RENEWABLE WOOD HEAT:

Warm Toes & Healthy Forests

Resorts Turn to Affordable & Sustainable Heat Source

BY JULIE KIES, USDA FOREST SERVICE

Bridger Bowl Ski Area in Montana and Mt. Abram in Maine know a good opportunity when they see it. In 2015, Bridger Bowl was upgrading the shop and lift operations buildings with plans to install a radiant floor heating system, and with annual summer maintenance of the ski hill including removal of dead standing trees, they knew they had a low-cost source of local fuel for their needs. When they discovered that a cordwood boiler would only need to be stoked twice a day, they realized they had a perfect low-carbon energy solution: a modern cordwood boiler that uses beetle-kill logs to provide hot water and heat to the buildings.

On the other side of the country, Mt. Abram has taken a similar step, using locally sourced wood fuel for a wood pellet heating system installed at their lodge in 2011. The pellet system is part of Mt. Abram's progressive environmental sustainability portfolio, which includes a solar array that produces three-quarters of the power used on the mountain and new high-efficiency airless snowmaking systems.

Bridger Bowl and Mt. Abram are part of a new wave of ski areas that are turning to renewable wood energy as a sustainable, low-cost solution to their heating needs so they can keep clients, residents, and employees comfortable, safe, and coming back for me. Many ski communities already are investing in sustainability initiatives to reduce their environmental impact and help minimize their contribution to climate change. Installing a wood energy system demonstrates their commitment to sustainability, and can be a practical, cost-effective solution to reducing fossil fuel use.

Wood Energy: A Scalable Solution

Wood energy is created by the combustion of wood in a modern, high-efficiency boiler or furnace system that captures and distributes the heat to provide space heat, domestic hot water, and even electricity in a combined heat and power scenario. Wood energy fuel comes in three forms: cordwood, wood chips, and wood pellets.

Cordwood, commonly known as firewood, is best suited for smaller scale facilities. Cordwood needs the least amount of capital to both process and burn, but requires labor in the form of hand-feeding into a firebox a few times a day.

Wood chips are small pieces of wood about the size of a matchbook that are typically made from wood byproducts sourced from forest thinning, logging operations, and sawmills. Wood chips are the most commonly used wood fuel in boilers across the country.

Wood pellets (shown in the photo on the left) are the most processed and uniform type of wood fuel, and also the most expensive to buy. The pellets resemble animal feed pellets and are produced by compressing dried sawdust and wood shavings (mainly sawmill byproducts) into small cylindrical pieces. While pellets are more expensive than other wood fuels, they produce more heat per pound and are easier to store and handle than the other wood fuels. Pellets are well-suited for facilities with limited space available for wood fuel storage.

Wood energy can be easily scaled—from a small wood or pellet stove in the après ski bar to a high-efficiency cordwood boiler for the groomer shop, to a fully automated wood chip or pellet system that provides hot water, space heating, and ice melting for base lodges and entire resort districts and communities—with the potential to also co-generate electricity for lifts, snowmaking, and multiple buildings. The operation and maintenance required for a modern wood energy system is comparable to that of a gas or liquid fuel system, but will vary depending on the fuel type, the operator's vigilance in ensuring good fuel quality, and the level of automation of the chosen system.

Several alpine resort towns in Europe have woodchip district heating systems that serve extensive networks of hotels, municipal buildings, and private residences. Toblach, an alpine resort town in South Tyrol, Italy, has a district wood heating system that serves more than 900 buildings as well as in the neighboring community of Innichen, 2.5 miles away. It's owned and run through an innovative co-op membership and gets its wood fuel from local, family-owned forests.

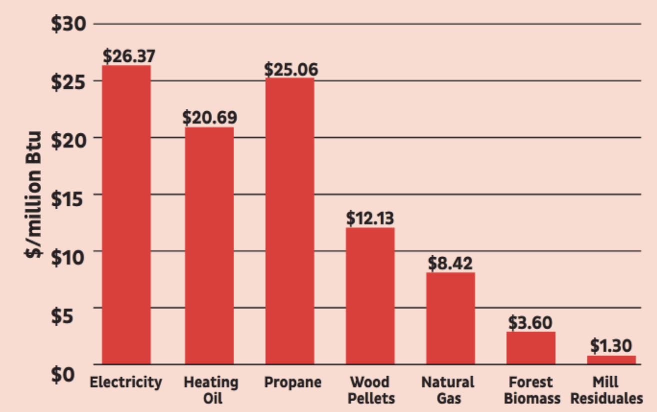
Savvy Pioneers Have Paved the Way

Several pioneering ski areas are discovering that wood energy is right for them. With grant funding from the state of Montana and the USDA Forest Service, Bridger Bowl installed a high-efficiency indoor cordwood boiler that heats two buildings with about 20 cords of dead-standing timber per season. The wood is harvested and processed on the mountain by the summer maintenance crew.

It is important to note that the cordwood displaces most, but not all, of Bridger's propane use at the groomer shop. Wood energy systems actually always have a fossil fuel back-up system that can help to meet the highest heat demand on the coldest days. Wood energy installations operate most efficiently when they are running full-bore, and are intentionally sized *not* to meet the highest heat demand of a facility—since those coldest days are not the majority of days in a heating season. The back-up fossil fuel system is retained to make up the remainder of the heat needs on those few coldest days while still allowing the wood boiler to run at its greatest and cleanest efficiency.

Bob Pettit, Bridger Bowl's business operations manager, says he is impressed with the system's efficiency. "The boiler system burns cleanly with a 90 percent efficiency rating," Pettit said. "It works great. You don't even know it's there. Just stoke it up twice a day and that's it." ›

fig. 1 **Comparison of Energy Costs by Fuel Type**



Source: Wisewood Energy, 2017.

Bridger collaborated with a local plumbing and heating contractor in Bozeman to design and install the boiler, and spent about $40,000, with nearly half of the cost covered by a grant. Pettit estimates the installation will pay for itself within about five years.

Since 2011, Mt. Abram has been heating their 7,500-foot temporary base lodge using locally sourced wood pellets—and displacing about 12,000 gallons of #2 heating oil per year. A pellet mill 6 miles away produces and delivers the pellets, keeping transportation costs low and the energy dollars local.

"The owners of Mt. Abram have always been committed to sustainability and supporting local business," said Dave Scanlan, former general manager at Mt. Abram. "It's a win-win for all—working with local businesses, lowering the ski area's carbon footprint, and doing something that supports the forest and the ski area's livelihood in the face of wildfire and climate change."

Several other ski areas have conducted feasibility studies to determine if wood energy makes sense for them. In Oregon, Mt. Bachelor is currently in the design phase of integrating a wood energy system. In Montana, Red Lodge Ski Area is seeking financing to move forward with an installation. In Pennsylvania, Seven Springs Mountain Resort is scoping out the potential of wood energy at Laurel Mountain. And in Big Sky, Montana, Moonlight Basin Ski Resort recently completed a feasibility study including a forest management plan that inventoried the sustainable supply of wood fuel from their own property. The resort is now well-positioned to include wood energy in their future resort developments.

Outside of ski areas, renewable wood energy has been broadly adopted by the commercial, industrial, and institutional sectors with more than 600 systems operating in the US. Universities, hospitals, schools, businesses, and government buildings have been using renewable wood energy systems for decades. In fact, eight out of the top 20 universities on the Sierra Club's 2016 list of America's Greenest Universities use wood energy on their campuses.

The Payback: More than Money

Wood fuel prices compete very strongly against propane, heating oil, and electricity (see figure 1). Cost savings being achieved by converting to wood energy range from 25 to 75 percent over fossil fuel heating costs. The financial payback on a wood energy system depends on fuel cost savings, wood fuel type and technology used, and the cost of new construction. In terms of construction costs, a wood energy system can range anywhere from $3,000 for a small high-efficiency wood stove in the bar to upwards of $350,000 to $1 million and beyond for a large base lodge and campus installation serving several buildings.

Sometimes, a wood energy system can be justified on purely financial grounds; however, many owners are primarily motivated by the environmental benefits these systems provide. Ski area professionals are acutely aware of how a changing climate impacts ski operations, and managing the carbon intensity of operations demonstrates a commitment to broad environmental stewardship. In addition, use of a wood energy system not only can reduce greenhouse gas impacts and improve forest health and resilience but it also supports local businesses and provides local jobs—a combination of benefits that few other renewables can offer.

A recently completed regional life-cycle analysis of the greenhouse gas impacts of using high-efficiency wood pellet boilers to heat buildings in Maine, New Hampshire, Vermont, and New York found heating with wood pellets to be "climate better." The report states, "On day one, using wood pellets for heat reduces greenhouse gas emissions by 54 percent compared to oil and 59 percent to natural gas" (www.northernforest.org, June 1, 2017).

Using wood for energy can have a positive impact in moderating climate change. The majority of wood burned to generate heat and energy in the US is wood waste and byproducts from sawmills, forest thinning, and logging operations. If not used in an alternate product such as wood energy, that wood material would meet other fates that release greenhouse gases and particulate emissions: decomposition in piles or landfills, or burned in open piles. Diverting this wood material to produce energy minimizes methane emissions (a potent greenhouse gas) while also displacing fossil fuel use.

Burning wood for energy recycles carbon that is already in a short-term carbon cycle as significant quantities of carbon dioxide are absorbed by trees through photosynthesis, and then released through decay. Whether wood from trees naturally decomposes or is burned, carbon dioxide is emitted back into the atmosphere, replacing carbon that was recently absorbed › during tree growth. Conversely, fossil fuels are ancient carbon deposits that have not been a part of the short-term carbon cycle for millions of years. When fossil fuels are burned, carbon dioxide is added to the atmosphere at a rate that is too great for land plants and oceans to absorb into the carbon cycle.

As long as the forests from which the wood came are sustainably managed in a way that stimulates the growth of replacement wood and the forest's capacity to continue to sequester carbon, there is no new carbon dioxide added to the atmosphere. The replacement tree growth absorbs the carbon dioxide that was released during wood combustion (https://edis.ifas.ufl.edu/pdffiles/FR/FR18800.pdf).

In addition, wood energy is a smart environmental choice because markets for wood energy underwrite the cost of managing forests to keep them healthy, resilient, and intact. Many forests across the US increasingly are vulnerable to disturbances including insects, disease, wildfire, and climate change. Keeping these forests healthy requires responsible stewardship and market demand for otherwise low-value wood.

Sustainable Sourcing

Where will the wood come from? Wood supply and sourcing are important considerations in a successful wood energy system. In general, wood fuels (chips, pellets, and cordwood) are byproducts of wood products manufacturing, forest management, fire risk reduction, and urban tree removal.

The size and specifications of a proposed system will determine the appropriate fuel. Wood pellets are available from local pellet manufacturers. If using cordwood or wood chips, the ski hill, local mills, or area forest could provide the needed supply. In many forested communities, forestry contractors own and operate equipment to efficiently process cordwood and wood chips.

Mountain communities and ski areas understand that forests need consistent active management. Active management produces sawlogs and "slash piles" of tree tops, limbs, and defected or small diameter trees. Hopefully, local mills will buy the sawlogs and you can reinvest that income to cover other maintenance costs, but most often the slash piles are burned on site. Burning slash in an open pile produces methane (a potent greenhouse gas), releases particulates, and raises the risk of an escaped wildfire. When demand from wood energy systems exists, slash piles can be converted into wood fuel and combusted in a controlled system that can typically decrease particulate emissions by 95 percent.

Design & Technology Considerations

The first step in exploring the integration of a wood energy system at your facility is to find an energy engineering firm with proven experience in designing and constructing wood energy systems. Wood energy systems handle a solid, variable fuel, which makes it very different from designing conventional gas, oil, and electric energy systems.

An engineer will visit your facility, assess energy usage and the existing distribution system, and determine if a wood energy system is feasible—technically, economically, and environmentally. If such a system makes sense, the engineer will then guide the selection of the right technology and fuel type to be determined by the heat and energy demands of your facility, available footprint, and other factors. For smaller projects, wood pellets or cordwood are often the best choice. For larger projects, wood chips often are the lowest cost solution (see figure 2).

Also look for proven technology—visit with the operators of wood energy systems in your region. Kick the tires and ask all of your burning questions (pun intended).

Where Wood Energy Works Best

- Expensive fossil fuel source
- Building(s) connected to a centralized heating system
- Large heating and/or power bills
- Nearby wood fuel source

Support & Financing

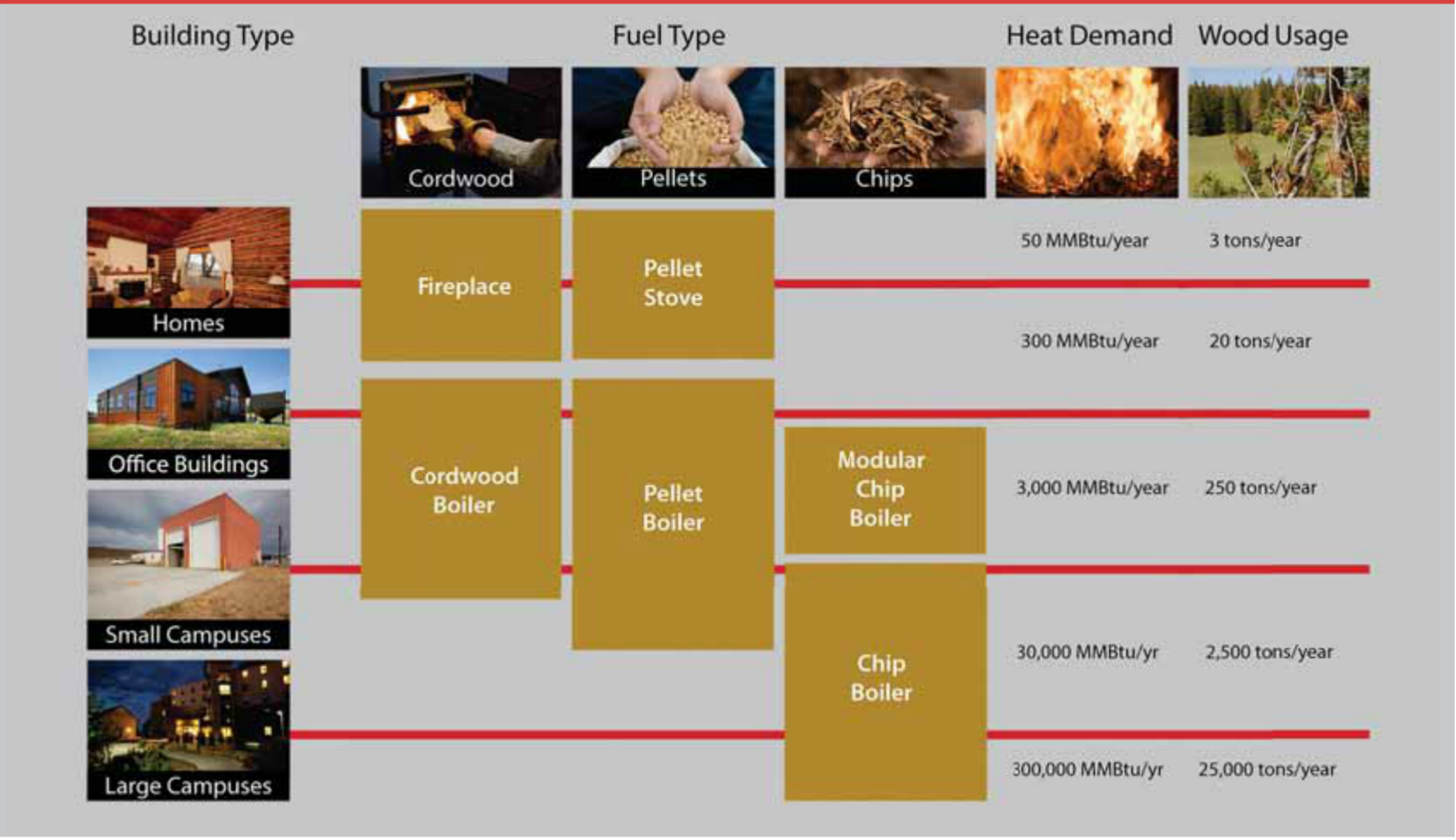
Many successful wood energy projects have accessed the diverse offerings of grants and loans available through state and local programs and federal agencies such as the Forest Service and USDA Rural Development. Other creative financing applied to projects includes performance contracts where the project cost savings are guaranteed by the engineering firm, or where a third-party covers the full installation cost of the system, then owns and operates the wood energy system and the metered energy is billed to the consumer. Financing may also be available through local utility companies, charitable foundations and private banks.

The Forest Service and US Department of Agriculture are committed to expanding domestic renewable energy including promoting wood energy. The use of wood for energy provides American-made goods while supporting sustainable forest management.

The Forest Service Wood Innovations program staff offer technical and financial assistance to wood energy project development. The Forest Service anticipates announcement of a Request for Proposals for the Wood Innovation Grants

fig. 2 Considerations for Scope of Wood Energy System

This chart provides a rough idea about which technologies are most appropriate for your application. It is not a design tool.



Mt Abram's installation of a containerized pellet system heats the 7,500-foot base lodge, displacing about 12,000 gallons of heating oil annually.
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in October 2017, which can support strong wood energy projects (https://www.fs.fed.us/science-technology/energy-forest-products/wood-innovation). In addition, 22 State Wood Energy Teams provide local technical and financial support, including grant funds for preliminary feasibility assessments and feasibility studies. Other resources are http://www.woodenergyproject.com, http://www.biomasscenter.org, and http://www.forgreenheat.org.

There is a compelling case to be made for ski areas and mountain communities to embrace modern wood energy. In many cases it is a way to save money on energy expenses, help reduce greenhouse emissions, and send a compelling message to guests, employees, the ski industry, and even other industries: that your area is committed to minimizing its environmental footprint, supporting the local economy, and preserving the slopes for skiing and snowboarding for future generations. N

To identify your local wood energy specialists and find out if wood energy could be a good fit for your facility, contact Julie Kies, Renewable Wood Energy Program, USDA Forest Service, (406) 329-3680, jkies@fs.fed.us.