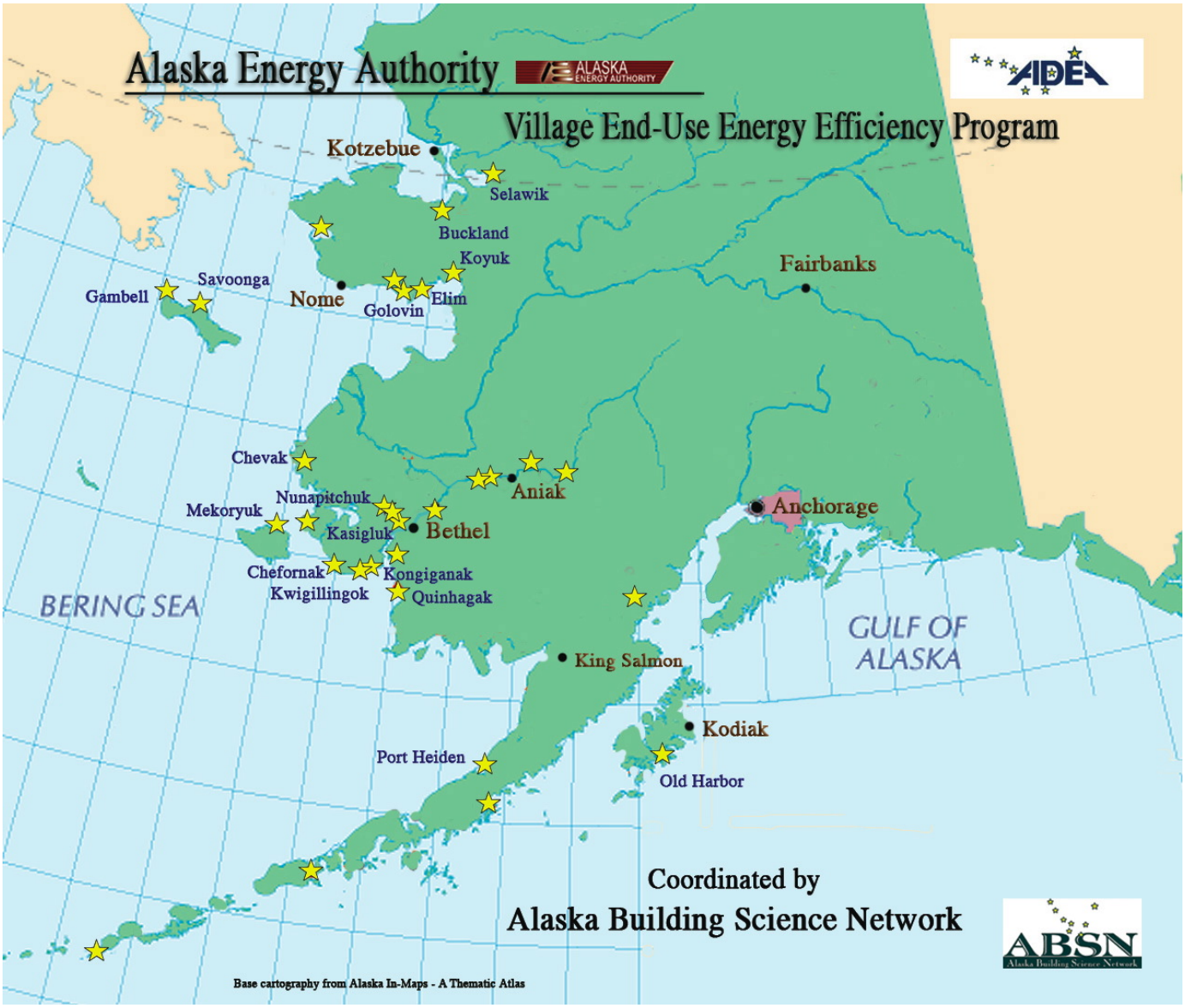
# FINAL REPORT

## AEA Grant # 2195234




## West Region
## 2005 – 2007

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May 2007

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# Village End Use Energy Efficiency Measures Program '05 – '06

**AEA Grant # 2195234 Administered by Alaska Building Science Network**

## Final Report - Executive Summary: West Region

- By ABSN Project Manager Geoff Butler, May, 2007

From Jan. 2005 – Jan. 2007 the following 8 rural Alaska villages received energy efficiency upgrades to community buildings:

**Chefornak, Chevak, Kasigluk, Kongiganak, Kwigillingok, Mekoryuk, Nunapitchuk, Quinhagak**

Total program grant funds: $298,000 Grant funds averaged per village: $37,250

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The goal of these grant projects was to facilitate energy efficiency upgrades to community buildings that would deliver the greatest energy savings at the fastest payback on grant funds. Energy efficient lighting upgrades were the first measures undertaken. ABSN provided project development, coordination, training, technical assistance, materials and logistical support to facilitate these projects. To advance technology transfer and provide rural employment and skills training, we partnered directly with 31 rural village entities region-wide and provided lighting retrofit training to approximately 50 local maintenance staff who completed lighting and other energy upgrades in their buildings. Region-wide, 88 community buildings and 62 teacher-housing units operated by rural school districts received energy efficiency improvements.

Original energy audits for these projects estimated light fixture (replacement) at a cost of $355 per fixture. Within this scenario, the 1,603 linear fluorescent light fixtures retrofitted region-wide, alone, would have cost $569,065 to complete! With ABSN's methods, when we deduct materials costs of heating measures, T5 and CFL lighting materials grant-wide, our cost for linear fluorescent retrofits is $138 per fixture. ABSN's approach of partnering with local city, tribal governments, village corporations and rural school districts, coupled with the substantial in-kind contributions arising from these partnerships - facilitated the lighting upgrades and allowed us to pursue many additional energy savings measures as well as provide skills training and employment for rural maintenance staff, all at a fraction of original audit estimates for these projects.

### Primary Accomplishments of this Grant Region-wide:

- 1,603 linear fluorescent lighting retrofits
- 1,052 Compact fluorescent light bulb installations
- Nine T5 light fixture upgrades in school gym and multi-purpose facilities
- $ 30,651 grant funds spent on additional energy efficiency measures beyond lighting
  - 2 low-mass boiler installations (partial in-kind support)
  - 2 boilers received energy efficiency cleaning, tuning and outdoor temp controls
  - 21 programmable thermostats installed
- 19 rural maintenance staff received comprehensive boiler energy efficiency and maintenance training (classroom hours provided in-kind by ABSN through AHFC funding).
- Acquired $ 77,057 in matching grant resources – extending the capacity of AEA grant funding by 25.8%
- **All within the total budget of $298,000**

## Grant funds payback and fuel saving measures

Savings from heating measures and corresponding grant expenditures are not included in payback calculations. Our region-wide payback estimate of 2.43 years* on total grant funds includes spending for all lighting and heating measures, but it does not account for any savings from the heating measures. In other words, our payback figures absorb the full cost of fuel savings measures, but do not benefit from any savings resulting from them. The heating measures will result in measurable fuel savings, which we currently do not have data to calculate. If it was possible to calculate fuel savings from the heating measures we are confident it would measurably reduce payback time on total grant funds.

## Region-Wide Lighting Upgrade Summary

**For all linear fluorescent, compact fluorescent bulb and T5 lighting retrofits and installations**: (for 8 villages compared with 9 villages in the NW/SW regions)

- Pre-retrofit energy use for all lighting: 289.07 kW
- Post-retrofit energy use for all lighting: 146.22 kW
- Energy savings from all lighting upgrades: 142.85 kW
- **Pre-retrofit to post retrofit energy reduction: 49 %**

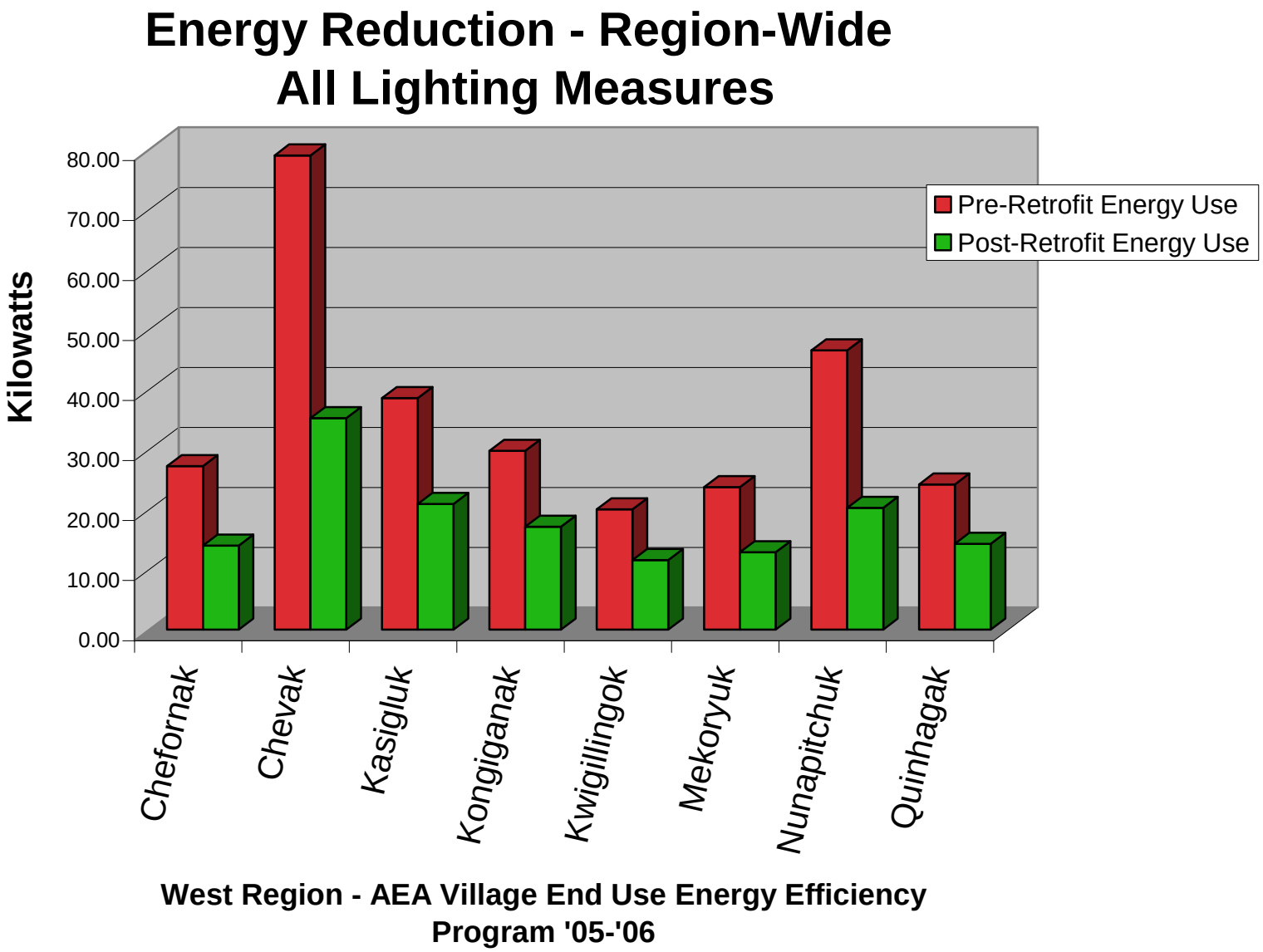
- **Estimated Annual Savings Range:**

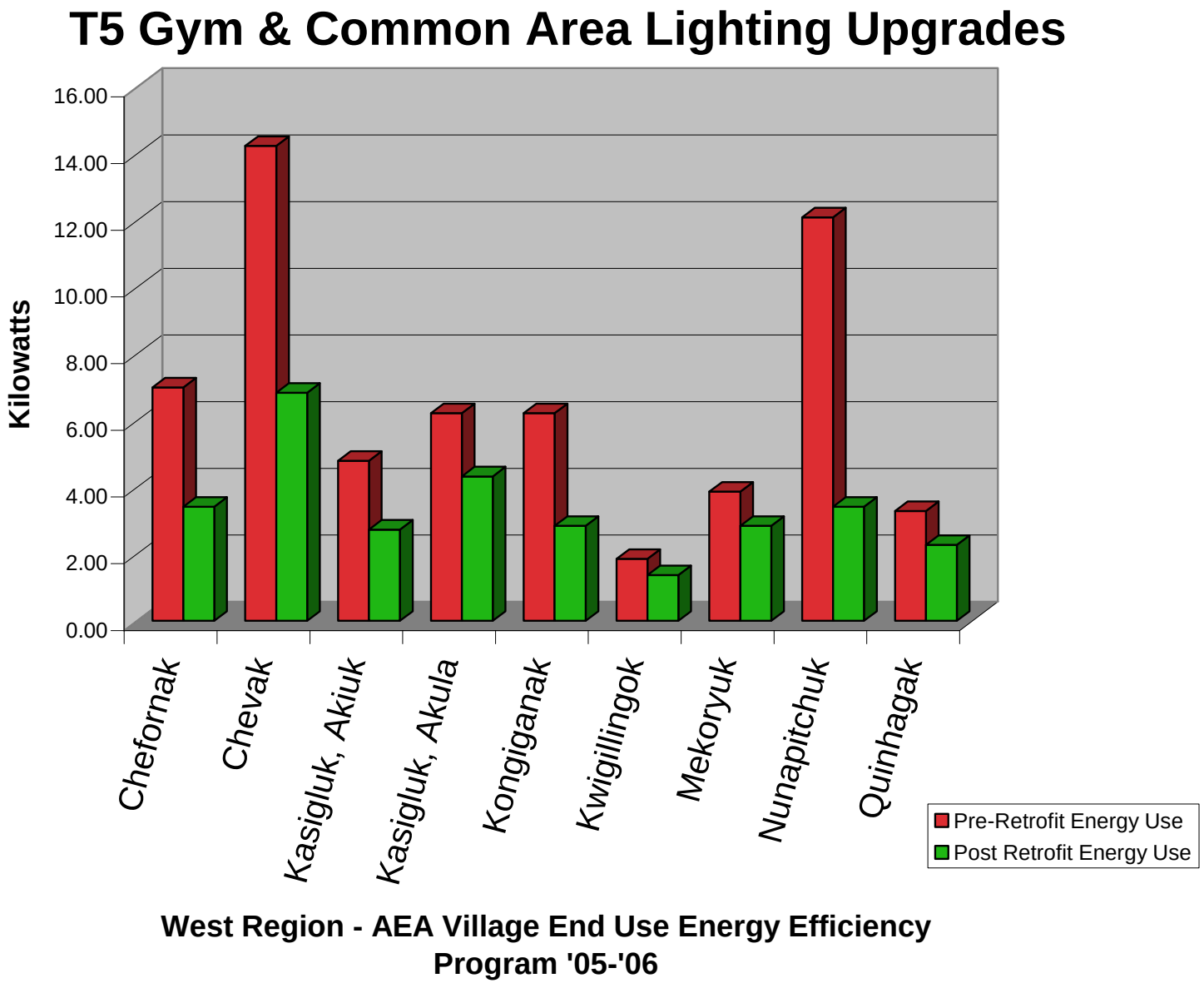
| Hours Per Day / 250 Days Per Year | Electrical Savings | Avoided Diesel Use (gallons) | Avoided Diesel Costs | Payback Est. (yrs) |
|---|---|---|---|---|
| 4 Hours | $ 70,125 | 10,963 | $ 22,035 | 4.25 |
| 7 Hours | $ 122,718 | 19,185 | $ 38,562 | 2.43 |
| 10 Hours | $ 175,311 | 27,408 | $ 55,088 | 1.70 |

- Total grant funds for all energy efficiency measures: $ 298,000
- Simple mean payback (All grant funds, but accounting for lighting savings only) 2.43 Years

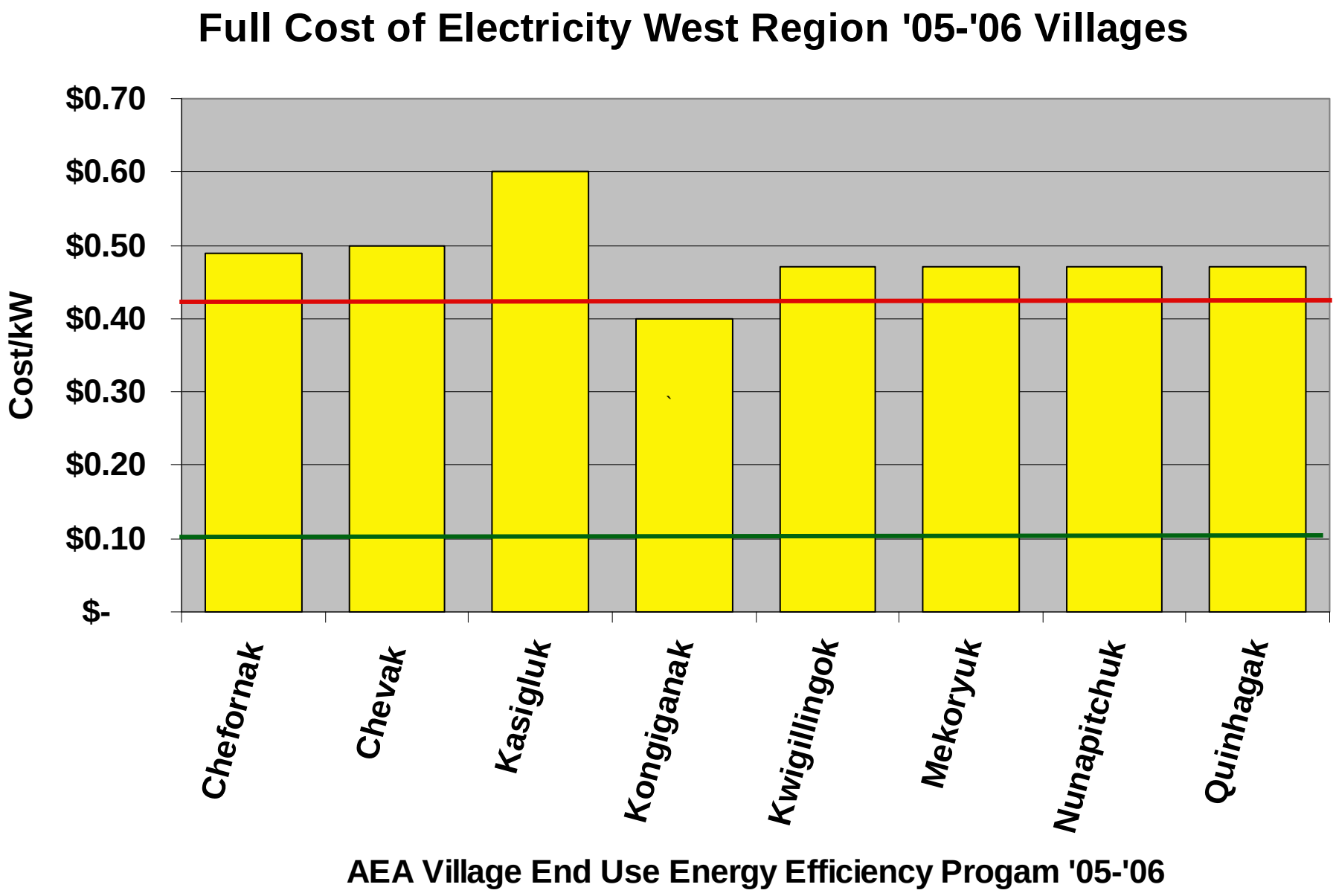
## Additional Energy Efficiency Measures **(Region-wide grant funding: $30,696)**

After completing lighting measures with good payback, we dedicated remaining grant funds to fuel saving measures and heating system energy efficiency training for village maintenance staff. For our regional boiler training in Bethel and our village boiler trainings, ABSN provided $2,100 for each of 2 trainings, or $4,200 total in-kind contributions region-wide. Our organizational focus in energy efficiency and northern building science places us in the unique position of being able to dovetail similar objectives from different projects providing a win-win benefit to the VEUEEM grants. These and many other in-kind resources enabled us to go far beyond the originally conceived scope of work and greatly expand the capacity of these energy efficiency projects.


Energy Reduction - Region-Wide
All Lighting Measures
Kilowatts
80.00
70.00
60.00
50.00
40.00
30.00
20.00
10.00
0.00
Pre-Retrofit Energy Use
Post-Retrofit Energy Use
Chefornak
Chevak
Kasigluk
Kongiganak
Kwigillingok
Mekoryuk
Nunapitchuk
Quinhagak
West Region - AEA Village End Use Energy Efficiency
Program '05-'06




**West Region - AEA Village End Use Energy Efficiency Program '05-'06**


Full Cost of Electricity West Region '05-'06 Villages
$0.70
$0.60
$0.50
$0.40
$0.30
$0.20
$0.10
$-
Cost/kW
Chefornak
Chevak
Kasigluk
Kongiganak
Kwigillingok
Mekoryuk
Nunapitchuk
Quinhagak
AEA Village End Use Energy Efficiency Progam '05-'06

## AEA, VEUEEM - Summary of Program Results for '05 - '06 West Grant Activities

**Building / Lighting Use Estimates of 7 hrs / day, 250 days/year:**

| Annual Savings (kWh) | Electricity Cost per kWh (without PCE) | Annual Village-wide savings (dollars) | Utility Fuel Usage (kWh/gal) from '05 AEA PCE Report | Annual Avoided Fuel Oil (gallons) | Diesel Cost per gallon (from '05 AEA, PCE Report) | Annual Avoided Fuel Costs (dollars) | Total Project Costs: All grant delivery, labor, materials, shipping and, disposal costs | Simple Payback (yrs) | # of Rural Entities Worked With | # of community Buildings Worked In | # of Teacher Housing Units Worked In | Est. # of Maintenance Staff Worked With |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | |
| 23,230 | $ 0.49 | $ 11,382 | 12.28 | 1,892 | $ 2.41 | $ 4,559 | $ 37,250 | 3.27 | 4 | 11 | 4 | 5 |
| 76,704 | $ 0.50 | $ 38,352 | 12.77 | 6,007 | $ 1.83 | $10,992 | $ 37,250 | 0.97 | 4 | 14 | 21 | 8 |
| 30,863 | $ 0.60 | $ 18,518 | 13.71 | 2,252 | $ 1.83 | $ 4,120 | $ 37,250 | 2.01 | 3 | 14 | 7 | 8 |
| 22,166 | $ 0.40 | $ 8,866 | 12.42 | 1,785 | $ 2.42 | $ 4,319 | $ 37,250 | 4.20 | 4 | 12 | 7 | 5 |
| 14,737 | $ 0.47 | $ 6,926 | 13.25 | 1,112 | $ 2.28 | $ 2,536 | $ 37,250 | 5.38 | 4 | 10 | 5 | 5 |
| 18,998 | $ 0.47 | $ 8,929 | 13.96 | 1,361 | $ 1.83 | $ 2,490 | $ 37,250 | 4.17 | 4 | 8 | 4 | 5 |
| 45,959 | $ 0.47 | $ 21,600 | 13.19 | 3,485 | $ 2.06 | $ 7,180 | $ 37,250 | 1.72 | 4 | 12 | 10 | 8 |
| 17,327 | $ 0.47 | $ 8,144 | 13.41 | 1,292 | $ 1.83 | $ 2,365 | $ 37,250 | 4.57 | 4 | 7 | 4 | 6 |
| 249,982 | | **$122,718** | | 19,185 | $ 16.49 | $38,562 | $ 298,000 | | 31 | 88 | 62 | 50 |

| | | |
|---|---|---|
| | **$122,718** | Projected Annual Savings (dollars) for all 8, '05-'06 - West villages |
| | **$298,000** | Total Grant Funds For All 8, '05-'06 West villages |
| **Simple Payback:** | **2.43** | years to payback entire grant (building use time: 7 hrs/day & 250 hrs/yr) |
| | $ 38,235 | **Total Project Cost for NW/SW Villages** |
| | $ 37,250 | **Total Project Cost for West Villages** |

## AEA, VEUEEM - Summary of Program Results for '05 - '06 West Grant Activities

**Building / Lighting Use Estimates of 7 hrs / day, 250 days/year:**

| # of 4' Fluorescent light Fixtures Retrofitted | # of CFLS Installed | # of Gym / Multi-purpose Bldgs Upgraded with T5s | Additional Measures Beyond Lighting (Materials and Labor Cost) | 9, Low-Mass Boiler training and installation for SD Staff | 3 Boilers cleaned, tuned and retro'd with outside temp controls | Provided energy efficiency boiler training for 19 village maint staff | Installed 21 Programmable T-Stats | Total In Kind Contributions from all Village Entities |
|---|---|---|---|---|---|---|---|---|
| 149 | 35 | 1 | $ 5,570 | 2 | | 3 | | $ 7,921 |
| 372 | 446 | 1 | $ 275 | | | | 6 | $ 10,805 |
| 184 | 79 | 2 | $ 1,989 | | | 1 | 2 | $ 16,487 |
| 218 | 71 | 1 | $ 4,954 | | 1 | 2 | 5 | $ 8,529 |
| 152 | 39 | 1 | $ 4,954 | | | 1 | | $ 7,571 |
| 129 | 136 | 1 | $ 5,144 | | | 1 | 3 | $ 9,255 |
| 251 | 168 | 1 | $ 2,432 | | 1 | 9 | 5 | $ 9,081 |
| 148 | 78 | 1 | $ 5,377 | | | 2 | | $ 7,408 |
| 1603 | 1052 | 9 | $ 30,696 | 2 | 2 | 19 | 21 | $ 77,057 |

| | | | | | |
|---|---|---|---|---|---|
| $ 569,065 | USKH Original estimates to replace 3,248 fixtures. | Bethel was 7 maint staff total | $ 76,884 | 25.80% | |
| $ 12,421 | USKH estimates total cost to REPLACE 35, 2-lamp T8 light fixtures in Kong, school, line 33 of their detailed costs. | | | | |
| $ 355 | per fixture replacement | 2 maint staff to be trained as part of LKSD MOA w/ Low-mass boiler project. | | | |
| $ 23,081 | USKH estimates total cost to REPLACE 65 T8 light fixtures in SAVOONGA, line 25 of their detailed costs. | | | | |
| $ 355 | per fixture replacement | | | | |
| $ 137.96 | ABSN averaged cost per linear fluorescent fixture: | | | | |

Total West grant funds - heating measures cost - T5 materials and shipping costs - materials cost of CFLs (1,052 x $2), all divided by number of linear fluorescent fixtures retrofitted region wide (1,603).

## AEA, VEUEEM - Summary of Program Results for '05 - '06 West Grant Activities

**Building / Lighting Use Estimates of 7 hrs / day, 250 days/year:**

| | Pre-retrofit Energy Use (watts) | Pre-retrofit Energy Use (Kilowatts) | Post-retrofit Energy Use (watts) | Post-retrofit Energy Use (Kilowatts) | Percent Wattage Reduction, Pre to Post retrofit | Energy Use Savings (watts) | Pre-Retrofit (kW) | Post-Retrofit (kW) | Energy Use Savings (kW) | Lighting / Building Use (hours/day) | Lighting / Building Use (days/year) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | |
| **Chefornak** | 27,248 | 27.25 | 13,974 | 13.97 | 49% | 13,274 | 27.25 | 13.97 | 13.27 | **7** | 250 |
| **Chevak** | 79,043 | 79.04 | 35,212 | 35.21 | 55% | 43,831 | 79.04 | 35.21 | 43.83 | **7** | 250 |
| **Kasigluk** | 38,572 | 38.57 | 20,936 | 20.94 | 46% | 17,636 | 38.57 | 20.94 | 17.64 | **7** | 250 |
| **Kongiganak** | 29,783 | 29.78 | 17,117 | 17.12 | 43% | 12,666 | 29.78 | 17.12 | 12.67 | **7** | 250 |
| **Kwigillingok** | 20,011 | 20.01 | 11,590 | 11.59 | 42% | 8,421 | 20.01 | 11.59 | 8.42 | **7** | 250 |
| **Mekoryuk** | 23,711 | 23.71 | 12,855 | 12.86 | 46% | 10,856 | 23.71 | 12.86 | 10.86 | **7** | 250 |
| **Nunapitchuk** | 46,520 | 46.52 | 20,258 | 20.26 | 56% | 26,262 | 46.52 | 20.26 | 26.26 | **7** | 250 |
| **Quinhagak** | 24,180 | 24.18 | 14,279 | 14.28 | 41% | 9,901 | 24.18 | 14.28 | 9.90 | **7** | 250 |
| TOTALS | 289,068 | 289.07 | 146,221 | 146.22 | 49% | 142,847 | 289 | 146 | 143 | | |

## Lighting Strategy and Savings Estimates

During initial site visits we verified lighting assessments including quantity, locations, and wattage of existing fixtures. From initial assessments and site visits we designed lighting plans and applied various lamp and ballast combinations along with de-lamping strategies to achieve a balance of optimal energy efficiency and good light levels for the activity at hand. From initial assessments and our lighting retrofit plans we determined pre and post energy use by building, village entity, village-wide and region-wide. With a known energy use, we could estimate energy and cost savings based on a predicted building and lighting use pattern. Since this information is extremely variable and would require separate grant funds to determine individual building use for these projects, we are reporting our saving estimates based on 250 days / year use and a 3-tier range of 4, 7, and 10 hours/day. For the purposes of this report we will focus on a mean lighting use of 7 hours/day. This generic use time is intended to average the use pattern of all buildings in our projects. Individual buildings and individual room spaces will have a wide range of use patterns. The actual savings and payback resulting from these projects we feel will fall somewhere within our range of 4 to 10 hours a day.

When considering savings estimates, it should be noted that for all practical purposes the only thing we can determine with reasonable accuracy is pre and post energy use. When it comes to savings, there are other questions that arise including: Who actually sees the savings? If the energy use is reduced in a village, the required operating costs of a village utility must still be met. Utility rates will continue to increase to meet operating costs. Where savings occur, some will be to the State of Alaska in reduced PCE payments, and some will be to the electricity rate-payer. There is also the question of load verses capacity of a given generation system. In some cases where a generation system's capacity is over-extended, dropping the electrical load will be favorable for that utility as they may be spared the costs of generator replacement or overhaul. In other cases, if a system is somewhat oversized for the load already, an additional drop in electrical use may not be favorable to the utility or school. The optimal operating cycle of a given generator will consume a set amount of fuel over time. Reduction in electrical load may not translate directly to how much fuel is burned in a given generator.

Although these factors should be understood, the pressures of ever-increasing fuel costs, coupled with the facts of life in rural Alaska, necessitate the pursuit of energy efficiency programs wherever possible. Also, the trend of improved diesel generation technology, and the ability to tailor power generation levels to match load cycles, means that projects dedicated to overall load reduction are critical. This trend is another practical reason to pursue energy efficiency as an important principle.

We at ABSN are extremely pleased with the results of our work in association with these projects and are happy to be contributing toward energy efficiency cost savings for rural Alaska.

## Savings and Payback Ranges - West Region Villages

| Based on hours of operation: 7 hrs/day for 250 days/year | | | |
|---|---|---|---|
| **Community** | **Annual Savings Projections** | **Total Project Costs** | **Simple Payback (yrs)** |
| Chefornak | $ 11,382 | $ 37,250 | 3.27 |
| Chevak | $ 38,352 | $ 37,250 | 0.97 |
| Kasigluk | $ 18,518 | $ 37,250 | 2.01 |
| Kongiganak | $ 8,866 | $ 37,250 | 4.20 |
| Kwigillingok | $ 6,926 | $ 37,250 | 5.38 |
| Mekoryuk | $ 8,929 | $ 37,250 | 4.17 |
| Nunapitchuk | $ 21,600 | $ 37,250 | 1.72 |
| Quinhagak | $ 8,144 | $ 37,250 | 4.57 |
| **TOTALS:** | **$122,718** | **$ 298,000** | **2.43** |

AEA Village End Use Energy Efficiency Program '05-'06

## Savings and Payback Ranges - West Region Villages

| Based on hours of operation: 4 hrs/day for 250 days/year | | | |
|---|---|---|---|
| **Community** | **Annual Savings Projections** | **Total Project Costs** | **Simple Payback (yrs)** |
| Chefornak | $ 6,504 | $ 37,250 | 5.73 |
| Chevak | $ 21,916 | $ 37,250 | 1.70 |
| Kasigluk | $ 10,582 | $ 37,250 | 3.52 |
| Kongiganak | $ 5,066 | $ 37,250 | 7.35 |
| Kwigillingok | $ 3,958 | $ 37,250 | 9.41 |
| Mekoryuk | $ 5,102 | $ 37,250 | 7.30 |
| Nunapitchuk | $ 12,343 | $ 37,250 | 3.02 |
| Quinhagak | $ 4,653 | $ 37,250 | 8.00 |
| TOTALS: | $70,125 | $ 298,000 | 4.25 |

| Community | Annual Savings Projections | Total Project Costs | Simple Payback (yrs) |
|---|---|---|---|
| Based on hours of operation: 10 hrs/day for 250 days/year | | | |
| Chefornak | $ 16,261 | $ 37,250 | 2.29 |
| Chevak | $ 54,789 | $ 37,250 | 0.68 |
| Kasigluk | $ 26,454 | $ 37,250 | 1.41 |
| Kongiganak | $ 12,666 | $ 37,250 | 2.94 |
| Kwigillingok | $ 9,895 | $ 37,250 | 3.76 |
| Mekoryuk | $ 12,756 | $ 37,250 | 2.92 |
| Nunapitchuk | $ 30,858 | $ 37,250 | 1.21 |
| Quinhagak | $ 11,634 | $ 37,250 | 3.20 |
| TOTALS: | $175,311 | $ 298,000 | 1.70 |

## Notes on Budget and Grant Spending

Our objective has been to spend grant funds evenly between villages to the greatest extent possible. Since the beginning of the grant in January, 2005 expenditures were separated by village, and also by specific budget category. Expenses were entered into individual village budget spreadsheets according to the following categories: Field Management, Project Management, Travel Expenses, Materials, and Village Labor. Each village budget totals $37,250, which is the original total grant amount of $298,000 divided by eight villages. As we got into spending on measures beyond lighting we did our best to choose projects that stayed within the individual village budgets. To adequately cover energy savings measures beyond lighting, left over village budgets within the region were pooled as needed to cover these measures. For example, the materials and labor costs to install two low-mass boilers in Chefornak were averaged and shared between all LKSD villages. It should be noted that all additional energy savings measures were undertaken in villages that showed interest and that provided matching funds for labor or materials to help make projects happen.

The village budget spreadsheets that come with these final reports as appendices are current to the beginning of January, 2007 when new AEA grant funds were added to this grant. Toward the end of the ’05-’06 grant cycle in late 2006, the individual village budgets allowed us to determine where remaining monies could be spent on additional energy saving measures. Between January, 2005 and the end of June, 2007 financial reporting period, all ’05-’06 spending for this grant will have been billed to AEA.

## Disposing and Recycling Old Lamps and Ballasts

ABSN’s goal was to ensure that all old and unused lamps and ballasts were shipped out of the villages to Anchorage for proper disposal and recycling. In cases where the existing 34-watt T-12 lamps were fairly new, village building owners sometimes preferred to keep the materials and pass them along for continued use. In most cases, lamps were at or near their useful lifespan and were no longer putting out optimum light. All fluorescent lamps contain mercury and as such should not be disposed of in landfills. As part of ’05 – ’06 projects, ABSN developed a system of packing and shipping used lamps and old magnetic ballasts from the villages to Total Reclaim Inc. of Anchorage - the largest recycler of fluorescent lamps in the state. From Anchorage the lamps and ballasts travel by container ship to lower 48 recycling facilities. The mercury from lamps is reclaimed, and the ballasts are recycled for their materials.

For shipping used lamps and ballasts from most villages to regional hubs we arranged free back-haul service - generously provided by Alaska Transportation Service (ATS). From the hub communities back to Anchorage, Northern Air Cargo provides backhaul at reduced rates for this program. Used lamps and non-PCB ballasts travel as general freight in properly sealed containers. Used lamps are categorized as non-hazardous universal waste.

Packing used lamps for recycling

A village shipment of used lamps and ballasts

Bring used lamps to the air strip

8ft, T-12 lamps prepared for recycling.

8ft lamp recycling container .

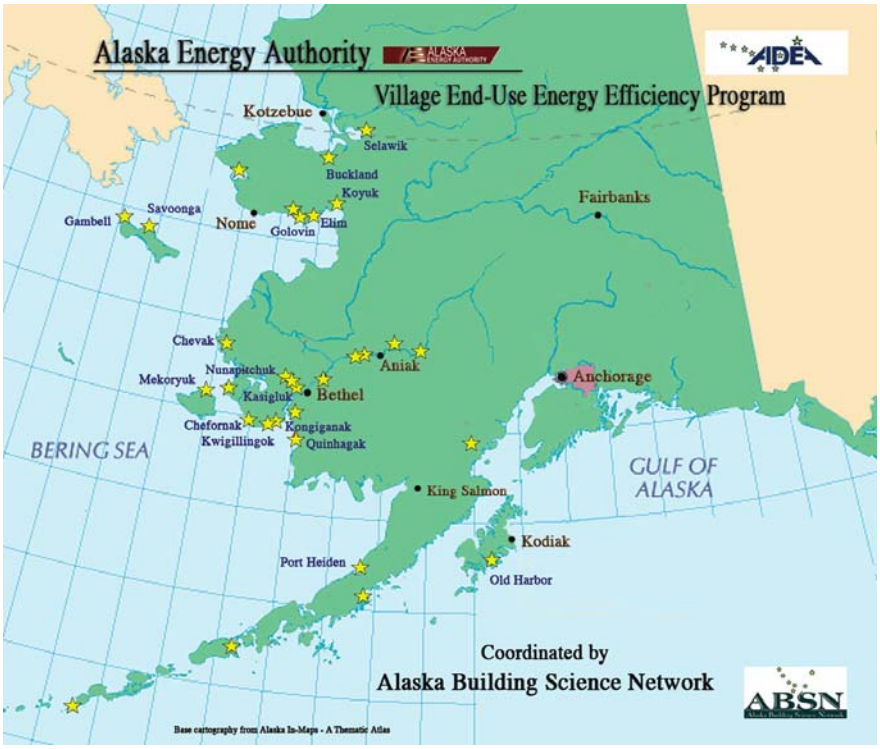
8ft lamps prepared for shipping.

## PCB Ballast Disposal

Ballasts manufactured during or before 1979 are considered to contain PCBs, and are classified hazardous waste. In some villages where PCB ballasts are found, they must be dealt with under OSHA, EPA, and DOT regulations for proper removal and transportation. About half our villages in this region had some PCB ballasts to remove and dispose of in order to complete lighting retrofits in all community buildings. As part of '05 – '06 projects, ABSN developed a PCB ballast removal and disposal method for village maintenance staff within EPA and DOT compliance and approved by Alaska State OSHA office. Proper removal procedures were facilitated by ABSN, with the village building owner and their maintenance staff taking responsibility for proper removal - as the generator of the hazardous waste.

Double checking ballasts for PCBs

DOT approved haz-mat container of PCB ballasts ready for shipment




**The following eight village reports detail lighting and heating measures**

**undertaken in each of our west region villages:**

# ELECTRONIC APPENDICES

## Village End Use Energy Efficiency Measures Program ’05 – ‘06
## West Region Final Reports

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**Electronic appendixes associated with these projects are provided as part of our final reports including:**

- Cover page and Final Report Executive Summary, file name:
  (**Cover_ExecSummary_West_FinalReport05-06.doc**)

- Regional final reporting summary data, charts and calculations spreadsheets:
  (**SummaryFinalReportDataWest_'05-'06.xls**)

- Final reports for each village in a folder titled:
  (**Final_ReportsVEUEEM’05-‘06_West**)

- Pre-Post retrofit spreadsheets for each village, in folder titled:
  (**TallySheets_West_'05-'06Final_Reports**)

- Regional final reporting summary data – By building energy savings calcs, file name:
  **(BldgSummary_Data_West'05-'06.xls)**

- Contact information for all village contacts, file name:
  (**Contacts_West_VEUEEM'05-'06.xls**)

- Budget breakdowns – by village from 12-31-06, file name:
  (**BudgetByVillageWest_'05-'06_FinalReport.xls**)

- Grant comparison memorandum, file name:
  (**Memo_VEUEEM'05-'06_Comparison.doc**)