Village End Use Energy Efficiency Measures Program
AEA Grant # 2195294 Administered by Alaska Building Science Network

Chitina Final Report

Community Summary

8 community buildings and teacher housing units received energy efficiency upgrades.

Trailer, Village Hall and Offices, Corporation Offices / Chitina Electric Offices, Eagle Clan Cabin, Generator Shed, Land Department, Post Office, Wrangle View Store

Retrofits Completed: July 2010

Village-Wide Lighting Retrofit Summary:

- Installed 31 compact fluorescent light bulbs
- Retrofitted 37 light fixtures with electronic ballasts & 8 lamps
- Pre-retrofit energy use for all lighting: 5.516 Kilowatts
- Post-retrofit energy use for all lighting: 3.104 Kilowatts
- Energy savings projection: 2.412 Kilowatts
- Pre-retrofit to post retrofit energy reduction: 44%

- Estimated Annual Savings:
  kWh Rate (FY 2009 AVE): $0.53 Fuel Cost (FY 2009 Ave): $3.14

Hours Per Day/ 250 Days Per Year	Electrical Savings	Comparative Avoided Diesel Use (gal)	Comparative Avoided Diesel Costs
Locally Estimated Use	$2,175.40	318.18	$999.08
4 Hours/day	$1,278.36	186.98	$587.11
7 Hours/day	$**2,237.13**	327.21	$1,027.44
10 Hours/day	$3,195.90	467.44	$1,467.77

- Total project cost for all measures: $8,000* Estimated Lighting Cost Not Including Ek Boiler
- Simple Payback (lighting measures only, using 7 hours/day lighting use run-time): 3.58
- Total village wide in-kind contribution: $568

Additional Energy Efficiency Measures:

- Installed 1 Energy Kinetics Boiler in the Village Hall

Native Village of Chitina Owned Buildings

2 buildings owned by the Native Village of Chitina received energy efficient lighting upgrades as follows:

Trailer, Village Hall and Offices, Corporation Offices / Chitina Electric Offices, Eagle Clan Cabin, Generator Shed, Land Department, Post Office, Wrangle View Store

- Lighting upgrades completed in July 2010
- Installed 5 compact fluorescent light bulbs
- Retrofitted 18 light fixtures with electronic ballasts & T8 lamps
- Pre-retrofit energy use for all lighting: 2.364 Kilowatts
- Post-retrofit energy use for all lighting: 1.678 Kilowatts
- Energy savings projection: 0.686 Kilowatts
- Pre-retrofit to post retrofit energy reduction: 29%
- Estimated Annual Savings:

Hours Per Day / 250 Days Per Year	Electrical Savings	Comparative Avoided Diesel Use (gal)	Comparative Avoided Diesel Costs
Locally Estimated	$1,049.67	153.53	$482.08
4 Hours/day	$363.58	53.18	$166.98
7 Hours/day	$636.27	93.06	$292.21
10 Hours/day	$908.95	132.95	$417.45

Trailer

Materials Installed	Quantity
2 ft fixture, 2-lamp electronic ballast, (2) 17 watt T8	1
2-lamp electronic ballast, (2) 25 watt T8 lamps	4
4-lamp electronic ballast, (4) 25 watt T8 lamps	1

- Pre-retrofit energy use: 472 watts
- Post-retrofit energy use: 306 watts
- Energy savings projection: 166 watts
- Pre-retrofit to post retrofit energy reduction: 35%
- Estimated annual savings:

Hours Per Day / 250 Days Per Year	Electrical Savings	Comparative Avoided Diesel Use (gal)	Comparative Avoided Diesel Costs
4 Hours/day	$87.98	12.87	$40.41
7 Hours/day	$153.97	22.52	$70.71
10 Hours/day	$219.95	32.17	$101.02
1750 Hours/year (Est.)	$153.97	22.52	$70.71

Village Hall and Offices

Materials Installed	Quantity
CFL-14 W	1
CFL-20 W	2
CFL-23 W	2
2-lamp electronic ballast, (2) 25 watt T8 lamps	2
8 ft fixture, 2 lamp electronic ballast, (2) 59 watt T8	10

- Pre-retrofit energy use: 1892 watts
- Post-retrofit energy use: 1372 watts
- Energy savings projection: 520 watts
- Pre-retrofit to post retrofit energy reduction: 27%
- Estimated annual savings:

Hours Per Day / 250 Days Per Year	Electrical Savings	Comparative Avoided Diesel Use (gal)	Comparative Avoided Diesel Costs
4 Hours/day	$275.60	40.31	$126.57
7 Hours/day	$482.30	70.54	$221.50
10 Hours/day	$689.00	100.78	$316.43
3250 Hours/year (Est.)	$895.70	131.01	$411.36

Chitina Native Corporation Owned Buildings

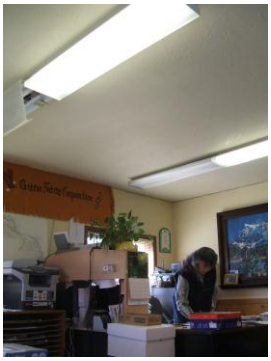
6 buildings owned by the Chitina Native Corporation received energy efficient lighting upgrades as follows:

Corporation Offices / Chitina Electric Offices, Eagle Clan Cabin, Generator Shed, Land Department, Post Office, Wrangle View Store

- Lighting upgrades completed in July 2010
- Installed 26 compact fluorescent light bulbs
- Retrofitted 19 light fixtures with electronic ballasts & T8 lamps
- Pre-retrofit energy use for all lighting: 3.152 Kilowatts
- Post-retrofit energy use for all lighting: 1.426 Kilowatts
- Energy savings projection: 1.726 Kilowatts
- Pre-retrofit to post retrofit energy reduction: 55%
- Estimated Annual Savings:

Hours Per Day / 250 Days Per Year	Electrical Savings	Comparative Avoided Diesel Use (gal)	Comparative Avoided Diesel Costs
Locally Estimated	$1,125.73	164.65	$517.01
4 Hours/day	$914.78	133.80	$420.13
7 Hours/day	$1,600.87	234.15	$735.22
10 Hours/day	$2,286.95	334.50	$1,050.32

Corporation Offices / Chitina Electric



Materials Installed	Quantity
CFL-20 W	2
2-lamp electronic ballast, (2) 25 watt T8 lamps	4
8 ft fixture, 2 lamp electronic ballast, (2) 59 watt T8	1

- Pre-retrofit energy use: 563 watts
- Post-retrofit energy use: 342 watts
- Energy savings projection: 221 watts
- Pre-retrofit to post retrofit energy reduction: 39%
- Estimated annual savings:

Hours Per Day / 250 Days Per Year	Electrical Savings	Comparative Avoided Diesel Use (gal)	Comparative Avoided Diesel Costs
4 Hours/day	$117.13	17.13	$53.79
7 Hours/day	$204.98	29.98	$94.14
10 Hours/day	$292.83	42.83	$134.48
2000 Hours/year (Est.)	$234.26	34.26	$107.59

Eagle Clan Cabin

Materials Installed	Quantity
CFL-14 W	2
CFL-23 W	3
2 ft fixture, 2-lamp electronic ballast, (2) 17 watt T8 lamps	1
2-lamp electronic ballast, (2) 25 watt T8 lamps	1

- Pre-retrofit energy use: 437 watts
- Post-retrofit energy use: 175 watts
- Energy savings projection: 262 watts
- Pre-retrofit to post retrofit energy reduction: 60%
- Estimated annual savings:

Hours Per Day / 250 Days Per Year	Electrical Savings	Comparative Avoided Diesel Use (gal)	Comparative Avoided Diesel Costs
4 Hours/day	$138.86	20.31	$63.77
7 Hours/day	$243.01	35.54	$111.60
10 Hours/day	$347.15	50.78	$159.43
800 Hours/year (Est.)	$111.09	16.25	$51.02

Generator Shed

Materials Installed	Quantity
2-lamp electronic ballast, (2) 25 watt T8 lamps	8

- Pre-retrofit energy use: 576 watts
- Post-retrofit energy use: 368 watts
- Energy savings projection: 208 watts
- Pre-retrofit to post retrofit energy reduction: 36%
- Estimated annual savings:

Hours Per Day / 250 Days Per Year	Electrical Savings	Comparative Avoided Diesel Use (gal)	Comparative Avoided Diesel Costs
4 Hours/day	$110.24	16.12	$50.63
7 Hours/day	$192.92	28.22	$88.60
10 Hours/day	$275.60	40.31	$126.57
800 Hours/year (Est.)	$88.19	12.90	$40.50

Land Department

Materials Installed	Quantity
CFL-14 W	12
CFL-27 W	1

- Pre-retrofit energy use: 820 watts
- Post-retrofit energy use: 195 watts
- Energy savings projection: 625 watts
- Pre-retrofit to post retrofit energy reduction: 76%
- Estimated annual savings:

Hours Per Day / 250 Days Per Year	Electrical Savings	Comparative Avoided Diesel Use (gal)	Comparative Avoided Diesel Costs
4 Hours/day	$331.25	48.45	$152.13
7 Hours/day	$579.69	84.79	$266.23
10 Hours/day	$828.13	121.12	$380.33
1000 Hours/year (Est.)	$331.25	48.45	$152.13

Post Office

Materials Installed	Quantity
CFL-27 W	2
2-lamp electronic ballast, (2) 25 watt T8 lamps	4

- Pre-retrofit energy use: 456 watts
- Post-retrofit energy use: 238 watts
- Energy savings projection: 218 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	$115.54	16.90	$53.06
7 Hours/day	$202.20	29.57	$92.86
10 Hours/day	$288.85	42.25	$132.66
1750 Hours/year (Est.)	$202.20	29.57	$92.86

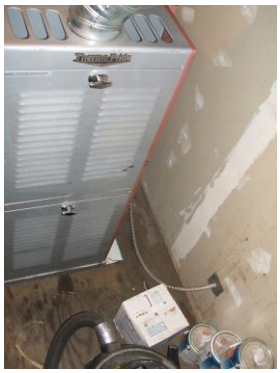
Wrangle View Store

Materials Installed	**Quantity**	
CFL-27 W	4	
• Pre-retrofit energy use:	300	watts
• Post-retrofit energy use:	108	watts
• Energy savings projection:	192	watts
• Pre-retrofit to post retrofit energy reduction:	64%	

• Estimated annual savings:

Hours Per Day / 250 Days Per Year	Electrical Savings	Comparative Avoided Diesel Use (gal)	Comparative Avoided Diesel Costs
4 Hours/day	$101.76	14.88	$46.73
7 Hours/day	$178.08	26.05	$81.79
10 Hours/day	$254.40	37.21	$116.84
1560 Hours/year (Est.)	$158.75	23.22	$72.91

Low-Mass Boiler Replacements for Chitina Village Tribal Hall:



Existing Forced Air Furnace

Existing Leaky, un-insulated forced air heating distribution system

To reduce fuel consumption for the Chitina Village Council, ABSN recommended a new heating system for the Village Council's main Tribal Hall building as a priority VEUEEM upgrade for measures beyond lighting. Grant funds paid for one Energy Kinetics, EK2 low-mass boiler including parts and shipping. The new boiler replaces an older, forced air furnace that had an extremely leaky, uninsulated duct delivery system located in a largely un-insulated crawl space. Fuel use with the existing system was substantially higher than it should have been.

For the Chitina EK2 installation, the Village Council partnered with their local Copper River Basin Regional Housing Authority - located in Copper Center - an hour's drive away, for the installation of the new boiler. Local Chitina maintenance staff received experience and training to maintain and operate the new system. 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 poor or no 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 CRBHA's commitment to provide in-kind labor and various material resources, the new low-mass boiler for the Chitina Village Council was a clear choice.

So far fuel savings from oil-fired Energy Kinetics retrofits undertaken with the Bering STraights School District have been substantial as reported by local maintenance staff responsible for fueling and boiler maintenance at Bering Straights School District sites where ABSN has partnered to install these systems. For all the Energy Kinetics systems installed with BSSD, the local fuel savings information from the field points to 30% to 50% savings over the existing boilers that were replaced.

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

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.

Chitina, 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, and review of intro materials (Number of entities x 1 hour each)		3	$ 15.00	$ 45.00	list number of entities
Staff time for Attending teleconference (TC/IRA)		1	$ 15.00	$ 15.00	list # of staff and wages if possible ($15/hr is an average wage designated for village entity staff).
Staff time for Attending teleconference (Village Corp)		2	$ 15.00	$ 30.00	"
Maint. Staff time to accompany Field Manager on building assessments - 1st site visit	Aug 11 - 13, 2008	7	18	$ 126.00	Chitina Traditional Indian Village Council, Dan Stevens, worked with me partial days - est 7 hours
Conservative village office administrative percentage of total project cost less ABSN Admin %. Total project cost = $8,000 /village - (our admin percentage , (around 12%) Approx: $960) = $7,040 x 5% = $352. (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.	Feb, '07 through			$ 352.00	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.
EK2 Low Mass Boiler installation and training by Copper River Basin Housing Authority	Summer, 2010			6,000	Conservative estimate of labor for install of new boiler and baseboard heating distribution system.
	TOTAL			$ 6,568.00	

The capacity of ABSN's scope of work was greatly increased by the response of local communities to work in partnership with ABSN and provide in-kind services of project coordination, paid labor for lighting retrofits, transportation and lodging for ABSN field staff, and other valuable contributions. This allowed ABSN and the community of Chitina to deliver 60% more energy savings measures beyond the original grant funding.