est.)	$106.48	15.09	$28.38
4 Hours/day	$106.48	15.09	$28.38
7 Hours/day	$186.34	26.42	$49.66
10 Hours/day	$266.20	37.74	$70.94

Brevig Mission Native Corporation Owned Buildings



1 building owned by the Brevig Mission Native Corporation received energy efficient lighting upgrades as follows:

Store

Upgrades completed: February 2008

Materials Installed	**Quantity**
3-lamp electronic ballast, (2) 32 watt T8 lamps	31

- Lighting upgrades completed in
- Installed 31 light fixtures with electronic ballasts & t8 lamps
- Pre-retrofit energy use for all lighting: 4.944 Kilowatts
- Post-retrofit energy use for all lighting: 2.015 Kilowatts
- Energy savings projection: 2.929 Kilowatts
- Pre-retrofit to post retrofit energy reduction: 59%

- Estimated Annual Savings:

Hours Per Day / 250 Days Per Year	Electrical Savings	Comparative Avoided Diesel Use (gal)	Comparative Avoided Diesel Costs
Locally Estimated	$4,366.32	618.96	$1,163.64
4 Hours/day	$1,559.40	221.06	$415.59
7 Hours/day	$2,728.95	386.85	$727.28
10 Hours/day	$3,898.50	552.64	$1,038.97

Notes: Thirty-one 4-lamp fixtures reduced to 2-lamp T-8 fixtures and one 4-lamp fixture taken offline.

Bering Straight School District Owned Buildings

2 buildings and 7 teacher housing units owned by the Bering Straight School District received energy efficient lighting upgrades as follows:

Brevig Mission School Welding Shop, Old School Complex Storage Area and Boiler Room, New Duplex Teacher Housing 1, New Duplex Teacher Housing 2, Old School Complex - Unit 1, Old School Complex - Unit 2, Principal's Apt., Trailer House I, Trailer House II,

- Lighting upgrades completed February – May 2008
- Retrofitted 60 light fixtures with electronic ballasts & T8 lamps
- Installed 136 compact fluorescent light bulbs
- Pre-retrofit energy use for all lighting: 15.079 Kilowatts
- Post-retrofit energy use for all lighting: 5.927 Kilowatts
- Energy savings projection: 9.152 Kilowatts
- Pre-retrofit to post retrofit energy reduction: 61%

- Estimated Annual Savings:

Hours Per Day / 250 Days Per Year	Electrical Savings	Comparative Avoided Diesel Use (gal)	Comparative Avoided Diesel Costs
4 Hours/day	$4,872.52	690.72	$1,298.55
7 Hours/day	$8,526.92	1208.75	$2,272.46
10 Hours/day	$12,181.3	1726.79	$3,246.37

Additional Energy Efficiency Measures:

- Nine programmable thermostats installed in BSSD teacher housing units.
- Two EK3 low-mass boilers installed in BSSD Old School Complex teacher housing and storage building

Notes: Programmable thermostats installed by local maintenance staff in all BSSD teacher-housing units with oil-fired forced air and boiler heating systems. Our goal is to set thermostats to a night time set-back of 62 - 64 degrees and a daytime / evening / weekend temp of 68-70 degrees. If occupants are interested and willing to go beyond that, maintenance staff work with them to program the thermostat to 62 degrees during the weekdays when teachers are away working. Programmable thermostats used and maintained as programmed are known to achieve an overall fuel savings of between 5 and 10% over non-programmed thermostats.

Welding Shop

Materials Installed	Quantity
2-lamp electronic ballast, (2) 32 watt T8 lamps	12
• Pre-retrofit energy use:	936 watts
• Post-retrofit energy use:	720 watts
• Energy savings projection:	216 watts
• Pre-retrofit to post retrofit energy reduction:	23%

• Estimated annual savings:

Hours Per Day / 250 Days Per Year	Electrical Savings	Comparative Avoided Diesel Use (gal)	Comparative Avoided Diesel Costs
1200 Hours/year (Est.)	$138.00	19.56	$36.78
4 Hours/day	$115.00	16.30	$30.65
7 Hours/day	$201.25	28.53	$53.63
10 Hours/day	$287.50	40.75	$76.62

Old School Complex Storage Area and Boiler Room

Approx 25 hazardous waste PCB ballasts removed from the Old School Complex and shipped out of the village for proper disposal.

Materials Installed	Quantity
2-lamp electronic ballast, (2) 32 watt T8 lamps	14
CFL-23 W	2
• Pre-retrofit energy use:	1158 watts
• Post-retrofit energy use:	886 watts
• Energy savings projection:	272 watts
• Pre-retrofit to post retrofit energy reduction:	23%

• Estimated annual savings:

Hours Per Day / 250 Days Per Year	Electrical Savings	Comparative Avoided Diesel Use (gal)	Comparative Avoided Diesel Costs
4 Hours/day	$144.81	20.53	$38.59
7 Hours/day	$253.42	35.92	$67.54
10 Hours/day	$362.03	51.32	$96.48

New Duplex Teacher Housing 1

Programmable thermostats installed
in nine teacher housing units.

Materials Installed	Quantity
2-Lamp Fixture (w/existing electronic ballast) re-lamped with (2)25 watt T8 Lamps	4
4-Lamp Fixture (w/existing electronic ballast) re-lamped with (3) 25 watt T8 Lamps	2
4-Lamp Fixture (w/existing electronic ballast) re-lamped with, (4) 25 watt T8 lamps	2
CFL-11 W	12
CFL-14 W	5
CFL-20 W	8
CFL-23 W	5
CFL-27 W	3

- Pre-retrofit energy use: 3305 watts
- Post-retrofit energy use: 1076 watts
- Energy savings projection: 2229 watts
- Pre-retrofit to post retrofit energy reduction: 67%
- Estimated annual savings:

Hours Per Day / 250 Days Per Year	Electrical Savings	Comparative Avoided Diesel Use (gal)	Comparative Avoided Diesel Costs
1500 Hours/year (Est.)	$1,780.08	252.34	$474.40
4 Hours/day	$1,186.72	168.23	$316.27
7 Hours/day	$2,076.76	294.40	$553.46
10 Hours/day	$2,966.80	420.57	$790.66

New Duplex Teacher Housing 2

Materials Installed	Quantity
2-Lamp Fixture (w/existing electronic ballast) re-lamped with (2)25 watt T8 Lamps	4
4-Lamp Fixture (w/existing electronic ballast) re-lamped with (3) 25 watt T8 Lamps	4
CFL-11 W	12
CFL-14 W	4
CFL-20 W	8
CFL-23 W	4
CFL-27 W	3

- Pre-retrofit energy use: 3305 watts
- Post-retrofit energy use: 1009 watts
- Energy savings projection: 2296 watts
- Pre-retrofit to post retrofit energy reduction: 69%
- Estimated annual savings:

Hours Per Day / 250 Days Per Year	Electrical Savings	Comparative Avoided Diesel Use (gal)	Comparative Avoided Diesel Costs
1500 Hours/year (Est.)	$1,833.59	259.92	$488.66
4 Hours/day	$1,222.39	173.28	$325.77
7 Hours/day	$2,139.18	303.25	$570.10
10 Hours/day	$3,055.98	433.21	$814.43

Old School Complex, Unit 1

Materials Installed	Quantity
2-lamp electronic ballast, (2) 25 watt T8 lamps	2
CFL 3-Way: 12-20-26 W	1
CFL-14 W	14
CFL-20 W	4
CFL-23 W	1
CFL-27 W	1

- Pre-retrofit energy use: 1534 watts
- Post-retrofit energy use: 440 watts
- Energy savings projection: 1094 watts
- Pre-retrofit to post retrofit energy reduction: 71%
- Estimated annual savings:

Hours Per Day / 250 Days Per Year	Electrical Savings	Comparative Avoided Diesel Use (gal)	Comparative Avoided Diesel Costs
4 Hours/day	$582.45	82.57	$155.22
7 Hours/day	$1,019.28	144.49	$271.64
10 Hours/day	$1,456.11	206.42	$388.06

Old School Complex, Unit 2

Materials Installed	Quantity
2-lamp electronic ballast, (2) 25 watt T8 lamps	8
CFL 3-Way: 12-20-26 W	5
CFL-14 W	5
CFL-23 W	2
CFL-27 W	3

- Pre-retrofit energy use: 1651 watts
- Post-retrofit energy use: 673 watts
- Energy savings projection: 978 watts
- Pre-retrofit to post retrofit energy reduction: 59%
- Estimated annual savings:

Hours Per Day / 250 Days Per Year	Electrical Savings	Comparative Avoided Diesel Use (gal)	Comparative Avoided Diesel Costs
4 Hours/day	$520.69	73.81	$138.77
7 Hours/day	$911.20	129.17	$242.84
10 Hours/day	$1,301.72	184.53	$346.91

Principal's Apt.

Materials Installed	Quantity
2-lamp electronic ballast, (2) 25 watt T8 lamps	7
4-lamp electronic ballast, (4) 25 watt T8 lamps	1
CFL-14 W	4
• Pre-retrofit energy use:	910 watts
• Post-retrofit energy use:	475 watts
• Energy savings projection:	435 watts
• Pre-retrofit to post retrofit energy reduction:	48%

• Estimated annual savings:

Hours Per Day / 250 Days Per Year	Electrical Savings	Comparative Avoided Diesel Use (gal)	Comparative Avoided Diesel Costs
4 Hours/day	$231.59	32.83	$61.72
7 Hours/day	$405.29	57.45	$108.01
10 Hours/day	$578.99	82.08	$154.30

Trailer House I

Materials Installed	Quantity
CFL 3-Way: 12-20-26 W	4
CFL-14 W	1
CFL-23 W	10
• Pre-retrofit energy use:	1140 watts
• Post-retrofit energy use:	324 watts
• Energy savings projection:	816 watts
• Pre-retrofit to post retrofit energy reduction:	72%

• Estimated annual savings:

Hours Per Day / 250 Days Per Year	Electrical Savings	Comparative Avoided Diesel Use (gal)	Comparative Avoided Diesel Costs
1500 Hours/year (Est.)	$651.66	92.38	$173.67
4 Hours/day	$434.44	61.58	$115.78
7 Hours/day	$760.27	107.77	$202.61
10 Hours/day	$1,086.10	153.96	$289.45

Trailer House II

Materials Installed	Quantity
CFL 3-Way: 12-20-26 W	4
CFL-14 W	1
CFL-23 W	10

- Pre-retrofit energy use: 1140 watts
- Post-retrofit energy use: 324 watts
- Energy savings projection: 816 watts
- Pre-retrofit to post retrofit energy reduction: 72%
- Estimated annual savings:

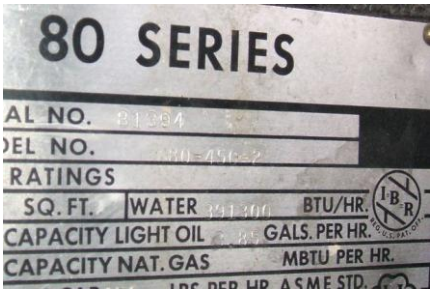
Hours Per Day / 250 Days Per Year	Electrical Savings	Comparative Avoided Diesel Use (gal)	Comparative Avoided Diesel Costs
1500 Hours/year (Est.)	$651.66	92.38	$173.67
4 Hours/day	$434.44	61.58	$115.78
7 Hours/day	$760.27	107.77	$202.61
10 Hours/day	$1,086.10	153.96	$289.45

Low-Mass Boiler Replacements for Bering Straits School District Teacher Housing:

Old School Complex.

BSSD Old School Complex in Brevig Mission

Former oil-hog cast iron boilers from the 20th century - late 1960s



Former Boilers had firing rates of 3.85 and 2.85 gallons of oil per hour of boiler run time

At the request of the Bering Straits School District, ABSN selected a new heating system in the Brevig Mission Old School Complex, as a priority VEUEEM upgrade for measures beyond lighting. Grant funds paid for two EK3 Energy Kinetics low-mass boilers and shipping to Unalakleet for a redundant system - to supply heat to three teacher-housing units and a school storage area. The new heating system replaces two, over-sized, 40-year-old cast iron boilers that had firing rates of 2.85 and 3.85 gallons per minute of boiler run time. The new EK3 boilers burn up to 1.3 gallons of fuel per hour of run time.

During phase 1 of the VEUEEM grants ABSN partnered with Bering Straits School District to complete installation of 7 Energy Kinetics, Low-Mass Boilers at three BSSD sites. So far fuel savings from these retrofits have been large as reported by local maintenance staff responsible for fueling and boiler maintenance at the sites. BSSD has a staff person at their headquarters in Unalakleet who is trained and experienced in engineering, installation and maintenance with Energy Kinetics boiler systems. Since the first round of EK boilers in the summer of 2007, BSSD boiler technicians have received training on installation and maintenance of the systems. This local knowledge and experience is an essential element for success when it comes to introducing a different boiler technology – especially in rural Alaska where lack of road connectivity and easy access to parts and specialized labor all play into challenging logistics. With the essential element of local expertise in place, and BSSD's continued commitment to provide full in-kind labor and various material resources, the new low-mass boilers in Brevig teacher housing was a clear choice.

New EK3 boilers – Old School Complex replaced in summer '08

New EK3 boilers burn up to 1.3 gallons of oil per hour of boiler run time.

Notes: Before and after fuel Use records for the Brevig Mission site were not available at the time of this report.

While on a Brevig Mission site visit in February ’08 ABSN project manger Geoff Butler met with Ron Rodriguez, BSSD itinerant boiler man. Ron gave positive reviews of the new EK systems and mentioned all the BSSD boiler technicians are sold on the systems. Elaborating on the issue of maintenance concerns Ron stated: *“They come with extra circuit boards and the boards themselves now seem to do quite well with intermittent village power and frequent outages. The site maintenance men are not fueling nearly as much. They've had no problems or maintenance issues. They are saving big-time and looking forward to more EK systems if the (VEUEEM grants) can supply more systems.”*

The following is from a conversation with Golovin School site maintenance staff Chon Peterson in September of 2008, after their first winter with their new EK boiler systems in their teacher housing and water plant buildings:

"The thing I see - we usually used 500 gallons week.” (2,000 gallons/month). *“From Nov - Feb, last winter* (winter of ‘07-‘08) *we used about 1000 gallons in that entire time last year - I couldn't believe it - thought there was something wrong with the boilers - they weren’t using any fuel - they are just awesome - unbelievable fuel savings. We filled up in June this year. Instead of using 250 gallons like a normal summer - we probably used less than 50 gallons.* (due to no standby heat losses*). “First month of operation* (August) *we went through 120 gallons - I just couldn't believe it. It heats 4 apartments: Principal's apt, a 3-bed apt with office, two, 2-bed rental apartments, and a three bed rental. It's a Redundant system with one boiler going at a time.”*

Former Boilers: BSSD Duplex Teacher Housing Building, Golovin,

New EK Boilers - Golovin Duplex Teacher Housing Building, installed summer, 2007

New Energy Kinetics System 2000 Low-Mass Boilers – awaiting installation in BSSD buildings, spring, 2007

Chon Peterson commented further on the new EK system installed to heat the Golovin school water plant: *“For the water plant - tank has 350,000 gallons of water, and 3,000 foot of pipe round trip between boiler and tank. 20 - 30 degrees below zero - no problems. It goes 4 months on 1000 gallons of fuel - before that we could burn 1000 gallons / month, Nov - Feb. I have nothing but good to say about these boilers. If you called for bad news, you called the wrong guy! We (school) pays I think $4.86 / gal*. (fall of 2008 local fuel prices), *Village pays $8.23/gal for heating fuel, $7.50/gal gas and $1.07/ kwh. Last winter was comparable to our usual winters".*

Former BSSD Water Plant Boilers, Golovin

New EK Boilers - BSSD Water Plant Boilers, Golovin, installed summer, 2007

If we do the simple math on Chon Peterson's comments: For just the 4 months of winter cold, '07-'08:
Apartment boilers: former use: 6,000 gallons (1,500 gallons / month). New use: 1000 gallons for the 4 months.
5,000 gallons saved x $4.86/gal = $24,300 /year
Conservative estimate of materials and labor for the job: $30k = 1.23 years simple payback on the winter use savings alone.

Water plant: former use: 4,000 gallons. New use: 1000 gallons. 3,000 gallons saved x $4.86/gal = $14,580 /year
Conservative estimate of materials and labor for the job: $25k = 1.72 years simple payback on the winter use savings alone.

For a scientific study, boiler run time and daily temperature / weather data would have to be incorporated to compare the severity of the winters for before and after the retrofit. Anecdotal information supplied informs us the winters were comparable winters. Even if the '07-'08 winter was warmer than normal, which by all accounts and personal experience all over the state it was not, we are convinced the fuel savings from the new EK systems is quite large.

Low-Mass Boilers – Research Information:

Following is information from our research that led us to pursue installations and training for low-mass boiler systems as energy saving measures for these grants:

The industry standard for rating energy efficiency is the: Annual Fuel Utilization Efficiency (AFUE) rating. This system is decades old and does not account for some of the most important elements effecting energy efficiency of a heating system. AFUE does not measure heat loss and accompanying fuel use due to:

- jacket losses from uninsulated or minimally insulated boilers
- Standby (idle) losses from boilers that always run at operating temperature and never cool to room temperature.
- Room air losses / draft regulator losses and heat-loss up the chimney.

These areas taken together contribute significantly to increased fuel use. These areas of heat (and fuel) losses are why conventional boiler systems burn more fuel than necessary. Low-mass boiler systems were designed to minimize losses in these specific areas.

On Kodiak Island, the U.S. Coast Guard is in the process of finalizing a project to have over 150 EK 2000 low-mass boilers installed in their Kodiak island housing units. They have had a performance-contracting project going for a couple years and have discovered excellent results in replacing conventional cast iron indirect tank systems. According to Energy Kinetics' Vice President, the Coast Guard has described the boiler replacements as the fastest pay-back of all the heating energy retrofits they are monitoring.

These boilers have been around more than 2 decades and have proven themselves in the field. Once the operations and maintenance of these systems is understood, they are not prohibitive to maintain or get parts for.

Recent research findings by the Brookhaven National Laboratory point to significant fuel savings with low-mass boilers over conventional cast iron boilers:

Excerpts from:

The Performance of Integrated Hydronic Heating Systems

Dr. T. Butcher, Y. Celebi, and G. Wei
Brookhaven National Laboratory, New York

An 82% AFUE (Annual Fuel Utilization Efficiency) Heat and Hot Water Boiler runs with 61% seasonal efficiency – and the real efficiency is even *lower*.
An 82% AFUE boiler (with an 80% steady state thermal efficiency) performs with seasonal efficiency of 61%. These results are meticulously calculated by very accurately measuring the amount of energy consumed and the amount of energy delivered to the conditioned space and for domestic hot water. The majority of the reduction in efficiency comes from downtime losses (idle losses) that are not accounted for in the AFUE rating system.[1] The 61% seasonal efficiency is further lowered by draft regulator losses, so the real efficiency is around 55%.
In another example, Dr. Butcher highlights savings of 29.5% when comparing steady state thermal efficiency of 88% versus 80%. In this case, 76% of the savings is achieved by reducing the idle loss from 3% to .15%.

87% AFUE System 2000 outperforms a 93% AFUE condensing boiler.
System 2000 has the highest seasonal efficiency and the lowest idle loss of all systems tested. For example, Dr. Butcher notes that System 2000's "value of .15% here for idle loss represents the best level measured in the lab tests to-date. Here the reduction in annual fuel use is actually lower than with the condensing system and demonstrates the important impact that the idle losses have."[2] The extremely low idle losses (see yellow graph) indicate that System 2000 is nearly unaffected by oversizing and performs at near peak efficiency in summer, spring, winter and fall.

AFUE	Equipment Type	Steady State Thermal Efficiency	Idle Loss	Oversize Factor	Seasonal Efficiency (Real Efficiency is lower if draft regulator required)
87%	**System 2000**	**86.5%**	**.15%**	**3**	**85.2%**
93%	Condensing Boiler with Indirect Tank	92.0%	1.5%	3	79.6%
89%	Boiler with Indirect Tank	88.0%	3%	3	67.1%
82%	Tankless Coil Boiler	80.0%	3%	3	61.0%

Outdoor reset controls These controls can reduce idle losses, but typically will account for savings of less than 6 or 8%.

[1]Dr. Thomas Butcher of Brookhaven National Labs May 2, 2006 presentation at the Atlantic Region Energy Expo, "Is there a better method than AFUE?"
[2]Butcher, T., Celebi, Y, and Wei, G., The Performance of Integrated Hydronic Heating Systems, Proceedings of the Fifth Aachen Oilheat Colloquium, Aachen Germany, Sept. 2006, Olwarme Institute.

Brevig Mission, In-Kind Contribution Tracking Record - ABSN Energy Efficiency Projects:

In-Kind Item	Dates	Hours Contri-buted	Hourly Wage	Value / Amount	Notes
Staff time for project contact, introduction & intro materials		4	$15.00	$60.00	list number of entities (Number of entities x 1 hour ea.)
Staff time for Attending telecon		1	$15.00	$15.00	City
Staff time for Attending telecon		1	$15.00	$15.00	Village Corp
Staff time for Attending telecon		1	$15.00	$15.00	School
Maint. Staff time to accompany Field Manager on assessments - 1st visit	27-Aug	5	$15.00	$ 75.00	Sam Goodhope, maint staff City of Brevig Mission
Maint. Staff time to accompany Field Manager on assessments - 1st visit	27-Aug	0.5	$18.00	$ 9.00	Arnold Seetot, maint staff City of Brevig Mission
Floyd Ollana - Maint. Staff time to attend ABSN training & do upgrades	2-25 to 2-26-08	11	$20.84	$ 218.82	list entity and maint staff, add rows as necessary
Time to attend ABSN training and perform lighting upgrades	2-25 to 2-28-08	26	$ 4.77	$ 376.64	Robbin - Maint Staff
Time to complete welding shop lighting, gather recyclables, etc		8	$25.00	$ 200.00	CO Rudstrom.
Time for John Licken to install programmable t-stats	Feb & March '08	6	$18.00	$108.00	9 programmable T-stats in teacher housing
Village labor - Brevig Mission Native Corp lighting upgrades, match our $15/hr with a supplemental $10/hr	2-25 to 2-28-08	14	$10.00	$140.00	Brevig Muit Store -For CO Rudstrom's 14 hours for store lighting retrofits
City of White Mountain In-kind labor - generally they pay $20/hr for their maint staff. They paid the $5 difference of our $15/hr labor reimbursement for City staff lighting hrs. Total of 122.5 hrs	3-10 to 3-27-08	123	$5.00	$612.50	
Village labor - Brevig Mission lighting upgrades, match our $15/hr with a supplemental $5/hr for 42.75 hr	3-10 to 3-27-08	43	$5.00	$213.75	White Mountain IRA Council
Conservative village office admin % of total project cost less ABSN Admin %. Total project cost = $37,775/village - (our admin percentage , (around 12%) Approx: $4,533) = $33,242 x 5.5% = $1,828 (this 5.5% village admin cost estimate is spread across all entities we work with for the course of the grant for completing all energy efficiency measures. These are primarily for cumulative, otherwise unaccounted time expense for village- based project support.	Feb, '07 through			$1,828.00	Each time we call, email, or fax a village entity, someone has to receive the communication, review and/or forward the information, follow-up on requests, etc. Whether it is to set-up a teleconference, verify maintenance staff participation in lighting or boiler trainings, set-up in-kind lodging and transportation, lighting trainings, track a shipment, verify completion of lighting in a given building, ship lamps and ballasts out of the village, request a labor reimbursement agreement, or invoice etc, etc. Village expenses for phone charges, copying and fax costs, office supplies, etc are part of this amount.
Lodging for ABSN Field Managers	8-27-28-07	2	$35.00	$70.00	1st Site Visit - Assessment
Transportation and fuel costs	8-27-28-07	2	$50.00	$100.00	2 days 4-wheeler use, 1st Visit
Lodging for ABSN Field Managers	2-25-28-08	6	$50.00	$300.00	2nd Site Visit - Upgrade
Labor for Bering Straits SD	6-4-Jul-08	156	$56.21	$8,768.96	Teacher Housing Low-mass boiler installation
Extra supplies for BSSD				$1,233.80	Teacher Housing Low-mass boiler installation
	TOTAL			$14,359.47	