



# Colorado Woody Biomass Market Development

## The Salvation Army High Peak Camp

*Phase 1: Creating a fundable plan and proposal*

Submitted by Bihn Systems, LLC. as part of P.O. #06-075, on May 22, 2007  
 Woody Biomass - WGA Grant: High Peak Salvation Army Camp Biomass Utilization Study

**Project Goal:** Create a viable, fundable biomass heating project plan for the cafeteria and meeting hall at the Salvation Army Camp near Estes Park, including both energy analysis and a wood supply analysis suitable for a cordwood boiler.

### Initial Plan (from Statement of Work)

Assess the heat load, energy/propane consumption of the building to be converted to biomass heat. This requires metering the specific building from the other buildings at the facility. Only the propane supplier can attach the appropriate meter.

1. Dan Bihn and Salvation Army personnel to monitor the meter and record data to properly assess the energy use and costs
2. Install the replacement system (This cost to be born by Salvation Army)
3. Dr. Kurt Mackes, Dan Bihn with assistance from GEO to work with Salvation Army personnel to assess their supply costs from the forest management activities being conducted on S. A. Camp property. Supply plan also to include outside sources.
4. Complete report on heating costs using new system and assess savings and make recommendations on the system and compare the propane system and new biomass system.

### Discoveries and Variances

- The GARN company had suggested that \$5,000 would be more than sufficient to cover the building cost. This will likely prove very optimistic. AND the proposal did not include needed engineering.
- Economics are good (simple payback better than 5 years). Can be excellent if boiler is integrated into a new construction project.
- Sub-metering at the appliance level, not building, would have been more accurate and would have allowed the use of lower-cost, residential-scale, propane meters.
- The one-on-one time investment needed to make this project work significantly exceeded initial estimate. Consultant absorbed this variance.

### What Actually Happened

**Success! On March 16, 2007 we informed that Salvation Army is planning to fund the purchase and installation of the cordwood boiler recommended by this project.**

Tasks accomplished:

- Selected Building
- Installed propane meter to monitor (sub-meter) consumption of the Cafeteria building.
- Monitored consumption and estimated size of a cordwood boiler – and estimated savings.
- Estimated Cost Savings with the proposed GARN cordwood boiler system.
- Created Plan – including high-level design.
- Wrote a fundable proposal delivered to the Salvation Army staff in Denver (Intermountain Division).
- Completed entire heating season consumption monitoring.
- Completed this report.

### Next Steps

We are working with the local Salvation Army staff and their contractors to create a final design for the boiler system including the new boiler building and the system integration.

- A detailed, well-engineered design of a complete system – ideally one that can be freely distributed and used as a reference.
- Air Quality measurement and, ideally, on-going monitoring.



# Why is the Salvation Army Camp a good candidate?

To accelerate the woody biomass market in Colorado, the CO-Wood team decided to pursue showcase projects that clearly demonstrate the economic, environmental, and operational desirability of proven wood-fired technology.

Our investigation identified the Salvation Army's High Peak Camp on Highway 7, 10 miles south of Estes Park as an ideal candidate meeting the following criteria:



## YEAR-ROUND USAGE AND HIGH ALTITUDE.



Significant total savings compared to business as usual. Heating costs must be a significant part of their budget -- either because they heat a lot or the fuels they use are expensive. The cafeteria makes for an excellent year-round demand.

The whole camp uses more than \$60K per year of propane.



## NO ACCESS TO NATURAL GAS.



Propane along the Front Range cost between \$1.50 and \$3.00 per gallon – \$16 to \$32 per MMBTU – at least twice as much as natural gas. This dramatically improves project economics, more than halving the simple payback period.



## ON-SITE SUPPLY OF WOOD.



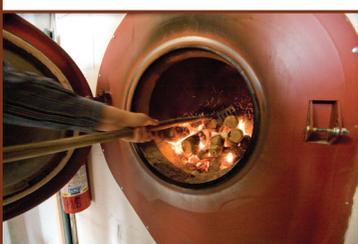
Projects on forested lands in need of thinning for both forest health and fire mitigation are ideal. Treating and removing wood from forested land costs between \$400 and \$1,500 per acre. Cleanly consuming the wood on-site eliminates the transport and potential landfill costs. The Camp is on a 400 acre site, approximately half is densely forested.



## EXISTING HYDRONIC HEATING SYSTEM.



Wood-fired boilers work best with hydronic (hot water) in-floor heating – which allow the most energy to be extracted from the system. The cafeteria at the Camp is a modern building (1990's) with hydronic heating. A heat exchanger and small modifications to the existing system should be very straightforward.



## ON-SITE STAFF WITH STRONG ARMS.



Cord wood systems do not have automatic fueling systems – keeping the capital cost and maintenance low. However, someone needs to manually load the firebox once or twice per day – potentially three times on very cold days. The Camp has live-in caretakers routinely doing heavy manual labor.



## A GOOD PLACE FOR TOURS AND SEMINARS.



Key to being a good demonstration site, is the ability to have the public and decision makers visit the facility and see for themselves how the system works, and hear what the actual operators think of the system. The Camp has a full meeting and overnight accommodations for several hundred visitors.

## Building Demand

The Camp's cafeteria was selected because of its high year-round usage and likely high energy demand. To accurately assess the building's use age, a propane meter was installed on the pipe entering the cafeteria building in May, 1996 to sub-meter the building's fuel demand.

The consumption was measured from June 6<sup>th</sup>, 2006 to March 23<sup>rd</sup>, when the study ended. The total consumption during this period was 3,064 gallons. Based on this interval and earlier data, we estimate the typical annual demand for propane to be approximately 3,500 gallons of which, we estimate at least 80%, 2,800 gallons per year, will be used for space heating and domestic hot water (DWH) – the remainder for cooking. We estimate 80%, or 2,240 gallons per year, of this heating and DHW demand can be provided by the wood boiler system.

**Annual Demand:** 2,240 gallons contains approximately 200MMBTU, the equivalent of 18 tons of seasoned cordwood (5,500 BTU per pound), roughly 100 pounds per day, on average.

**Peak Demand:** Over a cold, fully occupied weekend was 2.2MMBTU per day — nearly 400 pounds of seasoned cordwood (note: this is higher than our initial estimate we used for our proposal).

**Design:** Based on these measurements, we are recommending a 300,000 BTU per hour GARN system. Based on discussions with the manufacture, we suspect a full 100 pound of cordwood “charge” will need to be loaded into the unit:

- 3 times a day on the coldest days;
- 2 times a day in winter; and
- 1 time per day in the summer.

The unit stores energy for several days, so on warm days with low activity, the unit will not need to be stoked. If the unit cannot be stoked for any reason, the propane system will automatically turn on, to provide 100% back-up.



## Supply Study.

Dr. Kurt Mackes, CSU, visited the Camp to interview the management and examine Camp's land on August 21st, 2006. There are at least 200 acres of forested land in need of some level of thinning. Forest thinning in similar parts of Colorado yield between 5 and 10 tons of wood residue per acre. So Dr. Mackes estimates heating demand the Camp cafeteria, 20-30 tons per year, will require the thinning residue from less than 6 acres each year.

Due to the significant margins between the large supply and the relatively small demand, a more detailed supply study was deemed unnecessary.

- More than 200 acres of forested land in need of treatment.
- Less than 6 acres per year of thinning residue will be needed (probably around 3 acres).



## Economics Analysis

The recommended wood boiler will save more than 2,000 gallons of propane annually. At \$2.50 per gallon, potentially conservative number, this will save \$5000. Increased labor costs, \$1,000 (15 minutes per day (100 hours per year @ \$10) -- average. Some days none, some days 1-hour.

Net anticipated savings: \$4,000.

System Cost:

Boiler: \$10K

System cost: \$5K

Outbuilding: \$5-10K

**Total: \$20K - \$25K**

Simple payback of 5-6 years. Savings for thinning is currently not calculated – they haven't created their fire plan yet – so direct savings could be significantly higher.



Proposal created and submitted to the Salvation Army management and Lyle Laverty, October 2006 (note: this is before a full year of heating data had been collected, but estimates were close – the same design, same basic payback, but peak demand turns out to be significantly higher -- requiring more labor on cold days).

## Heating off the Land: Forest Biomass for the High Peaks Camp

### A CAPITAL IMPROVEMENT THAT REDUCES BOTH OPERATING COSTS AND WILDFIRE RISK

GOAL: To reduce energy costs at the Salvation Army's High Peaks Camp by installing a commercial cordwood boiler fueled by cordwood collected on site.

- To develop an economically, ecologically, and aesthetically viable blueprint for sustainable utilization of forest resources for use by other mountain camps.
- To offset the cost of forest management by creating a value-stream of otherwise non-merchantable timber.
- To prepare for a likely Mountain Pine Beetle attack in the next few years.

BACKGROUND: The Salvation Army's 480-acre High Peaks Camp, located near Estes Park, Colorado, is heated by increasingly expensive propane gas. In 2005, the Camp used more than 36,000 gallons of propane – \$93K at today's price (\$2.60 in August 2006, a 250% increase over 2000). Propane is the Camp's second largest expense item.

The Camp is located in the middle of a sub-alpine forest – primarily lodgepole pine (more than 100-acres). For both fire mitigation and forest health reasons, thinning projects are underway at the Camp. The biomass from thinning activities is currently being given away or burned in piles.

Based on a preliminary study funded by Colorado's GEO (the Governor's Office of Energy Management and Conservation), a cordwood boiler will save more than 1,900 gallons of propane each year – a net savings at today's price of nearly \$5,000. On average, the building will need 50 pounds of wood each day in the summer and up to 150 pounds a day in the winter.

Colorado Wood Program (CSU) proposes the purchase and installation of a clean-burning 350,000-BTU cordwood boiler to offset a majority of the cafeteria's energy demand.

GEO/CSU will provide the detailed design and on going monitoring using graduate students and researchers. CSU will create the long-term forest energy management plan.

FINANCIALS: we propose the installation of a GARN 1500 – at a cost of \$15K (\$12K for the installed boiler and \$3K for a shed). Estimated:

- Fuel savings of \$5,000/year.
- Increased labor \$1,000 (15 minutes / day (100 hr/year @ \$10).
- Net annual savings of \$4,000 (This gives us a 3.75 year simple payback, or an internal rate of return in excess of 30%.)

CSU is securing funding for the boiler and installation (\$12K). The Salvation Army is being asked to supply the shed (14' X 16' with concrete floor).

STATUS: Preliminary design in complete, sub-meter has been installed, and the cafeteria's energy consumption is being monitored. Once the order has been secured with a \$2,500 initial payment, delivery is estimated at 6-weeks.

ACTION: To meet with the Salvation Army management team in Denver and present this plan.