# Village End Use Energy Efficiency Measures Program '05 – '06
**AEA Grant # 2195225 Administered by Alaska Building Science Network**

# Elim Final Report

The Town of Elim
Photo By: Bill Stokes


Maintenance Crew Changing Ballasts


City Building T8 Lamps

## Community Summary

**6 Community buildings and 6 teacher housing units received energy efficiency upgrades February '06 - October '06: City Office, Library, IRA Office, Boys and Girls Club and 6 Teacher Housing Units**

**Village-Wide Lighting Retrofit Summary**:

- Retrofitted 118 fixtures village-wide with electronic ballasts and T8 lamps
- Installed: 58 compact fluorescent light bulbs village-wide
- Pre-retrofit energy use for all lighting: 16,993 watts
- Post-retrofit energy use for all lighting: 10,459 watts
- Energy savings projection: 6,534 watts (6.53 kW)
- **Pre-retrofit to post retrofit energy reduction**: 38 %
- **Estimated Annual Savings:**

| Hours Per Day / 250 Days Per Year | Electrical Savings | Avoided Diesel Use | Avoided Diesel Costs |
|---|---|---|---|
| 4 Hours | $2,352 | 478 Gallons | $837 |
| 7 Hours | $4,116 | 837Gallons | $1,465 |
| 10 Hours | $5,881 | 1,196 Gallons | $2,093 |

- Total project cost for village lighting: $ 38,235
- Simple mean payback (lighting measures only): 9.29 Years
- Total village wide in-kind contributions: $ 10,370

*(Payback figured on total grant funds, using lighting savings only – based on 250 days/yr & 7 hrs/day. Payback figure includes boiler installation expenses, but no savings since fuel savings data has yet been compiled).

**Additional Energy Efficiency Measures:** (Budget Expense: $ 19,915)

- 3 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.

# Elim City Owned Buildings

Energy efficient lighting upgrades were completed in two buildings owned by the City of Elim.

**City owned Buildings - Lighting Retrofit Summary**:

- Lighting upgrades completed in February, 2006
- Retrofitted 58 linear fluorescent fixtures with T8 lamps and electronic ballasts
- Installed: 9 compact fluorescent light bulbs
- Pre-retrofit energy use for all lighting: 8,040 watts
- Post-retrofit energy use for all lighting: 5,553 watts
- Energy savings projection: 2,487 watts (2.49 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 | $895 | 182 Gallons | $319 |
| 7 Hours | $1,567 | 319 Gallons | $558 |
| 10 Hours | $2,238 | 455 Gallons | $ 797 |

**Elim City Office 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 |
|---|---|---|---|---|---|---|---|---|---|
| **City Office** | 26 | 24 | 0 | 0 | 0 | 0 | 6 | 0 | 3 |

- Pre-retrofit energy use: 6,728 watts
- Post-Retrofit Energy Use: 4,593 watts
- Energy savings projection: 2,135 watts (2.14 Kw)
- **Pre-retrofit to post retrofit energy reduction**: 32 %

- **Estimated Annual Savings:**

| Hours Per Day / 250 Days Per Year | Electrical Savings | Avoided Diesel Use | Avoided Diesel Costs |
|---|---|---|---|
| 4 Hours | $769 | 156 Gallons | $274 |
| 7 Hours | $1,345 | 274 Gallons | $479 |
| 10 Hours | $1,922 | 391 Gallons | $684 |

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.

**Library 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 |
|---|---|---|---|---|---|---|---|---|---|
| **Library** | 0 | 8 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

- Pre-retrofit energy use: 1,312 watts
- Post-Retrofit Energy Use: 960 watts
- Energy savings projection: 352 watts (.35 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 | $127 | 26 Gallons | $45 |
| 7 Hours | $222 | 45 Gallons | $79 |
| 10 Hours | $317 | 64 Gallons | $113 |

# Elim IRA Owned Buildings

Energy efficient lighting upgrades were completed in two buildings owned by the Elim IRA

**IRA owned Buildings - Lighting Retrofit Summary**:

- Lighting upgrades completed in February, 2006
- Retrofitted 31 linear fluorescent fixtures with T8 lamps and electronic ballasts
- Installed: 11 compact fluorescent light bulbs
- Pre-retrofit energy use for all lighting: 3,730 watts
- Post-retrofit energy use for all lighting: 2,475 watts
- Energy savings projection: 1,255 watts (1.26 kW)
- **Pre-retrofit to post retrofit energy reduction**: 34 %
- **Estimated Annual Savings:**

| Hours Per Day / 250 Days Per Year | Electrical Savings | Avoided Diesel Use | Avoided Diesel Costs |
|---|---|---|---|
| 4 Hours | $452 | 92 Gallons | $161 |
| 7 Hours | $791 | 161 Gallons | $281 |
| 10 Hours | $1,130 | 230 Gallons | $402 |

**IRA 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 |
|---|---|---|---|---|---|---|---|---|---|
| **IRA Office** | 25 | 6 | 0 | 0 | 0 | 0 | 0 | 4 | 0 |

- Pre-retrofit energy use: 3,030 watts
- Post-Retrofit Energy Use: 2,300 watts
- Energy savings projection: 730 watts (F Kw)
- **Pre-retrofit to post retrofit energy reduction**: 24 %

- **Estimated Annual Savings:**

| Hours Per Day / 250 Days Per Year | Electrical Savings | Avoided Diesel Use | Avoided Diesel Costs |
|---|---|---|---|
| 4 Hours | $263 | 53 Gallons | $94 |
| 7 Hours | $460 | 94Gallons | $164 |
| 10 Hours | $657 | 134 Gallons | $234 |

### Boys and Girls Club

| **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 |
|---|---|---|---|---|---|---|---|---|---|
| **Boys & Girls Club** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 7 |

- Pre-retrofit energy use: 700 watts
- Post-Retrofit Energy Use: 175 watts
- Energy savings projection: 525 watts (.53 Kw)
- **Pre-retrofit to post retrofit energy reduction**: 75 %
- **Estimated Annual Savings:**

| Hours Per Day / 250 Days Per Year | Electrical Savings | Avoided Diesel Use | Avoided Diesel Costs |
|---|---|---|---|
| 4 Hours | $189 | 38 Gallons | $67 |
| 7 Hours | $331 | 67 Gallons | $118 |
| 10 Hours | $473 | 96 Gallons | $168 |

## Elim School Owned Buildings


Teacher Housing 3 Plex


Teacher Housing 5 Plex

Energy efficient lighting upgrades were completed in six teacher housing units owned by Bering Straits School District. These buildings will also receive 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 October, 2006
- Retrofitted 29 linear fluorescent fixtures with T8 lamps and electronic ballasts
- Installed: 38 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** | 29 | 0 | 0 | 0 | 0 | 0 | 17 | 11 | 10 |

- Pre-retrofit energy use for all lighting: 5,223 watts
- Post-retrofit energy use for all lighting: 2,431 watts
- Energy savings projection: 2,792 watts (2.79 kW)
- **Pre-retrofit to post retrofit energy reduction**: 53 %
- **Estimated Annual Savings:**

| Hours Per Day / 250 Days Per Year | Electrical Savings | Avoided Diesel Use | Avoided Diesel Costs |
|---|---|---|---|
| 4 Hours | $1,005 | 204 Gallons | $358 |
| 7 Hours | $1,759 | 358 Gallons | $626 |
| 10 Hours | $2,513 | 511 Gallons | $894 |

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

Teacher Housing 3-plex boiler to be replaced in summer '07

Teacher Housing 5-plex boilers to be replaced in summer '07

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

Elim and Golovin were two relatively small villages with a much smaller scope of work in the lighting sector. Neither of these two villages had 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. Elim will receive an Energy Kinetics EK-1 boiler for the BSSD tri-plex teacher housing building. Elim will also receive two Energy Kinetics EK-2 boilers for the 5-plex BSSD housing building. 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% of the older, existing cast iron boilers.

## Elim Low-Mass Boilers – Fuel Use Monitoring

Run-time data logger on Existing
Elim 3-plex boiler

The existing cast iron boilers 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 Elim. 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 40 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 still be less than 3 months. Approximately 320 cfl's were handed out.

## 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.

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

| In-Kind Item | Dates | Hours Contri-buted | 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, etc. |
| Staff time for Attending teleconference village-wide | | 4.5 | $15.00 | $67.50 | 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 | | 3 | $12.00 | $36.00 | 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 |
| **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 Managers - 1st assessment site visit | | | | $120.00 | 2 nights x $60/night |
| Lodging for ABSN Field Managers - 2nd site visit | | | | $60.00 | 1 nights x $60/night |
| School & teacher housing lighting upgrades | | | | $432.00 | Approx 24 hrs x $18/hr |
| ABSN Contribution to fund Elim Energy Fair | Dec '06 | | | $450.00 | ABSN field manager time for presentation. (6 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 replacement for one unit in Tri-plex, BSSD teacher housing building in Elim. (Installation of one Energy Kinetics EK1 boiler system. And, Heating system replacements for 5 units in 5-plex BSSD teacher housing building in Elim - Installation of two, Energy Kinetics, EK2 boiler systems. Estimated Install and training costs for the 3 boilers,including travel, perdiem, lodging and monitoring fuel use: $7,000 | | | | | |
| | | | | $7,000.00 | |
| | TOTAL | | | $10,369.83 | |