Kotzebue Electric Association
Solar Thermal Alternative Residential Heating Methods
Quarterly Report
12/15/2010

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 Community Energy Task Force (CETF) has identified up to ten Elders homes which are most in need of home heating assistance. These homes will serve as test sites. Up to ten solar-thermal heating systems, some using flat plate and some using evacuated tubes, will be installed. 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.

Background:

In 2009 Kotzebue Electric Association submitted a grant application for round two of the Denali Commission's Emerging Energy Technology Grant for a total amount of $127,000, with a $17,000 in-kind match (11%). The total project cost is $144,000.

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

Solar thermal systems are not new technology. Using solar thermal power to actively supplement other methods of water and space heating has many benefits; however the deployment in northern Alaska has been nearly non-existent for several reasons, but primarily economic. As fossil fuel prices continue to rise the benefits of solar thermal will become increasingly obvious. Initial modeling done in ReScreen showed a payback on these systems in less than 8 years-finance depending- but must first be demonstrated in order to streamline the design of these systems using off-the-shelf technology. However, in the time between the initial grant application and the following award the price structures of the equipment and labor increased.

The objective of this project is to mitigate the rising costs of home heating in rural Alaska. KEA will install up to ten solar-thermal heating systems, each in different homes, to assess the feasibility of this technology above the Arctic Circle. To our knowledge not many people have experimented with this technology at this latitude, however Alaska Battery Systems has installed one system in Nome, and the Cold Climate Housing Research Center has installed both an evacuated tube space heating solar thermal system and a glazed panel water heating system in Fairbanks. Each has their advantages and disadvantages. The purpose of this project is to determine the most efficient combination for home space and/or water heating.

Modeling done in RetScreen has shown that the Northwest Arctic Region can obtain a 50% solar refraction on a properly designed system. Meaning solar energy could reduce their current energy use by half. However, conservatively, KEA is expecting to see a 30% reduction in fuel use for domestic hot water heating and a less substantial reduction in home space heating.

The original grant proposal suggested at least four air-source heat pumps to be installed to determine if the technology would reduce energy costs to homeowners in the Arcitic. However, due to their technical challenge and to poor track record as related from an NRECA report it was determined that the defrost cycles experienced in states such as Ohio would have cost a large energy cost increase to the home owner. Therefore, KEA has decided to focus on flat plate and evacuated tube solar collectors for water and space heating. Tracking mounting for solar collectors was also discussed but again risked the increase of electrical consumption for the home owner. In keeping with the attempt of reducing home owner's cost of energy and ease of operation (as home owners are Elders) track mounting options were dismissed.

Hybrid air source heat pump hot water heaters (GE 50-Gallon GeoSpring™ Hybrid Water Heater) have also been discussed with one eligible home identified as suitable for this installation. Up to 20% of the total heating fuel in the Northwest Arctic Borough is used to heat hot water. While solar thermal hot water is practical up to nine months of the year, these hybrid hot water heaters utilize both air-source and electrical energy. By combining the two, KEA had hoped to provide reliable hot water to this home while attaining the manufacturers

estimated 62% reduction in electrical consumption for hot water. However, budget constraints may not allow this installation.

There are numerous ways to design solar thermal space and hot water heating systems with flat plates or evacuated tubes. Each installation will have a slightly different configuration to allow KEA to make a comparison for each home and recommend system designs accordingly.

Project Work Plan

A. Site Identification, Planning, and Equipment

Site Identification: *Complete*
KEA has coordinated with the Kotzebue CETF to identify homes that are suitable for this demonstration project. KEA and CETF had over 25 applicants and 10 met the following criteria: Elders status in Kotzebue, full-time Elders residence, and currently on State Energy Assistance. KEA then worked with CETF and Susitna Energy Systems (SES) designers to identify the homes with the least amount of equipment needed in order to demonstrate the most systems. After careful review, and pricing evaluations, 6 homes where selected for solar collectors and one additional home was identified as suitable for a hybrid air-source electric hot water heater, if the budget allows.

Planning: *Complete*
Several of the 6 homes selected for this demonstration project utilize hydronic base board heating to heat the homes. In this type of home heating system a glycol based fluid is heated by the same boiler that domestic hot water is heated. It is therefore possible to allow a solar thermal collector to pre-heat both systems. This requires slightly more complex plumbing as well as more advanced thus more expensive, storage tanks.

In order to best demonstrate the capacity of solar thermal collectors to reduce fossil fuel consumption, and therefore energy cost, KEA deemed it necessary to install both DHW (domestic hot water) systems as well as combined DHW and hydronic base board heating capacity. Again, the selection of which homes would receive DHW or combined systems was based on costs of installation and space within the home's utility room to accommodate the necessary equipment.

This demonstration project also needed to evaluate the production differences between flat plate and evacuated tube solar collectors. There are several manufacturers with respectable reputations that make both types of collectors, but only two that are well represented with

installation companies here in Alaska: Viessmann Manufacturing Company Inc. represented by Gensco Alaska and installed by Susitna Energy Systems (SES), and Heliodyne Inc. represented and installed by Alaska Battery Systems (ABS). KEA elected to split the 6 homes between the two manufacturing and installation companies as well as purchases both flat plates and evacuated tubes from each.
Viessmann Inc was reluctant to install their equipment to serve as combined DHW and heating as it was designed for DHW only. Therefore KEA chose to purchase 2 flat plate and 1 evacuated tube collector from Viessmann to be installed by SES. Heliodyne was more flexible in their system design capacity and with ABS having experience installing a combined DHW and heating solar thermal system in Nome, KEA felt comfortable purchasing 2 flat plat and 1 evacuated tube collector from Heliodyne to be installed by ABS.

Generally, evacuated tube solar thermal collectors have performed slightly better than flat plate collectors in the lower 48. However, evacuated tubes are more expensive and have the capacity to be more troublesome and fragile. Therefore, in the interest of installing and testing the most systems, KEA elected to install 2 evacuated tube and 4 flat plat systems as follows:

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

The specific angle of each solar collector was also considered. Generally a solar collector is south facing with an angle approximate to the latitude on site. This is the case with 4 of the collectors. The Two Viessmann flat plate collectors were installed at the angle of the roof (approximately 29 degrees) for two reasons: 1) reduced wind resistance lowering the possibility of damage to the unit, and 2) to determine if the DHW only systems would benefit from increased production during summer months when the sun in Kotzebue stays high in the sky for18-24 hours and the boiler systems in the homes generally are not running to produce space heating.

Equipment
All equipment was ordered from the manufacturers through the installation/design firms listed above and have followed the procurement procedure of ACEP/UAF.

B. Installation: *83% Complete (on schedule)*

At the time of this report the installation of all 6 solar thermal systems is 83% complete. There are three major installation components to each system: rooftop solar collector, plumbing, and controls. The remaining 17% represents the wiring of 3 control units for the SES systems. This will be complete by December 22nd- which is on track for all 6 systems commissioned and running by January 1, 2011 as per the contractual agreement with Denali Commission and ACEP.

The installation of solar thermal systems in homes requires mounting of collectors on roof tops, placement of thermal storage tanks, wiring and connection of control/data logging units, plumbing of solar loop, plumbing to auxiliary heating systems and hot water distribution systems. A certified plumber is required to do the majority of the plumbing work. However, labor availability constraints pushed the final installation of the SES units back farther than was anticipated.

In October of 2010, SES and Gensco sent 3 installation technicians to Kotzebue to work with KEA on the initial installations of 3 systems. The local IRA organization provided a plumber to work in conjunction with KEA as per CETF's In-Kind labor contributions. However, before plumbing was complete overriding duties called the IRA plumber away to other jobs. SES and KEA successfully mounted the solar collection units and plumbed the line-set into the houses. No further work could continue until the plumbing within the house, including thermal storage tanks, was complete.

In November of 2010, ABS sent 2 installation technicians to Kotzebue to work with KEA on the installations of the 3 other systems. During their stay a local plumber was located and worked with the ABS team. All aspects of the installation were complete by November 22nd. Some minor glitches were found in the control units and rectified. These systems are currently up and running and final commissioning will take place in December 2010.

Final plumbing on the first 3 SES systems took place between November 23th and December 19th, 2010.

On December 19, 2010, SES will be sending 1 installation technician to Kotzebue to work with KEA to complete the installation and commissioning of the SES systems. All that remains is to wire in the control units and fill the solar thermal line-set with a food-grade glycol-based solar thermal solution. These units will be commissioned on or before December 22, 2010.

C. 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.

D. Conclusion

This demonstration project proved to be somewhat complex due to the coordination of several entities as well as several home owners. The accomplishments to date are listed in the above narrative: Site Selection is complete; the planning phase is complete; the installation is 83% complete and on schedule.

The originally proposed budget could not foresee the increased price structure of the equipment and labor and for this reason the project was scaled back from 10 systems to 6. Nor could the original budget foresee the lack of availability of a plumber to be donated as In-Kind from CETF. CETF has been invaluable in coordinating communications between KEA, NIHA, Crowley Fuel Services, and the home owners. However, a local plumber was not available as donated labor and therefore KEA hired one and this hourly wage will be coming directly from the budget. This additional expense was not anticipated. Other labor invoices have not been received by KEA, but by the best estimation the project is on budget aside from the plumber. For this reason the purchase and installation of an air-source hybrid hot water heater is on hold. It is possible that KEA will be able to absorb some of CETF's In-Kind contribution but if an unsustainable threshold is reached KEA will attempt to recoup costs from future grants and/or other sources.

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

E. Pictures of Work Performed

Viessmann Flat Plate Collector: Line-set installation. *Left:* David Lindeen (SES), *Center:* Claude Wilson (KEA), *Right:* Mark Kuhlman (Gensco, Inc).

Viessmann Flat Plat solar thermal collector installed.

Viessmann Evacuated Tube Installation of line-set. *Left:* Derek Fox (Gensco, Inc) *Right:* Mark Kuhlman (Gensco, Inc)

Viessmann Evacuated Tube Racking Mount- awaiting final plumbing.

Viessmann Flat Plate Solar Collector. Loader operator: Claude Wilson (KEA).

Viessmann Flat Plat Solar Collector.

Heliodyne Flat Plate Collector.

Heliodyne Flat Plate collector installation. ***Top:*** **Eddie Davidson (ABS),** ***Bottom:*** **Claude Wilson (KEA).**

Heliodyne Flat Plate Installation. Jesse Logan (KEA)

Heliodyne Evacuated Tube Solar Collector.

Heliodyne Thermal Storage tank, control unit and plumbing.

Heliodyne Thermal Storage Tank, Controls and Plumbing.

Heliodyne pluming system. Tim Karka (KEA)