

# Making Wood



# Work for Colorado Camps

Using their own salvaged on-site wood, the Salvation Army's High Peak Camp near Estes Park expects to save \$7,000 each year on their propane bill by heating their dining hall with a modern wood boiler – the cost of a one week summer camp scholarship for about 30 kids.

A public-private partnership between the Salvation Army's High Peak Camp, the Colorado State Forest Service, and the Colorado Governor's Energy Office (GEO), is answering the question:

*How can wood provide economical, clean, climate-friendly energy for Colorado's mountain camps and resorts?*



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**Governor's  
Energy Office**

For more information visit [www.colorado.gov/energy/](http://www.colorado.gov/energy/)

# The Salvation Army's High Peak Camp, Estes Park, Colorado

## The Camp at a Glance

**Location:** Estes Park, Colorado

**Altitude:** 9,060 feet

**Building:** Dining hall 8,100 square feet

**Past Propane Consumption:** 3,000 gallons/year for heating, hot water, and cooking

**System:** 198,000 BTU/hr TARM wood boiler with 900 gallons of thermal storage (hot water)

**Estimated Annual Wood Consumption:** 17 cords (1 to 2 cords per month)

**Retrofit Cost:** \$55,000 (not including new high-efficiency propane back-up boiler)

**Simple Payback** (depending on propane costs):  
9-years @ \$2/gal., 6-years @ \$3/gal., 4.5-years @ \$4.00/gal.



Wood boilers are a perfect match for many of the more than 20 buildings at the Salvation Army's High Peak Camp near Estes Park, Colorado. Operating a lodge year-round at 9,000' elevation takes a lot of heat and a lot of money. Rising energy prices now make propane the second most costly line-item in their annual budget, just below payroll.

The Camp's forested 400-acre site – boarding the Rocky Mountain National Park – is in need of wildfire mitigation thinning. That takes time and money, but with no local demand for the thinning wood waste (fire-wood, etc.), hauling it to the landfill or burning it in on-site slash piles have been the only options.

- ◇ High propane bills, high altitude, cold winters
- ◇ Forested land in need of thinning
- ◇ Year-round staff

Perfect! The 8,100 square foot dining hall, built in 1990, is the first building to be converted to wood heat. Year-round use, a kitchen that washes dishes for 500 guests 3 times a day, and radiant (hot water) in-floor heating, made this building an ideal candidate for conversion to wood heat.

When propane was at \$1.00 per gallon, *retrofitting* with a state-of-the-art, clean-burning wood boiler system probably isn't economical, but propane at \$2.00 per gallon make sense – paying for itself in 5-10 years. And when propane approaches \$3.00 per gallon it is **just good business.**

The Salvation Army, with financial and technical help from Colorado State Forest Service (CSFS) and the Governor's Energy Office (GEO), replaced the dining hall's aging propane boiler with a 198,000 BTU/hour wood boiler system and a new high-efficiency propane boiler for back-up and peak demand. The complete wood boiler system costs \$55K and is expected to save between \$6K and \$9K each year.





This TARM Solo 60 Mark II, 198,000 BTU/hour wood boiler is the heart of the system. It is one of the cleanest burning boilers on the US market. Bioheat USA, who has been importing TARM boilers from Denmark for more than 30-years, is introducing new boilers featuring real-time electronically managed combustion this year, further raising the bar on air emissions.



Integral to the system design, this 900 gallon water-filled thermal energy storage tank stores heat from the boiler. You stoke the boiler when it is convenient, the building uses the heat when it is needed.

Thermal energy storage allows the boiler to run at it's cleanest and most efficient setting, one of the keys to emissions reduction.

Heat from the boiler can be distributed to the building using a forced air furnace, a baseboard hot water radiators, or an in-floor radiant (hydronic) floors.

The Camp's dining hall existing radiant floor system is a very good match for these wood boilers.



Tim and Darcy Sunderland run the Camp. Their vision of "creating the most sustainable mountain camp in the West" is one step closer to reality with their new carbon-neutral wood boiler system. "We're very pleased how well the system works and how easy it is to operate and maintain."

Take a quick "virtual" spin around the boiler room through this interactive 360° panorama (electronic multi-media version only).





# Heating with a Wood Boiler

## Wood boilers are...

### Simple, manual systems



Manual fuel (wood) loading makes these systems very simple. With few moving parts, these systems are reliable and relatively inexpensive.

### Fueled directly from on-site thinnings



All you need is a chainsaw and strong arms.

Make sure everyone has been properly trained and given the correct safety equipment.

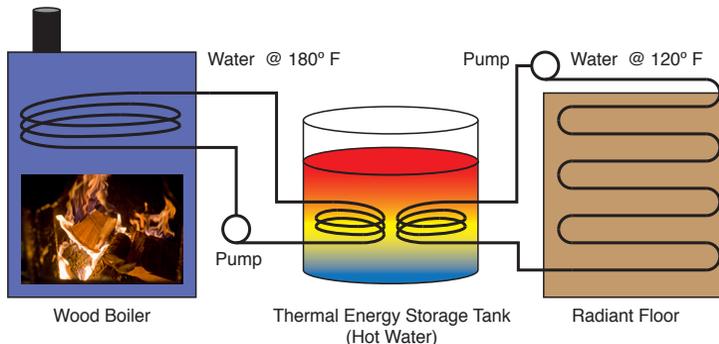
### Not for everyone...



Handling 100-500 pounds of wood each day is a lot of work. If you're team isn't involved with on-site forest management, this might not be the right technology for you.

Modern wood boilers can be very clean and efficient. These systems are designed to burn wood at a fast, constant rate to prevent smoldering fires. The combustion is clean and complete.

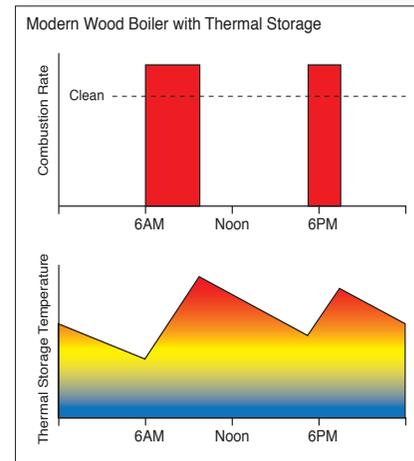
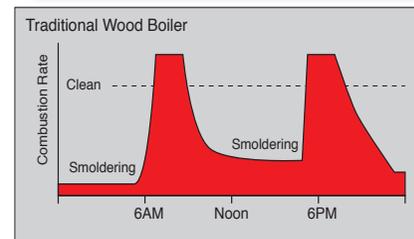
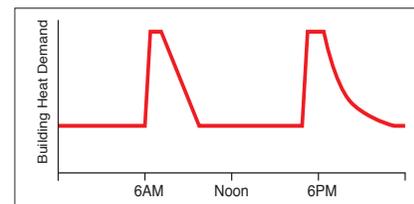
Older traditional boilers, however, often control their heat output by limiting the amount of air entering the firebox through a damper – adjusting the rate of combustion. At lower heat settings, this often leads to incomplete combustion and smoke.



Modern boilers solve this problem by cleanly burning the wood at a high, steady rate. However, if the heat from the boiler directly heated the building, the building would be either too hot or too cold most of the time. So, the boiler first heats water in a large, intermediate *Thermal Energy Storage* tank by circulating very hot water through a metal coiled pipe (usually copper), storing the heat energy until it is needed.

When the building needs heat, a second coil circulates water through the thermal energy storage tank.

In the winter, the boiler may run frequently (2-3 times a day). In the summer, the boiler may on run a few times a week (maybe less). How often the boiler runs depends on how much heat the building uses from the storage tank.



# Operation and Maintenance



## Stoking the firebox

Stoke the firebox with 40-50 pounds of seasoned (not green) firewood, light a match, and in about 5 minutes the boiler is burning hot and clean.

In the summer months, you may only need to stoke the boiler a few times each week. On the coldest winter days, you might need to stoke it 2 or 3 times a day. And if no one is available to stoke the system, a back-up propane boiler automatically takes over.

## Removing the ash

Daily ash removal takes less than a minute. These systems typically generate a few pounds of ash each week. The ash can be directly used in the garden as a soil amendment to reduce soil acidity.

Check with your local gardening center to see if this is suitable for your soil.

## Cleaning the boiler tubes

Water is heated as the flames and combustion gases pass through the boiler tubes. A small amount of ash collects in these tubes, requiring manual cleaning using a brush provided with the boiler.

Cleaning typically takes 10 minutes about once a month.

What about other wood technologies?



**Wood chips** can be made on-site – but the boilers don't make economic sense until you're heating at least 50,000 square feet.



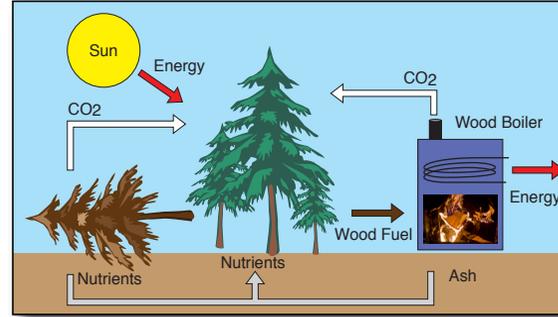
**Wood pellets** are a great fuel for heating – clean and easy to use. But you can't make them yourself (10,000 tons per year is a very small pellet factory).

# Why Wood Heat for Colorado?



## Forest Health & Beetle Kill Fire Hazard Reduction

Using wood to heat buildings creates a direct financial incentive to do needed forest thinning. Wood burning appliances, such as wood boilers, are ***much*** cleaner than slash pile burning.



## Renewable Carbon-neutral Energy Source

Wood is a carbon-neutral fuel. When a tree grows, it absorbs  $\text{CO}_2$  from the atmosphere, converting the carbon into wood. When the wood burns, the identical amount of carbon is returned to the atmosphere.



## Reduced Operating Costs for Camps

Even including the additional labor costs of handling wood, removing ash, and maintaining the boiler, wood is still significantly cheaper than propane.



## Local Economic Development

Heating with wood creates jobs ranging from tree cutting, wood splitting, and hauling, to heating system design and installation. Using local wood for energy means nearly all of that money stays in your community.

# Why Public & Private Partnership? Faster, Better, Cleaner.

With the price of fossil fuels increasing, markets will naturally emerge. So why should public agencies get involved?

- ◇ Building a market based on the new realities of higher priced fossil fuel, new wood technology, and the public benefit of lowering our carbon footprint, **takes time**.
- ◇ Markets do not always favor the cleanest technology. High-performance combustions systems have long-term economic benefits and immediate emissions benefits, but have a moderate price premium.

By collaboratively creating a small number of showcase projects, the market can be accelerated so Colorado can get the benefits sooner, and get those benefits in the most environmentally and economically sustainable way.



## Develop a compelling local showcase

Most camp and resort operators want to see a local working system – working economically, operationally, and environmentally. Without a real example, most operators are reluctant to move forward.

By assisting and guiding a small number of projects that clearly demonstrate the right technology for the right application, this partnership is speeding market development.



## Develop regional design & installation expertise

If you decided to invest in this new technology, will there be qualified people to design, install, and maintain it?

Many projects have failed because this experience didn't exist. This partnership is building the needed capacity.



## Develop an understanding of the cleanest technology

Emissions. Not all wood boilers are clean and efficient. Some low-cost boilers are not clean – damaging the environment AND ruining the reputation of the good systems. This partnership is committed to using the cleanest technology available.

Starting early 2009, emissions testing will begin to validate the manufacture's specifications. This data will be available to the public.

**COMPLETED**



## Phase 1: Finding a great candidate



### Economic Value

Most importantly, the project needs to make financial sense. If a mountain camp or resort manager learns about this project, the first thing they'll want to know is, Can this technology really save me money?

A separate propane meter was installed on the dining hall and measured its consumption for 18-months to determine the economic value of this project. The same meter will be used to verify the actual savings during the 2008-9 heating season.



### Sustainable Wood Supply

Will there be an adequate supply of wood from prudent on-site thinning for at least 15 years? The economics for a wood boiler are dependent on on-site fuel availability. If wood needs to be purchased, the economics usually break down.

Dr. Kurt Mackes, Colorado State University researcher and faculty member, surveyed the site and confirmed the supply.



### Clean Technology

Not all wood boilers are clean and efficient. The lowest cost units often have poor emissions. Compounding the problem, due to poor system design, these units are often operated in a way that leads to incomplete combustion – smoldering and smoking.

The right technology selection, proper system design and installation are key to clean, smoke-free operation.



### Fundable Plan

The economics were analyzed, the on-site wood supply validated, and the technology selected, a solid business plan and proposal was created.

The next challenge was finding the right team and the right funding sources.

**COMPLETED**

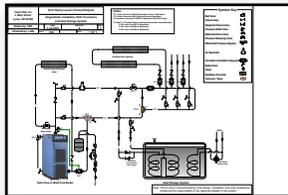
## Phase 2: Capacity Building & Installation



### Build the Team & Secure Funding

Even with the project foundation in place, there is risk in doing something new. To overcome this barrier, a public-private partnership was created to make this happen.

Modern wood boilers are new to the Colorado market. Finding the right people with the right skills and experience is key to making this project a success – and showing Colorado how to do it right. (See [page 11](#) for details.)



### Get it designed right

The wood boiler manufacturers standard designs will get you started, but you still need a professional design to meet your building's needs. The Colorado State Forest Service funded a professional mechanical design to be used on this project and to serve as a starting point for other Colorado installations.



### Get it installed right

Wood boilers are not more complicated than conventional boilers, but they are **different** and experience does matter. As the market grows, so will the number of experienced installers. In the meantime, you should be prudent and find the people who really know what they are doing – even if it costs a bit more.

Qualified installers are out there, and they are great to work with.

## Phase 3: Monitoring Emissions & Operations



During the 2008-9 heating season, the partnership will be testing actual emissions, monitoring operational performance, and collecting cost data. An updated report will be available in May, 2009 with the final recommendations.

**IN PROGRESS**

# What makes a great place for a wood boiler? **Four Key Attributes.**



## **High propane or electric heating bill**

If you spend at least \$5K a year to heat using propane, switching to a wood boiler can make good economic sense.



## **High-altitude & year-round use**

High altitude winter heating and year-round hot water needs such as a kitchen or showers make for good economics. The more you use your heating system the better the economics are.



## **Forested land at risk**

If you have forest thinnings, your waste disposal problem can now be an affordable fuel solution. All you'll need is a chainsaw and vehicle to move the wood.



## **On-site staff with a *can-do* attitude**

Cordwood is not for everyone. You'll need 100-400 pounds of dry cordwood each day to heat a 8,100 square foot building during the winter. A lot of work, but a lot of value.



## The Salvation Army High Peak Camp

*Funded capital improvements, provided long-term vision of sustainability and stewardship*

One of more than 50 camps owned and operated by the Salvation Army, in the USA, High Peak Camp is located 7 miles south of Estes Park at the foot of Long's Peak. It accommodates more than 200 people for multi-day stays.

<http://www.highpeakcamp.info/>



## The Colorado Wood Utilization and Marketing Program (CO-Wood)

*Funded system design and engineering, provided project leadership*

Part of the Colorado State Forest Service, CO-Wood works to support and expand Colorado's forest-based business sectors by providing education, technical assistance, applied research, and advocacy.

<http://www.colostate.edu/programs/cowood/>



*Governor's*  
**Energy Office**

## Governor's Energy Office (GEO)

*Funded initial feasibility study, provided project management, and is providing performance & environmental monitoring*

The GEO's mission is to lead Colorado to a New Energy Economy by advancing energy efficiency and renewable, clean energy resources.

<http://www.colorado.gov/energy>



## Advanced Hydronics, Inc.

*Provided design and engineering expertise*

Engineers and installs hydronic heating and cooling systems in Colorado – designs that are simple and elegant, systems that are comfortable and maintainable.

<http://advancedhydronics.com/>



## BioHeatUSA

*Provided biomass boiler*

BioHeatUSA, formerly TARM USA, is a third-generation, family owned business that has pioneered the sales and service of European residential central heating equipment to North America for over 30 years.

<http://www.woodboilers.com/>



## Governor's Energy Office

Leading Colorado to a New Energy Economy by advancing energy efficiency and renewable, clean energy resources.

### Community Woody Biomass for Thermal Usage Program

The Governor's Energy Office (GEO) offers the Community Biomass for Thermal Usage Program for promoting and developing community-scale bio-heating projects in Colorado. The GEO will work closely with several projects throughout the state to support the utilization of community woody biomass (including wood chips, pellets and cordwood generated in Colorado) in a bio-heating project. Projects that will use annual forest thinnings, wood waste (including but not limited to bark beetle kill) and urban waste are encouraged to apply.

For further details, please visit the GEO website: <http://www.colorado.gov/energy>

Notes:

### Where Wood Works

This 16 page booklet provides an overview of woody biomass technologies that are working in Colorado today – including wood chips, wood pellets, cordwood, and co-firing large coal-fired power plants with wood chips. Download *Where Wood Works* from the GEO website <http://www.colorado.gov/energy>. Please refer to the publications or resources sections.

