# Village End Use Energy Efficiency Measures Program

**AEA Grant # 2195225 Administered by Alaska Building Science Network**

# Stebbins Final Report



## Community Summary

15 community buildings and 12 teacher housing units received energy efficiency upgrades as follows:

Washeteria, Clinic, Community Hall, Learning Center, Police Department, Water Plant, New IRA Office, Teen Center, Stebbins Native Corp Office, Store, Stebbins/Tukurngailnguq school, Portable Classroom, Utility Building, School Gym & Teacher Housing

Retrofits Completed: November 2009 – January 2010
ABSN Field Management by: Garrison Collette, Dan Lung and Anna Hilbruner.
Trained 11 local maintenance staff who were employed by village entities to complete lighting retrofits

### Village-Wide Lighting Retrofit Summary:

- Retrofitted 982 light fixtures with electronic ballasts & t8 lamps
- Installed 87 existing electronic ballasts with t8 lamps
- Installed 226 compact fluorescent light bulbs
- Installed 15 T5 linear fluorescent fixtures in the School Gym
- Pre-retrofit energy use for all lighting: 139.73 Kilowatts
- Post-retrofit energy use for all lighting: 84.46 Kilowatts
- Energy savings projection: 55.27 Kilowatts
- Pre-retrofit to post retrofit energy reduction: 40%
- Estimated Annual Savings:

kWh Rate (FY 2009 AVE): $0.61 Fuel Cost (FY 2009 Ave): $4.16

| Hours Per Day/ 250 Days Per Year | Electrical Savings | Comparative Avoided Diesel Use (gal) | Comparative Avoided Diesel Costs |
|---|---|---|---|
| Locally Estimated Use | $94,717 | 11603 | $48,271 |
| 4 Hours/day | $33,644 | 4121 | $17,146 |
| 7 Hours/day | **$58,877** | 7212 | $30,005 |
| 10 Hours/day | $84,110 | 10304 | $42,865 |

- Total project cost for all measures: $83,000 (Allocated according to number of lighting retrofits and tracked grant expense)
- Simple Payback (lighting measures only, using 7 hours/day lighting use run-time): 1.41 years
- Total village wide in-kind contribution: $31,926

**Additional Energy Efficiency Measures:**

- Energy assessments for local churches - lighting and air-sealing upgrades were the primary recommendations.
- Two EK3 low-mass boilers installed in Bering Straights School District Utility Building
- Consulting / energy education for additional fuel savings in Clinic and Teen Center

# City of Stebbins Owned Buildings



6 buildings owned by the City of Stebbins received energy efficient lighting upgrades as follows:

Washeteria, Clinic, Community Hall, Learning Center, Police Department, Water Plant

- Lighting upgrades completed in: January 2010
- Retrofitted 154 light fixtures with electronic ballasts & T8 lamps
- Installed 7 compact fluorescent light bulbs
- Pre-retrofit energy use for all lighting: 18.26 Kilowatts
- Post-retrofit energy use for all lighting: 12.679 Kilowatts
- Energy savings projection: 5.581 Kilowatts
- Pre-retrofit to post retrofit energy reduction: 31%

- Estimated Annual Savings:

| Hours Per Day / 250 Days Per Year | Electrical Savings | Comparative Avoided Diesel Use (gal) | Comparative Avoided Diesel Costs |
|---|---|---|---|
| Locally Estimated | $10,382.10 | 1271.90 | $5,291.12 |
| 4 Hours/day | $3,397.15 | 416.18 | $1,731.32 |
| 7 Hours/day | $5,945.02 | 728.32 | $3,029.80 |
| 10 Hours/day | $8,492.89 | 1040.45 | $4,328.29 |

## Washeteria

| Materials Installed | Quantity |
|---|---|
| 2 ft fixture, 2-lamp electronic ballast, (2) 17 watt T8 | 2 |
| 2-lamp electronic ballast, (1) 25 watt T8 lamp | 2 |
| 2-lamp electronic ballast, (2) 25 watt T8 lamps | 11 |
| 3-lamp electronic ballast, (2) 25 watt T8 lamps | 5 |
| 3-lamp electronic ballast, (3) 25 watt T8 lamps | 5 |
| 3-lamp electronic ballast, (3) 32 watt T8 lamps | 10 |

- Pre-retrofit energy use: 3896 watts
- Post-retrofit energy use: 2152 watts
- Energy savings projection: 1744 watts
- Pre-retrofit to post retrofit energy reduction: 45%
- Estimated annual savings:

| Hours Per Day / 250 Days Per Year | Electrical Savings | Comparative Avoided Diesel Use (gal) | Comparative Avoided Diesel Costs |
|---|---|---|---|
| 4 Hours/day | $1,061.57 | 130.05 | $541.02 |
| 7 Hours/day | $1,857.75 | 227.59 | $946.78 |
| 10 Hours/day | $2,653.93 | 325.13 | $1,352.54 |
| 5800 Hours/year (Est.) | $6,157.12 | 754.30 | $3,137.90 |

## Community Hall

| Materials Installed | Quantity |
|---|---|
| 8 ft fixture, 2 lamp electronic ballast, (2) 59 watt T8 | 31 |
| CFL-27 W | 4 |

- Pre-retrofit energy use: 4430 watts
- Post-retrofit energy use: 3766 watts
- Energy savings projection: 664 watts
- Pre-retrofit to post retrofit energy reduction: 15%
- Estimated annual savings:

| Hours Per Day / 250 Days Per Year | Electrical Savings | Comparative Avoided Diesel Use (gal) | Comparative Avoided Diesel Costs |
|---|---|---|---|
| 4 Hours/day | $404.18 | 49.52 | $205.98 |
| 7 Hours/day | $707.31 | 86.65 | $360.47 |
| 10 Hours/day | $1,010.44 | 123.79 | $514.96 |
| 2080 Hours/year (Est.) | $840.69 | 102.99 | $428.45 |

## Stebbins Clinic



| **Materials Installed** | **Quantity** |
|---|---|
| 4-lamp existing electronic ballast, re-lamped with (3) | 12 |
| 4-lamp existing electronic ballast, re-lamped with (4) | 33 |
| 2-lamp electronic ballast, (2) 25 watt T8 lamps | 3 |

- Pre-retrofit energy use: 5364 watts
- Post-retrofit energy use: 4008 watts
- Energy savings projection: 1356 watts
- Pre-retrofit to post retrofit energy reduction: 25%

- Estimated annual savings:

| Hours Per Day / 250 Days Per Year | Electrical Savings | Comparative Avoided Diesel Use (gal) | Comparative Avoided Diesel Costs |
|---|---|---|---|
| 4 Hours/day | $825.40 | 101.12 | $420.65 |
| 7 Hours/day | $1,444.45 | 176.96 | $736.14 |
| 10 Hours/day | $2,063.49 | 252.80 | $1,051.63 |
| 1800 Hours/year (Est.) | $1,485.71 | 182.01 | $757.18 |


**Note:** Education is an important part of energy conservation. In commercial buildings, occupant variations on use determine the difference between a 70% confidence in energy projections without education to a 10% confidence on savings projections with occupant and building manager education. The Heat Recovery Ventilation system in the Stebbins clinic was not providing adequate air to the occupants and was wasting energy because the system was clogged. Stebbins, ABSN Field manager cleaned the system (above) and educated staff on the maintenance intervals for these systems. This should save substantial kilowatt hours per year on costs for running the HRV fan.

## Community Hall

| Materials Installed | Quantity |
|---|---|
| 8 ft fixture, 2 lamp electronic ballast, (2) 59 watt T8 | 31 |
| CFL-27 W | 4 |

- Pre-retrofit energy use: 4430 watts
- Post-retrofit energy use: 3766 watts
- Energy savings projection: 664 watts
- Pre-retrofit to post retrofit energy reduction: 15%
- Estimated annual savings:

| Hours Per Day / 250 Days Per Year | Electrical Savings | Comparative Avoided Diesel Use (gal) | Comparative Avoided Diesel Costs |
|---|---|---|---|
| 4 Hours/day | $404.18 | 49.52 | $205.98 |
| 7 Hours/day | $707.31 | 86.65 | $360.47 |
| 10 Hours/day | $1,010.44 | 123.79 | $514.96 |
| 2080 Hours/year (Est.) | $840.69 | 102.99 | $428.45 |

## Learning Center

| Materials Installed | Quantity |
|---|---|
| 2-lamp electronic ballast, (1) 25 watt T8 lamp | 1 |
| 2-lamp electronic ballast, (2) 25 watt T8 lamps | 5 |
| 4-lamp electronic ballast, (4) 25 watt T8 lamps | 11 |

- Pre-retrofit energy use: 1979 watts
- Post-retrofit energy use: 1246 watts
- Energy savings projection: 733 watts
- Pre-retrofit to post retrofit energy reduction: 37%
- Estimated annual savings:

| Hours Per Day / 250 Days Per Year | Electrical Savings | Comparative Avoided Diesel Use (gal) | Comparative Avoided Diesel Costs |
|---|---|---|---|
| 4 Hours/day | $446.18 | 54.66 | $227.39 |
| 7 Hours/day | $780.81 | 95.66 | $397.93 |
| 10 Hours/day | $1,115.44 | 136.65 | $568.47 |
| 1500 Hours/year (Est.) | $669.27 | 81.99 | $341.08 |

## Police Department



| Materials Installed | Quantity |
|---|---|
| 2-lamp electronic ballast, (2) 25 watt T8 lamps | 1 |
| 3-lamp electronic ballast, (3) 25 watt T8 lamps | 3 |
| 4-lamp electronic ballast, (3) 25 watt T8 lamps | 4 |
| CFL-27 W | 2 |

- Pre-retrofit energy use: 1364 watts
- Post-retrofit energy use: 622 watts
- Energy savings projection: 742 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 |
|---|---|---|---|
| 4 Hours/day | $451.66 | 55.33 | $230.18 |
| 7 Hours/day | $790.40 | 96.83 | $402.82 |
| 10 Hours/day | $1,129.14 | 138.33 | $575.45 |
| 1800 Hours/year (Est.) | $812.98 | 99.60 | $414.32 |

## Water Plant



| Materials Installed | Quantity |
|---|---|
| 2-lamp electronic ballast, (2) 25 watt T8 lamps | 3 |
| 2-lamp electronic ballast, (2) 32 watt T8 lamps | 12 |
| CFL-27 W | 1 |

- Pre-retrofit energy use: 1227 watts
- Post-retrofit energy use: 885 watts
- Energy savings projection: 342 watts
- Pre-retrofit to post retrofit energy reduction: 28%
- Estimated annual savings:

| Hours Per Day / 250 Days Per Year | Electrical Savings | Comparative Avoided Diesel Use (gal) | Comparative Avoided Diesel Costs |
|---|---|---|---|
| 4 Hours/day | $208.18 | 25.50 | $106.09 |
| 7 Hours/day | $364.31 | 44.63 | $185.66 |
| 10 Hours/day | $520.44 | 63.76 | $265.23 |
| 2000 Hours/year (Est.) | $416.35 | 51.01 | $212.19 |

# Stebbins Community Association Owned Buildings

*Above (left): The Stebbins Community Center and New IRA office sits above the village of Stebbins. The new building featured modern lighting and building systems, but at right the wind showed its power through an uncovered wall outlet opening. ABSN retrofits improved lighting efficiency by 35% along with color rendering.*

2 buildings owned by the Stebbins Community Association received energy efficient lighting upgrades as follows:

New IRA Office, Teen Center

- Lighting upgrades completed in January 2010
- Retrofitted 99 light fixtures with electronic ballasts & T8 lamps
- Installed 9 compact fluorescent light bulbs
- Pre-retrofit energy use for all lighting: 10.28 Kilowatts
- Post-retrofit energy use for all lighting: 6.682 Kilowatts
- Energy savings projection: 3.598 Kilowatts
- 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 |
|---|---|---|---|
| Locally Estimated | $3,515.12 | 430.63 | $1,791.44 |
| 4 Hours/day | $2,190.10 | 268.31 | $1,116.16 |
| 7 Hours/day | $3,832.68 | 469.54 | $1,953.28 |
| 10 Hours/day | $5,475.26 | 670.77 | $2,790.40 |

## New IRA Office



| Materials Installed | Quantity |
|---|---|
| 4-lamp existing electronic ballast, re-lamped with (4) CFL-27 W | 42<br>8 |
| • Pre-retrofit energy use: | 5840 watts |
| • Post-retrofit energy use: | 3996 watts |
| • Energy savings projection: | 1844 watts |
| • Pre-retrofit to post retrofit energy reduction: | 32% |

• Estimated annual savings:

| Hours Per Day / 250 Days Per Year | Electrical Savings | Comparative Avoided Diesel Use (gal) | Comparative Avoided Diesel Costs |
|---|---|---|---|
| 4 Hours/day | $1,122.44 | 137.51 | $572.04 |
| 7 Hours/day | $1,964.27 | 240.64 | $1,001.07 |
| 10 Hours/day | $2,806.11 | 343.77 | $1,430.10 |
| 1800 Hours/year (Est.) | $2,020.40 | 247.52 | $1,029.67 |

## Teen Center



| Materials Installed | Quantity |
|---|---|
| 2-lamp electronic ballast, (2) 25 watt T8 lamps | 56 |
| 3-lamp electronic ballast, (3) 32 watt T8 lamps | 1 |
| CFL-20 W | 1 |
| • Pre-retrofit energy use: | 4440 watts |
| • Post-retrofit energy use: | 2686 watts |
| • Energy savings projection: | 1754 watts |
| • Pre-retrofit to post retrofit energy reduction: | 40% |

• Estimated annual savings:

| Hours Per Day / 250 Days Per Year | Electrical Savings | Comparative Avoided Diesel Use (gal) | Comparative Avoided Diesel Costs |
|---|---|---|---|
| 4 Hours/day | $1,067.66 | 130.80 | $544.12 |
| 7 Hours/day | $1,868.40 | 228.90 | $952.21 |
| 10 Hours/day | $2,669.15 | 326.99 | $1,360.30 |
| 1400 Hours/year (Est.) | $1,494.72 | 183.12 | $761.77 |

**Note:** Stebbins ABSN field manager worked with RurAl CAP (The Rural Alaska Community Action Program), who leased the Stebbins Teen Center, to improve the heating plant in the building. The existing heating plant, above, was old and inefficient. The system we recommended would add radiant hydronic panels to the ceiling of the center allowing the temperature to drop while maintaining occupant comfort, and provide domestic hot water to the building as well as radiant and baseboard heat. Savings are projected at 25 to 30%, or about 400 gallons of diesel per year.

# Stebbins Native Corporation Owned Buildings


Two buildings owned by the Stebbins Native Corporation received energy efficient lighting upgrades as follows:

Office, Store

- Lighting upgrades completed in November 2009
- Retrofitted 61 light fixtures with electronic ballasts & T8 lamps
- Installed 1 compact fluorescent light bulbs
- Pre-retrofit energy use for all lighting: 8.787 Kilowatts
- Post-retrofit energy use for all lighting: 5.125 Kilowatts
- Energy savings projection: 3.662 Kilowatts
- 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 |
|---|---|---|---|
| Locally Estimated | $5,964.04 | 730.65 | $3,039.50 |
| 4 Hours/day | $2,229.06 | 273.08 | $1,136.01 |
| 7 Hours/day | $3,900.85 | 477.89 | $1,988.02 |
| 10 Hours/day | $5,572.65 | 682.70 | $2,840.03 |

## Office



*Above center and right, respectively, we see the before and after lighting in the village corp. office*

| **Materials Installed** | **Quantity** |
|---|---|
| 2-lamp electronic ballast, (2) 25 watt T8 lamps | 3 |
| 3-lamp electronic ballast, (2) 25 watt T8 lamps | 4 |
| 4-lamp electronic ballast, (3) 25 watt T8 lamps | 4 |
| CFL-23 W | 1 |

- Pre-retrofit energy use: 1659 watts
- Post-retrofit energy use: 669 watts
- Energy savings projection: 990 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 | $602.61 | 73.83 | $307.11 |
| 7 Hours/day | $1,054.57 | 129.19 | $537.45 |
| 10 Hours/day | $1,506.53 | 184.56 | $767.79 |
| 1800 Hours/year (Est.) | $1,084.70 | 132.89 | $552.81 |

## Store



| **Materials Installed** | **Quantity** |
|---|---|
| 2-lamp electronic ballast, (2) 25 watt T8 lamps | 1 |
| 4-lamp electronic ballast, (4) 25 watt T8 lamps | 49 |

- Pre-retrofit energy use: 7128 watts
- Post-retrofit energy use: 4456 watts
- Energy savings projection: 2672 watts
- Pre-retrofit to post retrofit energy reduction: 37%
- Estimated annual savings:

| Hours Per Day / 250 Days Per Year | Electrical Savings | Comparative Avoided Diesel Use (gal) | Comparative Avoided Diesel Costs |
|---|---|---|---|
| 4 Hours/day | $1,626.45 | 199.25 | $828.90 |
| 7 Hours/day | $2,846.28 | 348.70 | $1,450.57 |
| 10 Hours/day | $4,066.12 | 498.14 | $2,072.24 |
| 3000 Hours/year (Est.) | $4,879.34 | 597.76 | $2,486.69 |

# Bering Straits School District Owned Buildings



3 buildings owned by the Bering Straits School District and 12 teacher housing units received energy efficient lighting upgrades as follows:

Tukurngailnguq School Main Building, Portable Classroom, Utility Building, 5-Plex Teacher Housing, Tri-Plex, 4-Plex Teacher Housing, School Gym

- Lighting upgrades completed in: January 2010
- Retrofitted 749 light fixtures with electronic ballasts & T8 lamps
- Installed 209 compact fluorescent light bulbs
- Installed 15 T5 linear fluorescent fixtures
- Post-retrofit energy use for all lighting: 59.98 Kilowatts
- Energy savings projection: 42.43 Kilowatts
- Pre-retrofit to post retrofit energy reduction: 41%
- Estimated Annual Savings:

| Hours Per Day / 250 Days Per Year | Electrical Savings | Comparative Avoided Diesel Use (gal) | Comparative Avoided Diesel Costs |
|---|---|---|---|
| Locally Estimated | $74,856.50 | 9170.60 | $38,149.70 |
| 4 Hours/day | $25,827.70 | 3164.13 | $13,162.70 |
| 7 Hours/day | $45,198.50 | 5537.23 | $23,034.80 |
| 10 Hours/day | $64,569.30 | 7910.33 | $32,906.90 |

In-kind Labor: Bering Straits School District generously provided all maintenance staff labor in-kind to the grant to complete school facility and teacher housing lighting retrofits - resulting in substantial direct cost savings to the grants.

**Additional Energy Efficiency Measures:**

- BSSD Boiler specialists Ron Rodriguez and Calvin Haugen installed two new EK3 low-mass boilers in the BSSD utility building. These boilers supply heat for the utility building, six teacher housing units and the heating loops for teacher housing domestic water. The new boilers replace a bank of three, decades-old Hydrotherm cast iron boilers. Fuel savings is expected to range between 30% and 40% over the former boilers.

## Stebbins/Tukurngailnguq School Main Building



| Materials Installed | Quantity |
|---|---|
| 2-lamp electronic ballast, (2) 25 watt T8 lamps | 148 |
| 3-lamp electronic ballast, (2) 32 watt T8 lamps | 7 |
| 3-lamp electronic ballast, (3) 32 watt T8 lamps | 15 |
| 3-lamp fixture, (2) 2-lamp electronic ballasts (3) 25 | 361 |
| 4-lamp electronic ballast, (3) 25 watt T8 lamps | 19 |
| 4-lamp electronic ballast, (4) 25 watt T8 lamps | 28 |
| 8 ft fixture, 2 lamp electronic ballast, (2) 59 watt T8 | 34 |
| CFL-20 W | 2 |
| CFL-27 W | 16 |

- Pre-retrofit energy use: 65820 watts
- Post-retrofit energy use: 43034 watts
- Energy savings projection: 22786 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 | $13,869.80 | 1699.18 | $7,068.59 |
| 7 Hours/day | $24,272.20 | 2973.56 | $12,370.00 |
| 10 Hours/day | $34,674.60 | 4247.95 | $17,671.40 |
| 4050 Hours/year (Est.) | $56,172.80 | 6881.68 | $28,627.70 |

## Portable Classroom


| Materials Installed | Quantity |
|---|---|
| 4-lamp electronic ballast, (4) 25 watt T8 lamps | 32 |

- Pre-retrofit energy use: 4608 watts
- Post-retrofit energy use: 2880 watts
- Energy savings projection: 1728 watts
- Pre-retrofit to post retrofit energy reduction: 38%
- Estimated annual savings:

| Hours Per Day / 250 Days Per Year | Electrical Savings | Comparative Avoided Diesel Use (gal) | Comparative Avoided Diesel Costs |
|---|---|---|---|
| 4 Hours/day | $1,051.83 | 128.86 | $536.05 |
| 7 Hours/day | $1,840.71 | 225.50 | $938.09 |
| 10 Hours/day | $2,629.58 | 322.15 | $1,340.13 |
| 1500 Hours/year (Est.) | $1,577.75 | 193.29 | $804.08 |

## Utility Building



| Materials Installed | Quantity |
|---|---|
| 2-lamp electronic ballast, (2) 25 watt T8 lamps | 14 |
| CFL-27 W | 12 |

- Pre-retrofit energy use: 2208 watts
- Post-retrofit energy use: 968 watts
- Energy savings projection: 1240 watts
- Pre-retrofit to post retrofit energy reduction: 56%
- Estimated annual savings:

| Hours Per Day / 250 Days Per Year | Electrical Savings | Comparative Avoided Diesel Use (gal) | Comparative Avoided Diesel Costs |
|---|---|---|---|
| 4 Hours/day | $754.79 | 92.47 | $384.67 |
| 7 Hours/day | $1,320.88 | 161.82 | $673.17 |
| 10 Hours/day | $1,886.97 | 231.17 | $961.67 |
| 1800 Hours/year (Est.) | $1,358.62 | 166.44 | $692.40 |

## 5-Plex Teacher Housing



| Materials Installed | Quantity |
|---|---|
| 2-lamp electronic ballast, (2) 25 watt T8 lamps | 66 |
| CFL-14 W | 7 |
| CFL-20 W | 9 |
| CFL-23 W | 17 |
| CFL-27 W | 20 |

- Pre-retrofit energy use: 11773 watts
- Post-retrofit energy use: 4245 watts
- Energy savings projection: 7528 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 | $4,582.29 | 561.37 | $2,335.31 |
| 7 Hours/day | $8,019.01 | 982.40 | $4,086.79 |
| 10 Hours/day | $11,455.7 | 1403.43 | $5,838.27 |
| 1500 Hours/year (Est.) | $6,873.44 | 842.06 | $3,502.96 |

## Tri-Plex Teacher Housing

| Materials Installed | Quantity |
|---|---|
| CFL-14 W | 11 |
| CFL-20 W | 40 |
| CFL-23 W | 18 |
| CFL-27 W | 4 |

- Pre-retrofit energy use: 4590 watts
- Post-retrofit energy use: 1476 watts
- Energy savings projection: 3114 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 |
|---|---|---|---|
| 4 Hours/day | $1,895.49 | 232.21 | $966.01 |
| 7 Hours/day | $3,317.11 | 406.38 | $1,690.52 |
| 10 Hours/day | $4,738.73 | 580.54 | $2,415.03 |
| 1500 Hours/year (Est.) | $2,843.24 | 348.32 | $1,449.02 |

## 4-Plex Teacher Housing

| Materials Installed | Quantity |
|---|---|
| 2 ft fixture, 2-lamp electronic ballast, (2) 17 watt T8 lamps | 4 |
| 2-lamp electronic ballast, (2) 25 watt T8 lamps | 4 |
| 3-lamp electronic ballast, (3) 25 watt T8 lamps | 3 |
| CFL-11 W | 3 |
| CFL-14 W | 11 |
| CFL-20 W | 9 |
| CFL-23 W | 29 |
| CFL-27 W | 1 |

- Pre-retrofit energy use: 4210 watts
- Post-retrofit energy use: 1595 watts
- Energy savings projection: 2615 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 |
|---|---|---|---|
| 4 Hours/day | $1,591.75 | 195.00 | $811.22 |
| 7 Hours/day | $2,785.56 | 341.26 | $1,419.63 |
| 10 Hours/day | $3,979.38 | 487.51 | $2,028.04 |
| 1500 Hours/year (Est.) | $2,387.63 | 292.51 | $1,216.82 |

## School Gym

Former HPS lighting with very poor color rendering and low light levels (CRI of likely around 30 – 40)

New T5s with their CRI of 85 and improved light levels

| **Materials Installed** | **Quantity** |
|---|---|
| 8 ft fixture, 2 lamp electronic ballast, (2) 59 watt T8 lamps | 20 |
| T5 fixture, electronic ballast, (4) 54 watt T5 HO | 15 |
| • Pre-retrofit energy use: | 9200 watts |
| • Post-retrofit energy use: | 5780 watts |
| • Energy savings projection: | 3420 watts |
| • Pre-retrofit to post retrofit energy reduction: | 37% |

• Estimated annual savings:

| Hours Per Day / 250 Days Per Year | Electrical Savings | Comparative Avoided Diesel Use (gal) | Comparative Avoided Diesel Costs |
|---|---|---|---|
| 4 Hours/day | $2,081.75 | 255.03 | $1,060.94 |
| 7 Hours/day | $3,643.07 | 446.31 | $1,856.64 |
| 10 Hours/day | $5,204.39 | 637.58 | $2,652.35 |
| 1750 Hours/year (Est.) | $3,643.07 | 446.31 | $1,856.64 |

The Stebbins gym lighting was installed entirely with in-kind school district funding for certified electrician and local labor support. This includes travel, per diem and fringe expense - bringing substantial cost savings to the grant. Along with 15 existing HPS fixtures, 20, 2-lamp eight-foot T8 fixtures were also retrofitted resulting in a 37% overall savings for the gym lighting. The 8-foot HO ballasts for the retrofit were also purchased in-kind by BSSD.

ABSN T5 Lighting plans are designed to increase the average light levels throughout the area when all fixtures are switched on - in comparison with former existing light output. Existing switching controls are normally retained - allowing users to choose the appropriate number of light fixtures / rows of light fixtures needed for various use patterns. In many cases school staff will choose not to use all fixtures available, thereby achieving more electrical savings than what is shown above. Considering light quality, ABSN T5 lighting plans employ 54-watt, high output T5 lamps with a color-rendering index (CRI) of 85. Existing light fixtures in rural high ceiling areas typically have a CRI ranging from 30 to 70. With the T5 retrofits, the boost in CRI greatly improves light quality – resulting in objects appearing much closer to their true color as seen under sunlight. This increased light quality can result in less light needed to illuminate a given space. Another advantage appreciated by building owners is the instant-on function of T5 lighting compared with long waiting periods for older HID fixtures to come on. With the waiting period eliminated, building owners have indicated they are more likely to keep lighting off until needed.

**These T5 and 8-foot, HO T8 retrofits were completed in Feb, 2010.**

| **Stebbins Gym** | Length (feet) | Width (feet) | Ceiling Height (feet) | Type of Existing Fixture | # of Existing Fixtures | Existing Fixture Wattage | **Total Existing Wattage** | Existing Foot Candles | New Foot-Candles | # of New Fixtures | New fixtures | New Fixture Wattage | **Total New Wattage** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 18 | HPS 150 watt | | 160 | **0** | 35 | 52 | | T-5 2 lamps | 114 | **0** |
| Color shade of walls | | | | HPS 250 watt | 16 | 260 | **4,160** | | | | T-5 3 lamps | 171 | **0** |
| Color shade of floor | | | | Multi-Vapor 400 watt | | 415 | **0** | | | 15 | T-5 4 lamps | 228 | **3420** |
| | | | | 2-lamp, 8' T12 H.O | 24 | 210 | **5,040** | | | 20 | 59w, 2-lamp, 8' T8 H.O | 118 | **2360** |
| | | | | | Total Existing Watts | | 9,200 | | | | Total New Watts | | 5780 |

| **Percent Savings Pre to Post Retrofit:** | **37.17%** |
|---|---|

**Savings & Payback Calculation for Gym:**

1750 New watts / old watts

Assume 1750 hrs / year for 250 days/year of use

neg 1 (New watts / Old watts x 100 - 100) / 100

Full cost of electricity: $ 0.61 /kWh

Watts of existing lighting: 9,200

New wattage for T5 fixtures: 5,780

**Calculation: (Watts) x (hrs/year) / (1000w/kw) x (cost of electricity) = (cost / year)**

Existing Cost: $ 9,800

Retrofitted Cost: $ 6,157

**Annual Savings: $** $ 3,643

| | |
|---|---|
| T5 Materials costs | $ 4,888.00 |
| T5 shipping costs | $ 295.71 |

Material & shipping cost of Gym retrofit: $5,183.71

**Simple Payback:** Materials cost / annual savings = **1.42** years (for retrofit to pay for itself in materials)

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

## Utility Building – Former BIA School.

BSSD Utility Building for heating teacher housing units

Former oil-hog cast iron boilers from the late 20th century - 1960s. Existing Boilers had firing rates of around 2 gallons of oil per hour of boiler run time. Typically two boilers would run to keep up with heating loads during winter months.

At the request of the Bering Straits School District, ABSN selected a new heating system in the Stebbins Old Utility building, 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. The new boilers supply heat to six teacher-housing units and a school utility building. The new heating system replaces three, over-sized, 30 to 40-year-old cast iron boilers that had firing rates of around 2 gallons per minute of boiler run time. The new EK3 boilers burn up to 1.3 gallons of fuel per hour of run time. The new system is designed for one boiler to handle the heating load for much of the year.

During phase 1 and 2 of the VEUEEM grants ABSN partnered with Bering Straits School District to complete installation of 9 Energy Kinetics, Low-Mass Boilers at four BSSD sites. So far fuel savings from these retrofits have been substantial 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 for Stebbins teacher housing was a clear choice.

New EK3 boilers heat this 5-plex teacher housing building in Stebbins

BSSD itinerant boilerman Ron Rodriguez installs new EK boilers in Stebbins, Summer, 2009

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

## EK boiler notes from the field:

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."*

So far 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. The Bering Straits School District only tracks fuel use by the site and not by the building, which makes it prohibitive to acquire actual before and after fuel use for these boiler replacements.

## 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 un-insulated 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.

**Stebbins, 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, & review Of materials | | 4 | $ 20.00 | $ 80.00 | (Number of entities x 1 hour each) |
| | | | | | |
| Staff time for teleconference (TC/IRA) | | 2 | $ 20.00 | $ 40.00 | 2 Staff members attended |
| Staff time for Attending telecon (City) | | 2 | $ 20.00 | $ 40.00 | 2 Staff members attended |
| Staff time for Attending telecon (Corp) | | 1 | $ 20.00 | $ 20.00 | 1 Staff member attended |
| Staff time for teleconference (School) | | 4 | $ 20.00 | $ 80.00 | 4 Staff members attended |
| | | | | | |
| Maint. Staff time on assessments | 3/6/2009 | 3 | $15 | $ 45.00 | 1st site visit |
| **Conservative village office administrative percentage of total project cost less ABSN Admin %.** Total project cost = $83,000/village - (our admin percentage , (around 12%) Approx: $9,960) = $73,040 x 5.5% = $4,017 (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 | | | $ 4,017.00 | Each time we call, email, or fax a village entity, someone receives the communication, reviews and/or forwards the information, follows-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 for recycling, request a labor reimbursement agreement, or invoice etc. Village expenses for phone charges, copying and fax costs, office supplies, etc. are part of this amount. |
| Lodging for ABSN Field Managers - 1st assessment site visit | March 2-7, 2009 | | | $ 215.00 | They charged us $160 for five nights when the usual charge is $75 per night. |
| Transportation and fuel costs - 1st assessment site-visit | March 2-7, 2009 | | | $ 300 | IRA contributed 4-wheeler for the week |
| Lodging for ABSN Field Managers - 2nd site visit | 11/2/2009 | | | $1,500.00 | $100/night/person for five nights, three people; Stebbins school. Offered without asking. |
| | | | | | |
| City of Stebbins Fringe Contribution | 12/9/2009 | | | $ 420.00 | Overtime Etc. Peter Martin, Jeremy Pete, Calvin Tom |
| School - Worker's Time on T8s | 11/2-7/2009 | 480 | $15 | $ 7200.00 | From hour logs only 11/2-7/08 on T8 upgrades |
| School - Worker's Time on Gym T5s | Jan & Feb 2010 | | | $ 7,000.00 | Conservative value of all SD labor including travel and fringe. This is for replacing 15 pendent and 20 2-lamp HO fixtures. |
| School materials costs for new 277 volt HO 8-foot ballasts | Feb, 2010 | | | $ 1,060.00 | BSSD purchased 277 volt ballasts for the 8-foot HOs |
| School, BSSD install costs for 2 low-mass boilers | July, 2009 | 156 | $56.21 | $ 8,768.96 | Utility Bldg / Teacher Housing Low-mass boiler installation. |
| Tribal Teen Center Work | Dec 09-Jan 10 | 46 | $15 | $ 690.00 | Work done on the Teen Center after we left |
| City of Stebbins Office Building | January '10 | 30 | $15 | $ 450.00 | Work on 8' lamps in the Office / Community Center |
| | TOTAL | | | $31,926.00 | |

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 Stebbins to deliver 38% more energy savings measures beyond the original grant funding.