Kotzebue Electric Association
Solar Thermal Alternative Residential Heating Methods
Quarterly Report
4/20/2012

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Funding

Denali Commission	$127,000
KEA[1] In-Kind	$5,000
CETF[2] In-Kind	$12,000
Total	**$144,000**

Heliodyne Flat Plate Solar Collector.
Jesse Logan (KEA).

Project Summary:

This project will assess the feasibility of solar hot water heating systems on residential units in the NANA Region of Kotzebue. The Kotzebue Community Energy Task Force (CETF) had identified up to ten (10) Elders homes which are most in need of home heating assistance. System design and budget were considered for each home as well as southern exposure. After detailed review of designs and costs six (6) homes were identified to serve as test sites where solar-thermal systems, some using flat plate and some using evacuated tubes, have been installed (see figure below for manufacturer, installation contractors, collector type and system type). If the technology proves feasible above the Arctic Circle, these systems could be installed in homes throughout the region and serve as a model for alternative methods to heat homes without the use of fossil fuels.

[1] Kotzebue Electric Association
[2] Community Energy Task Force

Manufacturer	Installer	Collector Type	System Type
Viessmann	SES	1 evacuated tube	DHW
Viessmann	SES	2 flat plate	DHW
Heliodyne	ABS	1 evacuated tube	DHW and Space Heat
Heliodyne	ABS	2 flat plate	DHW and Space Heat

A. Administration, Management, and Reporting

KEA is responsible for the short- and long-term management, operations and maintenance of the solar thermal systems, in cooperation with CETF, NIHA[3] and NANA[4]. The Alaska Technical Center will have the opportunity to offer hands on training of the operation and maintenance of the installed systems, however only peripheral discussions have taken place so far. No students were available during installation. Additionally, the Chukchi Campus, a University of Alaska satellite campus, has recently developed a renewable energy training program. While no classes were offered at the Chukchi Campus during the semester of installation, discussions have taken place with program directors regarding a possible role for Chukchi's long term involvement with data collection and analysis.

B. Progress Update

In November of 2011 a severe winter storm hit the west coast of Alaska causing damage from Nome to Kotzebue. Recorded winds were above 70 miles per hour in the Kotzebue region. While both the Viessmann and Heliodyne systems are rated for wind speeds in excess of 100 miles per hour severe damage occurred to two Heliodyne flat plate collectors- one collector on two different systems (as reported last quarter). A wind loading analysis was done by ABS and found no fault in the installation site, placement, or angle. The orientation of both of these collectors is within 5 degrees of due south and the strongest wind gusts came from the East by Northeast. It is possible that strong wind collided with the collector's eastern corner and produced a vacuum on the front of the collector panel causing the protective layer to sheer off. (As a side note, the two (2) Veissmann flat plate collectors were installed at an angle equal to the pitch of the roof, around 29 degrees, and were not affected by the strong winds.)

[3] Northwest Inupiaq Housing Authority
[4] Northwest Alaska Regional Native Association

Heliodyne agreed to honor their manufacturer's warranty and has replaced the two (2) flat plate collectors.

In March 2012 one technician from ABS traveled to Kotzebue and, in conjunction with KEA, completed the replacement of the two (2) damaged collectors. KEA has paid the expenses including the shipping of the new collectors out of pocket. This expense is In-Kind from KEA and represents an additional $5,000 of In-Kind support for this project. Currently all six (6) systems are functional.

The data from both Veissmann and Heliodyne control systems are recorded in 3-5 second steps. There are gaps in the annual 3-5 second step data for the Heliodyne systems. However, the annual totals are complete. There has been no loss of data on the Veissmann systems, though acquisition has proved to be hit or miss.

ACEP has recently acquired a "data collection package" to help KEA acquire and transmit data. The package includes equipment for three (3) of the systems. As the Viessmann systems are not compatible with online data transmission in real-time ACEP has elected to continue data collection primarily from the three (3) Heliodyne systems. The data packages included pyranomters, domestic hot water flow meters, and wireless Wi-Fi routers. However, the routers purchased were incompatible with the Heliodyne systems. KEA located some older Wi-Fi routers and two (2) of the systems are currently transmitting data online. This data is stored in the Heliodyne server and is accessible to both KEA and Tom Johnston of ACEP. KEA was unaware of the flow meters and could not schedule a qualified plumber to install them during the ABS technician visit to Kotzebue.

This project was scheduled to close during this quarter, but KEA and ACEP have agreed to extend the data collection past the original 12 months. KEA and ACEP will continue data collection and system monitoring through September 2012.

a. Analysis

KEA's main goal with this project is to reduce the use of fossil fuels for residential systems. KEA has obtained historical fuel usage for five (5) of the six (6)[5] homes and has evaluated quantities for 2011 in comparison to three (3) year historical average fuel usage. The production values shown in data collection may or may not correspond to heating fuel saved.

[5] Historical fuel data not available for one of the homes.

System	2008	2009	2010	2008-2010 avg	2011	Change	decrees
1	522	829	502	617.67	585	-32.67	5%
3	562	562	832	652	443	-209.00	32%
4	575	606	506	562.33	550	-12.33	2%
5	693	1066	324	694.33	801	106.67	-15%
6	580	640	638	619.33	310	-309.33	50%

1. a. System 1

Fuel Usage(gal)

2008	2009	2010	2008-2010 avg	2011	Change	Decrees
522	829	502	617.67	585	-32.67	5%

System 1 is a Viessmann evacuated tube (30) array collector and serves domestic hot water (DHW) by utilizing an 80gal storage tank and a 5gal indirect fired on demand water heater. The home owner has realized a 5% decrees in fuel usage. This is less than what was expected. It is also unclear to what extent the reduction in fuel usage was due to the solar thermal system or the occupant's behavior. A DHW flow meter would help the analysis. This system is set to provide heat to the storage tank until it reaches 180F, at which point it can be dispatched by the DHW needs of the occupants. The system will dump heat if there is no call for it in the tank. For this reason households that use more DHW will realize higher production from the solar thermal system.

Additionally, during many high solar production months freezing temperatures occur that can drop below zero Fahrenheit. Evacuated tube collectors are more efficient at collecting solar radiation than flat plate collectors. Icing observed on the collectors remains longer throughout the day on evacuated tubes than on flat plate collectors. This reduces the availability of the evacuated tube systems.

b. System 3

Fuel Usage(gal)

2008	2009	2010	08-10 avg.	2011	Change	Decrees
562	562	832	652	443	-209.00	32%

System 3 is a Viessmann flat plate collector and serves DHW by utilizing an 80gal storage tank and an indirect fired water heater. The home owners have realized 32% degrees in fuel usage. This is nearly identical to how KEA expected these systems to function. It is unclear to what extent the reduction in fuel usage was due to the solar thermal system or the occupant's behavior. A DHW flow meter would help the analysis.

c. System 4

Fuel Usage(gal)

System	2008	2009	2010	2008-2010 avg	2011	Change	Decrees
4	575	606	506	562.33	550	-12.33	2%

System 4 is a Heliodyne evacuated tube collector and serves both DHW and space heating by utilizing an 80gal storage tank and the existing boiler. This system has been problematic. A winter storm froze the water pump on the control unit that caused the loss of availability of the system for at least 2 months in early 2011. After repairs were made several thermisters were also found to be faulty and replaced. The availability of this system is also reduced by icing similar to the Viessmann evacuated tube system (above). Overall the occupants realized 2% degrees in fuel usage. This is well below expected production. It is unclear to what extent the reduction in fuel usage was due to the solar thermal system or the occupant's behavior.

d. System 5

Fuel Usage(gal)

System	2008	2009	2010	2008-2010 avg	2011	Change	Decrees
5	693	1066	324	694.33	801	106.67	-15%

System 5 is a Heliodyne Flat Plate collector that serves both DHW and space heating by utilizing an 80gal storage tank, the existing boiler, and the existing 40gal water heater. It is unclear at this time why the fuel usage seems to have increased over the three year average. However, there may be an error in the fuel total for 2010 that KEA received from Crowley Fuel Services. A fuel flow meter would help the analysis. This system's availability was compromised for nearly 2 months due to a closed flow valve that was discovered after exhaustive trouble shooting by KEA.

e. System 6

Fuel Usage(gal)

System	2008	2009	2010	2008-2010 avg	2011	Change	Decrees
6	580	640	638	619.33	310	-309.33	50%

System 6 is a Heliodyne Flat Plate collector that serves both DHW and space heating by utilizing an 80gal storage tank, the existing boiler, and the existing 40gal water heater. The occupants

have realized a 50% reduction in fuel usage. It is unclear to what extent the reduction in fuel usage was due to the solar thermal system or the occupant's behavior. Both fuel and DHW flow meters would aid this analysis.

C. Conclusion

Production data that is available will be sent to the Commission via ACEP. There may be several causes contributing to the lower than expected production values. KEA has solicited advice from industry experts and will continue to monitor each system. Currently, two (2) Heliodyne systems are transmitting data in real-time. The installation of additional data collection equipment including pyranometers and DHW flow meters is planned.

Of the five systems that had historical fuel data available one set seems to be anomalous, showing a 15% increase in fuel with the solar thermal system installed, and this could be an error in the historical fuel data. Of the other four, the systems with flat plate collectors outperformed the evacuated tube systems. It is presumed that the difference in availability due to more overall icing hours on evacuated tubes is a contributing factor.

DHW flow meters will help determine the relationship between hot water usage by the occupant of the home and the utilization of solar radiation. Fuel flow meters would allow a much more precise measurement of the occupants fuel usage, currently KEA is relying on Crowley Fuel Services sales records.

KEA is also exploring options for the long term management of these systems. The Chukchi Campus and the Kotzebue Tech center have been approached for taking over management and maintenance of these systems to provide hands-on training in conjunction with upcoming renewable energy classes that may be offered.