Village End Use Energy Efficiency Measures Program ’05 – ’06

AEA Grant # 2195225 Administered by Alaska Building Science Network

Golovin Final Report

Community Summary

8 Community buildings and 8 teacher housing units received energy efficiency upgrades (May ’05 - October ’06)

City Hall, Fire Hall, Community Center, VPSO Building, Post Office, Store, BSSD Water Plant, and 8 Teacher Housing Units

Village-Wide Lighting Retrofit Summary:

- Retrofitted 108 light fixtures village-wide electronic ballasts and T8 lamps
- Installed: 146 compact fluorescent light bulbs village-wide
- Pre-retrofit energy use for all lighting: 19,993 watts
- Post-retrofit energy use for all lighting: 10,107 watts
- Energy savings projection: 9,886 watts (9.89 kW)
- **Pre-retrofit to post retrofit energy reduction**: 49 %
- **Estimated Annual Savings Range:**

Hours Per Day / 250 Days Per Year	Electrical Savings	Avoided Diesel Use	Avoided Diesel Costs
4 Hours	$3,757	745 Gallons	$1,699
7 Hours	$6,574	1,304 Gallons	$2,973
10 Hours	$9,392	1,862 Gallons	$4,246

- Total project cost for all measures: $38,235
- Simple mean payback: 5.82 Years
  *(All grant funds, but accounting for lighting savings only)
- Total village wide in-kind contribution: $20,073

Additional Energy Efficiency Measures: (Budget Expense: $ 26,325)

- 4 low-mass boiler installations in two Bering Straits School District housing buildings
- Training for school district maintenance staff in the installation, operation and maintenance of the low-mass boiler heating systems.

Golovin City Owned Buildings

Energy efficient lighting upgrades were completed in five buildings owned by the City of Golovin.

City owned Buildings - Lighting Retrofit Summary:

- Lighting upgrades completed in May, 2005
- Retrofitted 49 linear fluorescent fixtures with T8 lamps and electronic ballasts
- Installed: 25 compact fluorescent light bulbs
- Pre-retrofit energy use for all lighting: 7,224 watts
- Post-retrofit energy use for all lighting: 4,561 watts
- Energy savings projection: 2,663 watts (2.66 kW)
- **Pre-retrofit to post retrofit energy reduction**: 37 %
- **Estimated Annual Savings:**

Hours Per Day / 250 Days Per Year	Electrical Savings	Avoided Diesel Use	Avoided Diesel Costs
4 Hours	$1,012	201 Gallons	$458
7 Hours	$1,771	351 Gallons	$801
10 Hours	$2,530	502 Gallons	$1,144

City Hall

Materials Installed	2-Lamp Ballasts 32w lamps	4-Lamp Ballasts 32w lamps	2-Lamp Ballasts 25w lamps	2-Lamp Fixtures 3-lamp ballasts 25w lamps	4-Lamp Fixtures 3-lamp ballasts 25w lamps	4-Lamp Ballasts 25w lamps	13w CFL	20w CFL	25w CFL
City Hall	11	8	0	0	0	0	6	3	0

- Pre-retrofit energy use: 2,498 watts
- Post-Retrofit Energy Use: 1,758 watts
- Energy savings projection: 740 watts (.74 Kw)
- **Pre-retrofit to post retrofit energy reduction**: 30 %
- **Estimated Annual Savings:**

Hours Per Day / 250 Days Per Year	Electrical Savings	Avoided Diesel Use	Avoided Diesel Costs
4 Hours	$281	56 Gallons	$127
7 Hours	$492	98 Gallons	$223
10 Hours	$703	139 Gallons	$318

Notes: Some de-lamping of 4 lamp fixtures were done where significant over lighting was observed and agreed upon by the building owners. Incandescent lights were replaced with compact fluorescent lighting wherever possible.

Fire Hall

Materials Installed	2-Lamp Ballasts 32w lamps	4-Lamp Ballasts 32w lamps	2-Lamp Ballasts 25w lamps	2-Lamp Fixtures 3-lamp ballasts 25w lamps	4-Lamp Fixtures 3-lamp ballasts 25w lamps	4-Lamp Ballasts 25w lamps	13w CFL	20w CFL	25w CFL
Fire Hall	2	11	0	0	0	0	0	3	6

- Pre-retrofit energy use: 2,290 watts
- Post-Retrofit Energy Use: 1,650 watts
- Energy savings projection: 640 watts (.64 Kw)
- **Pre-retrofit to post retrofit energy reduction**: 28 %
- **Estimated Annual Savings:**

Hours Per Day / 250 Days Per Year	Electrical Savings	Avoided Diesel Use	Avoided Diesel Costs
4 Hours	$243	48 Gallons	$110
7 Hours	$426	84 Gallons	$192
10 Hours	$608	121 Gallons	$275

Community Center

Materials Installed	2-Lamp Ballasts 32w lamps	4-Lamp Ballasts 32w lamps	2-Lamp Ballasts 25w lamps	2-Lamp Fixtures 3-lamp ballasts 25w lamps	4-Lamp Fixtures 3-lamp ballasts 25w lamps	4-Lamp Ballasts 25w lamps	13w CFL	20w CFL	25w CFL
Community Center	10	0	0	0	0	0	1	0	0

- Pre-retrofit energy use: 840 watts
- Post-Retrofit Energy Use: 613 watts
- Energy savings projection: 227 watts (.23 Kw)
- **Pre-retrofit to post retrofit energy reduction**: 27 %
- **Estimated Annual Savings:**

Hours Per Day / 250 Days Per Year	Electrical Savings	Avoided Diesel Use	Avoided Diesel Costs
4 Hours	$86	17 Gallons	$39
7 Hours	$151	30 Gallons	$68
10 Hours	$216	43 Gallons	$98

VPSO Building

Materials Installed	2-Lamp Ballasts 32w lamps	4-Lamp Ballasts 32w lamps	2-Lamp Ballasts 25w lamps	2-Lamp Fixtures 3-lamp ballasts 25w lamps	4-Lamp Fixtures 3-lamp ballasts 25w lamps	4-Lamp Ballasts 25w lamps	13w CFL	20w CFL	25w CFL
VPSO Building	7	0	0	0	0	0	0	0	0

- Pre-retrofit energy use: 1,146 watts
- Post-Retrofit Energy Use: 420 watts
- Energy savings projection: 726 watts (.73 Kw)
- **Pre-retrofit to post retrofit energy reduction**: 63 %
- **Estimated Annual Savings:**

Hours Per Day / 250	Electrical	Avoided Diesel	Avoided

Days Per Year	Savings	Use	Diesel Costs
4 Hours	$276	55 Gallons	$125
7 Hours	$483	96 Gallons	$218
10 Hours	$690	137 Gallons	$312

Post Office

Materials Installed	2-Lamp Ballasts 32w lamps	4-Lamp Ballasts 32w lamps	2-Lamp Ballasts 25w lamps	2-Lamp Fixtures 3-lamp ballasts 25w lamps	4-Lamp Fixtures 3-lamp ballasts 25w lamps	4-Lamp Ballasts 25w lamps	13w CFL	20w CFL	25w CFL
Post Office	0	0	0	0	0	0	0	6	0

- Pre-retrofit energy use: 450 watts
- Post-Retrofit Energy Use: 120 watts
- Energy savings projection: 330 watts (.33 Kw)
- **Pre-retrofit to post retrofit energy reduction**: 73 %
- **Estimated Annual Savings:**

Hours Per Day / 250 Days Per Year	Electrical Savings	Avoided Diesel Use	Avoided Diesel Costs
4 Hours	$125	25 Gallons	$57
7 Hours	$219	44 Gallons	$99
10 Hours	$314	62 Gallons	$142

Golovin Village Corporation Owned Buildings

Energy efficient lighting upgrades were completed in the village corporation owned store.

Village Corporation Store - Lighting Retrofit Summary:

- Lighting upgrades completed in May, 2005
- Retrofitted 10 linear fluorescent fixtures with T8 lamps and electronic ballasts
- Installed: 2 compact fluorescent light bulbs

Materials Installed	2-Lamp Ballasts 32w lamps	4-Lamp Ballasts 32w lamps	2-Lamp Ballasts 25w lamps	2-Lamp Fixtures 3-lamp ballasts 25w lamps	4-Lamp Fixtures 3-lamp ballasts 25w lamps	4-Lamp Ballasts 25w lamps	13w CFL	20w CFL	25w CFL
Village Corp Store	**10**	**0**	**0**	0	0	0	0	**2**	**0**

- Pre-retrofit energy use for all lighting: 930 watts
- Post-retrofit energy use for all lighting: 640 watts
- Energy savings projection: 290 watts (.29 kW)
- **Pre-retrofit to post retrofit energy reduction**: 31 %
- **Estimated Annual Savings:**

Hours Per Day / 250 Days Per Year	Electrical Savings	Avoided Diesel Use	Avoided Diesel Costs
4 Hours	$110	22 Gallons	$50
7 Hours	$193	38 Gallons	$87
10 Hours	$276	55 Gallons	$125

Golovin School Owned Buildings

Energy efficient lighting upgrades were completed in eight teacher housing units owned by the Bering Straits School District. One of the Duplex housing buildings will also receive 2 low-mass boilers during the summer '07 recess to replace current cast iron boilers. Fuel savings are estimated at 10% – 30% for these energy efficiency measures.

Teacher Housing - Lighting Retrofit Summary:

- Lighting upgrades completed in May, 2005
- Retrofitted 49 linear fluorescent fixtures with T8 lamps and electronic ballasts
- Installed: 119 compact fluorescent light bulbs

Materials Installed	2-Lamp Ballasts 32w lamps	4-Lamp Ballasts 32w lamps	2-Lamp Ballasts 25w lamps	2-Lamp Fixtures 3-lamp ballasts 25w lamps	4-Lamp Fixtures 3-lamp ballasts 25w lamps	4-Lamp Ballasts 25w lamps	13w CFL	20w CFL	25w CFL
Teacher Housing	**16**	**0**	**33**	0	0	0	0	**116**	**3**

- Pre-retrofit energy use for all lighting: 11,839 watts
- Post-retrofit energy use for all lighting: 4,906 watts
- Energy savings projection: 6,933 watts (6.93 kW)
- **Pre-retrofit to post retrofit energy reduction**: 59 %
- **Estimated Annual Savings:**

Hours Per Day / 250 Days Per Year	Electrical Savings	Avoided Diesel Use	Avoided Diesel Costs
4 Hours	$2,635	522 Gallons	$1,191
7 Hours	$4,610	914 Gallons	$2,085
10 Hours	$6,586	1,306 Gallons	$2,978

Low-Mass Boiler Replacements for

Bering Straits School District Teacher Housing:

Existing Boilers - Goloviin Duplex Teacher Housing Building

Existing BSSD Water Treatment Plant Boilers

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

Golovin and Elim were two relatively small villages with a much smaller scope of work in the lighting sector. Additionally these two villages did not have any T5 retrofits for school gyms or other facilities. This resulted in substantial materials and village labor budget remaining for other energy saving measures. It was determined by ABSN and AEA that reducing heating fuel use would be a good use of remaining funds.

Through the ’05-’06 VEUEEM grants, ABSN formed a partnership with the Bering Straits School District to install 7, low-mass boilers in Elim and Golovin school district housing and other facilities. Golovin will receive two Energy Kinetics EK-2 boilers for their BSSD duplex teacher housing building. Golovin will also receive two Energy Kinetics, EK1 boilers for the BSSD water plant. BSSD will provide all the labor, travel, per diem, etc for installations as in-kind contribution. The district is contracting with a mechanical contractor experienced with these systems based in Unalakleet, which is the headquarters of BSSD. These two entities will work closely together during the boiler installations to ensure BSSD maintenance staff are trained in the installation, operations and maintenance of the new boiler systems. ABSN will be monitoring the installation process and provide AEA with relevant updates.

Although low-mass boilers are not commonly found in rural Alaska applications presently, their potential for fuel savings coupled with steady fuel cost increases may be catalysts in more of these systems being utilized. Rural entities have so far been reluctant to embrace a new heating system that has substantially different parts, technology and maintenance familiarity. With our recent research into low-mass boiler systems we believe the substantial fuel savings potential of the low-mass system will over shadow initial challenges of unfamiliarity. With the low-mass boiler system, providing installation and maintenance specifications of the manufacturer are followed, fuel savings is estimated to be 10% - 30% over the older, existing cast iron boilers.

Golovin Low-Mass Boilers – Fuel Use Monitoring

Golovin – BSSD water plant

Run-time data logger on existing Golovin water plant boiler

Temp sensor in boiler flu tells data logger when boiler cycles on and off.

The existing cast iron boilers in Golovin are being monitored for energy use from early March 2007 till change out during the summer of '07. The new boilers will be then monitored during the fall and early winter of 2007. Outdoor temperatures are being recorded and will be used to compare energy use difference between the old and new boilers. The new high efficiency low mass boilers reduce standby losses by remaining off until there is a call for heat. In addition, they do not have a barometric damper that pulls a significant amount of warm air out of the room and is wasted.

Village Energy Summit:

During the final site inspection our field manager arranged a community wide energy summit in Golovin. To encourage participation, a flyer was mailed to each homeowner offering $1000 worth of energy saving products for each attendee. Contributions from AVEC utility, ABSN and the Norton Sound Economic Development Corp, as well as funds from the AEA contract allowed us to distribute one Costco pack of 8 cfls, one storm window kit, and one box of weather stripping to each attendee. The meeting was well attended with approximately 20 homeowners attending which equated to about 50% of the homeowners in the village. Lighting and other low cost energy saving measures were discussed. Each cfl at $.25.kWh and 10,000 hour life would save $250 EACH. The $12 pack of eight cfls would save $2000 in electric costs at the subsidized PCE rate. If only half of the cfl's were installed and operated for just 3 hours per day, the payback would be still be less than 3 months. Approximately 160 cfl's were handed out.

During the same visit, a one-hour session on energy was held with the high school science class. The focus was on the inefficiency of diesel generation and combined with the inefficiency of the incandescent light bulb demonstrating incandescent lighting being only around 6% efficient, or for every 100 gallons of diesel burned for incandescent lighting, only around 6 gallons were useful and the other 94 gallons simply wasted. At the end of the class each student was given one cfl and encouraged to install it.

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.

Golovin, In-Kind Contribution Tracking Record - ABSN Energy Efficiency Projects:
Village entities worked with: City, Village Corp, School District.

In-Kind Item	Dates	Hours Contributed	Hourly Wage	Value / Amount	Notes
Staff time for project contact, introduction, and reviewof intro materials (Number of entities x 1 hour each)		3	$15.00	$45.00	# of entities we worked with in the village is indicated in the Hrs contributed column. $15 / hr is our generic estimated average wage for local village staff: Tribal Administrators, City Clerks,
Staff time for Attending teleconference village-wide	2/17/07	10.5	$15.00	$157.50	Hrs contributed column indicates length of telecon multiplied by # of village telecon participants
Tribal Maint. Staff time to assist Field Manager on building assessments - 1st site visit		5	$12.00	$60.00	list hrs of in-kind staff assisting FM on building assessments.
CityMaint. Staff time to assist Field Manager on building assessments - 1st site visit		3	$12.00	$36.00	
Maint. Staff time to attend ABSN training		6	$12.00	$72.00	Hrs contributed column indicates length of training multiplied by # of in-kind training participants
City of Golovin -payroll employer contribution	4/9/05			$61.72	
Justin's lighting inventory, City of Golovin	6/6/05	3 hrs @ $15/hr		$45.00	
Village office administrative percentage of total project cost less ABSN Admin %. Total project cost = $37,775/village - (our admin percentage , (around 9%) Approx: $3,400) = $34,375 x 5% = $1,718 (this 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 project support.	Jan '05 - Jan '07			$1,718.00	Each time we call, email, or fax a village entity, someone has to receive the communication, review and/or foward the information, follow-up on requests, etc. Wether 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 ammount.
Lodging for ABSN Field Manager - 3 site visits				$300.00	5 nights x $60/night
School & teacher housing lighting upgrades				$720.00	Approx 40 hrs x $18/hr
ABSN Contribution to fund Elim Energy Fair	Dec '06			$525.00	ABSN field manager time for presentation. (7 hrs @ $75/hr) (AEA covered air fare and travel expense)
Village Energy Fair - partnership grant project	Dec '06			$333.33	Norton Sound Economic Development Corp: In-Kind Grant for Village Energy Fair Kits, Credited to AEA Grant materials in 12-31-06 financial report
In-Kind labor: (Summer of 2007) Heating system replacements for two units in duplex BSSD teacher housing building in Golovin - Installation of two Energy Kinetics, EK2 boiler systems. Heating system replacements for two boilers in BSSD water plant building in Golovin Installation of two Energy Kinetics, EK1 boiler systems. Estimated Install and training costs for the 4 boilers, including travel, perdiem, lodging: $16,000					
				$16,000.00	
	TOTAL			$20,073.55	