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U.S. Endowment for Forestry & Communities, Inc.

Biomass Energy in Grant County: Case Studies

Oregon, USA

Grant 2012-002: Next Steps in Scaling-up Woody Biomass Energy: Learning & Priorities
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- Mark Webb, County Judge, Grant County
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- Nerissa Lindenfelser, Project Manager, Wisewood Inc.
- Mike Billman, Timber Manager, Malheur Lumber Company
- John Rowell, Plant Manager, Malheur Lumber Company
- Mark Witty, Superintendent, Grant Union School
- Dennis Flippence, Head of Maintenance, Grant Union School
- Bob Houser, CEO, Blue Mountain Hospital
- Steve Hill, Director of Facilities Services, Blue Mountain Hospital
- Patrick Bentz, Airport Manager, Grant County Regional Airport

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Introduction

With a population of just over 1,700 people, John Day is a small rural town located in east-central Oregon that despite its small population provides a successful model for biomass energy projects. The facilities that have converted to biomass systems in John Day (as well as a school located nearby in Prairie City) are geographically clustered within a high unemployment rural county. John Day is a very timber-reliant town and has experienced a great deal of economic stress due to restricted logging operations on federal lands and mill closures. Data from the Oregon Labor Market Information System shows that as of October 2012, Grant County had an unemployment rate of 13.6% percent.[1]

According to the US Forest Service, the National Forest land surrounding the town is in poor health, and it is believed that forest management activities that support increased restoration[2] will help improve forest conditions, benefit the local economy, create a sustainable biomass supply, and reduce wildfire threat. As a result, a broad collaborative effort centered on the Malheur National Forest has arisen and has been key to the success of the biomass cluster.

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[1] Source: "Oregon's Recession Timeline." Oregon Employment Department, Oct. 2012 http://www.qualityinfo.org/olmisj/OlmisZine?zineid=00000011 .

[2] Restoration is the process of assisting the recovery of an ecosystem that has been degraded, damaged, or destroyed. Ecological restoration focuses on re-establishing the composition, structure, pattern, and ecological processes necessary to facilitate terrestrial and aquatic ecosystem sustainability, resilience, and health under current and future conditions. Source: http://www.fs.fed.us/restoration/

Biomass clusters, like the one in Grant County, have multiple benefits such as improvements in efficiency by minimizing fuel transportation distances. According to the Oregon Bureau of Land Management, four primary features characterize biomass clusters:

1. A source of woody biomass (forest residue from forest management activities, for example).
2. A biomass manufacturer that produces biomass fuel.
3. A market to utilize the biomass product (schools with biomass boilers, for instance).
4. Close proximity of biomass sources, biomass fuel processors, and customers.[3]

The biomass energy development case studies reported herein summarize the experience of four clustered facilities that converted to biomass pellet systems; the development of a local pellet mill is also chronicled. This report also highlights the issues and cost of restoration efforts carried out in Western public lands and addresses whether the local use of biomass energy systems can help compliment forest management goals. The lessons learned from these sites, as well as the larger collaboration of the Blue Mountain Forest Partners, could act as a model of sustainable, clustered biomass energy development that could be implemented elsewhere in the Western U.S. where public lands are prominent.

Figure 1. John Day, Oregon

The Collaborative

Coincidental to an economic downturn affecting the town of John Day, the National Forest land surrounding the town is considered to be in poor health. As a result of these adverse conditions, a collaborative (centered on restoration[2] activities carried out on the southern end of the Malheur National Forest) was formed in 2006. The collaborative is known as the Blue Mountain Forest Partners (BMFP), and it includes a wide spectrum of stakeholders such as the Forest Service,

[3] Source: "Biomass Cluster Pilot Project." Bureau of Land Management, 19 Sep. 2012 http://www.blm.gov/or/resources/forests/files/BiomassClusterFAQ.pdf .

conservation groups, local mills, ranchers, contractors, city and county representatives, and local citizens. BMFP has allowed generally adverse groups to find common ground regarding restoration activities and has given the Forest Service social license to carry out restoration projects in the Malheur National Forest without fear of litigation. It is thought that increasing the number and scale of restoration projects in the area will help improve forest conditions, benefit the local economy, reduce wildfire threat, and open up a larger and more sustainable fuel supply for biomass energy utilization and other activities. The importance of the collaborative to the community and to the success of the biomass cluster came up repeatedly during interviews with various local stakeholders. One of the interviewees went so far as to say, "John Day would be a ghost town with just firefighters and ranchers without the collaborative."

In the fall of 2012, Dovetail Partners interviewed some of the major stakeholders involved in BMFP to learn more about its beginnings, lessons learned, and about best practices contributing to its success.

Main Goals and Drivers

According to Mark Webb, a County Judge who has been involved in BMFP, the initial goals of the collaboration were to reduce the risk of unnatural fires and to help support the local community. However, these initial goals evolved over time, with the emphasis now on fostering longer-term environmental resilience and community development. According to Mike Billman, Timber Manager at Malheur Lumber and a co-chair of BMFP, the overarching goal of the collaboration is focused on forest restoration. "Of course, some people feel that the main goal of the collaboration is more economic than environmental," Billman points out, "but the reality is that everything has to be driven by the ecological benefits because this is what keeps the environmental groups at the table." As Webb elaborated, "It increasingly became a desire not just to reduce fire danger and [improve] economic drivers, but to reintroduce or restore complex forest structures that are important for wildlife species, listed species, and species of concern as well as to reorient how commercial harvest looks at things."

For environmental groups, the main interest in the collaboration has been to preserve and protect forest resources such as large, old growth ponderosa pine trees. According to Curt Qual, Partnership Coordinator at USDA Forest Service, the Malheur National Forest is in very poor health. It is overstocked and has a high threat of wildfire stemming from years of fire suppression and reduced management. Insect infestations and various forest health threats are also problematic. Old growth trees in the National Forest, which were logged heavily in the past, are now being lost due to wildfire and pine beetles. According to the "Southern Blues Restoration Coalition" report, despite aggressive fire suppression efforts, there have been seventy-one large fires between 1980 and 2010 that have burned over 300,000 acres in the Malheur National Forest, and over half of the dry forests within the National Forest are overstocked. The report also states that roughly thirty percent of forested stands near the southern end of the Blue Mountain range could potentially lose twenty-five percent of their volume due to insects and disease over ten years.[4] Such conditions led the environmental

[4] Source: "Southern Blues Restoration Coalition." USDA Forest Service, 2011. http://www.fs.fed.us/restoration/documents/cflrp/2011Proposals/Region6/Malheur/2011SouthernBluesRestorationCoalitionCFLRPProposal.pdf .

community to realize that active management and commercial activity were needed to protect these environmental assets.

The interviewees explained that there was a great desire on the industry side to increase commercial activity in the National Forest. As a very timber-dependent town, these activities are strongly tied to the economic wellbeing of John Day. Commercial activity in the National Forest had almost completely dried up in the years prior to development of the cooperative. “Environmental efforts were very successful in shutting down the timber program. Even though greater than sixty percent of our county is Forest Service, we were not getting anywhere near the amount of timber we needed,” Billman said.

Overall, it seems clear that the beginnings of the BMFP collaboration was born out of necessity to address the pressing issues that could only be solved if various environmental, community, and industry stakeholders worked together. Billman believes it was the combination of the forest industry losing wood supply and environmental groups losing forest resources through wildfire that pulled these normally adverse groups together. Mark Webb emphasized the symbiotic relationship between the groups, “Environmental groups cannot achieve their goals for ecological restoration short of a viable timber industry. You cannot separate these things on the east side. . . because those parameters are forced on both groups. The timber industry is willing to reach for less than what they want as long as they get a commercially viable product . . . and the environmental community is much more willing to consider and put together projects that have a significant economic component for the sake of supporting the timber industry—as long as the prescriptions are ecologically appropriate.”

Benefits

The collaborative has led to a number of important benefits now that it has been operating for about six years. Curt Qual stated that perhaps the most important benefit of BMFP is that forest restoration planning has been able to keep pace with implementation in the Malheur National Forest. He explained that National Forest operations that lack collaborative programs are much smaller and their planning much more expensive because of litigation. Because of BMFP, diverse and adverse stakeholders have been able to come together and hash things out over the course of three to five years to come to an agreement regarding restoration efforts. Before the collaboration, it used to take about two to three years to get one small restoration document prepared just because it had to be ironclad legally so that it could be carried out.

Consequently, the number of National Forest acres on which restoration management activity occurred was very low. According to Mike Billman, the collaboration has opened up a greater supply of biomass and saw logs. The collaborative has been instrumental in helping get projects through the approval system faster. Billman said that project sizes have increased “from under 10,000 acres to now between 20,000-40,000 acres.” Furthermore, he explained, a higher percentage of these project acres are being treated where harvesting is included as part of the restoration operations. “It used to be maybe a third of the acres, now we’re up to fifty percent. The more acres you treat, the more biomass and saw logs are available,” he stated.

Mark Webb also agreed that the collaboration has helped reduce the amount of litigation that used to exist. There appears to be less reason for litigation. The prescriptions that are agreed to in the collaboration are more restoration-oriented and less aggressive commercially than timber harvesting in the past. He pointed out that these restoration activities would not exist without the collaborative. “The collaboration has definitely made a difference in getting large projects on the ground that are successful and that have made a difference to their existing mill,” he said. “I think as we get more aggressive with our prescriptions for biomass removal in order to achieve a more resilient situation, we are likely to see some attempts at litigation because some environmental members in the community are not comfortable with any kind of activity on forest land.”

Mike Billman also agreed that BMFP has helped avoid litigation and has benefitted both Malheur Lumber and the wider community. Several years ago when the recession first hit and the housing market slowed down, timber industries, including Malheur Lumber in John Day, were among the first to feel the impact. Conditions continued to deteriorate, and in August 2012, mill management announced that by November the sawmill would be closed permanently. However, within only several weeks, there was a huge local effort in the community to save the mill. Billman explained that this effort was not based just around the mill. “In this case, we had been very tight with the collaborative efforts and the collaborative efforts had been very substantial. This was about saving everything that [the collaborative] was doing on the Malheur National Forest,” he said. As the last mill in the area that can process logs, Malheur Lumber is an important part of the forest restoration work. Local support pulled together leaders from the environmental sector, timber industry, the U.S. Forest Service, and other citizens in John Day. This effort resulted in the Forest Service agreeing to speed up timber sales and increase restoration projects, which helped save the mill and allowed the collaborative to continue its work. “I believe this is all because of the collaborative,” Billman said.

Various reports also highlight the benefits of collaborative forest management activities in Oregon. For instance, a 2011 Forest Service report titled the “Southern Blues Restoration Coalition” estimates that restoration activities centered on the Malheur National Forest would lead to a sustainable supply of biomass and benefit local communities, increasing restoration-related employment by approximately seventy percent (or as many as 154 new jobs).[5] According to the report “National Forest Health Restoration: An Economic Assessment of Forest Restoration on Oregon’s Eastside National Forests,” for every one million dollars spent on restoration activities in eastern and south central Oregon, $5.7 million are generated in economic returns; furthermore, the report states that for each dollar the Forest Service spends on restoration activities, the agency avoids $1.45 as a potential loss due to wildfire-related costs.[6]

[5] Source: “Southern Blues Restoration Coalition.” USDA Forest Service, 2011. http://www.fs.fed.us/restoration/documents/cflrp/2011Proposals/Region6/Malheur/2011SouthernBluesRestorationCoalitionCFLRPProposal.pdf .

[6] Source: Krumenauer, Matt, et al. “National Forest Health Restoration.” 26 Nov. 2012. http://orsolutions.org/beta/wp-content/uploads/2011/08/OR_Forest_Restoration_Econ_Assessment_Nov_2012.pdf .

Best Practices and Lessons Learned

The management of Forest Service lands is driven extensively by federal policies, including the National Environmental Policy Act (NEPA).[7] The NEPA process has become integral to federal land management and requires public engagement in management decision-making and planning. Tools like a collaborative can provide a number of benefits, including the direct benefit of addressing the NEPA requirement for stakeholder engagement. According to Mark Webb, "As long as we're going to have NEPA and federal land management, the collaborative is the best way to go because it facilitates local ownership of a public process, where 'local' is understood broadly to include whoever is at the collaborative table, and thereby matures it in a manner that was lacking before, but is essential for moving forward. This collaborative probably has only been successful because so much is at stake for the industry and the environmental community."

It is clear that one of the largest benefits of the collaborative is that it has prevented litigation that used to bring forest management activities to a standstill. "Litigation is not the way forward because it shuts things down. This is where the collaborative is nice because it doesn't shut things down. It filters out the bad and facilitates the good. So, we need a Federal land management approach that is less litigation prone and more [focused on promoting resilience,]" Webb said.

Based on our interviews with stakeholders involved in the collaborative, BMFP, and similar collaborative efforts centered on National Forests, represent a best practice that can be employed to restore whole forests and landscapes rather than small patches of land. Collaboration is the foundation from which forest material [logs, biomass, etc.] is opened up and helps attract industry through a guaranteed sustainable supply.

However, there is a need to build the capacity of collaborative groups (like those involved in BMFP) in the West so that they can continue their work and help make bioenergy fuel access self-sustaining. In Oregon, other collaborative groups similar to BMFP are not well funded, and this is a limiting factor in carrying out forest restoration activities. Another major limiting factor, according to the interviewees, is that the Forest Service's funding for restoration activities is lagging behind collaborative proposals.

According to the 2011 "Southern Blues Restoration Coalition" report, biomass removal on the Malheur National Forest has been more feasible when both biomass and saw logs are removed at the same time. They have found that restoration treatments are economically viable when the saw log/biomass volume ratio is maintained at about 50/50. According to the same report, the Malheur National Forest has a fifty million dollar, five year "Collaborative Restoration Stewardship" contract that makes it more economically feasible to combine the removal of biomass and low value material: "The value of the products will return nearly 75% of the cost of

[7] NEPA was signed into law January 1, 1970 and establishes goals and a process that promote national environmental protection. Under the Act, federal agencies are required to thoroughly assess the potential environmental impacts of any major federal action that could significantly affect the environment. Citizens and organizations have the ability to sue a federal agency if it fails to enforce NEPA provisions under a proposed action. For more information about NEPA, please visit www.epa.gov/compliance/basics/nepa.html

the restoration thinning back to the Malheur National Forest, which will be used to accomplish additional restoration work that otherwise may not occur."[8]

Approaches to Help Foster Collaboration Around National Forests

Decision-Making Process

Mark Webb emphasized the importance of building a clear decision model. "It's really taken getting clear about common ground, what we are willing to live with and not willing to live with, and you need a pretty mature decision making process exercised by mature people," he said. "Because you're starting to push the edges of what is acceptable to either the timber industry or the environmental community. . . .You're going to be in situations where there will be outliers either with the industry or the environmental community." He pointed out that BMFP would not have been able to make progress if total consensus was required on every project before moving forward. BMFP needed a decision model that respected disagreement and diversity yet still facilitated robust projects. As such, to meet these needs, *the group tries to have representatives from a wide variety of relevant stakeholders and uses a majority rules system.* More specifically, the group adopted a system whereby a majority vote moves a recommendation forward to the Forest Service and requires that the majority recommendation include individuals from every interest group represented in the collaborative. Individuals who support an alternative are encouraged to share and submit their concerns and recommendations to the Forest Service for consideration.

According to Mike Billman, in order to find common ground between the generally adversarial groups, BMFP has relied on *good facilitation* particularly at the onset. The collaborative group was lucky, he explains, to have facilitation through Sustainable Northwest and other groups like the Gifford Pinchot Taskforce. These organizations have been vital in terms of facilitation and organizational leadership.

Field Tours

Another best practice highlighted by Mark Webb has been the *field tours* provided by the Collaborative. They found out that the industry and environmental organizations use very different language to support their perceptions and describe their goals. In a formal setting (like an office or a conference room) it can be much harder to neutralize the rhetoric between interest groups. In contrast, field tours get people on the ground to see firsthand what the landscape looks like before and after a restoration treatment. After the tours, Webb said that the groups involved in BMFP found that despite what often appeared to be deep differences in perception and interests when shared across a table, they were able to come closer to agreement about what is occurring on the ground and began to use common language, which made it easier to communicate more effectively with each other.

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[8] Source: "Southern Blues Restoration Coalition." USDA Forest Service, 2011. http://www.fs.fed.us/restoration/documents/cflrp/2011Proposals/Region6/Malheur/2011SouthernBluesRestorationCoalitionCFLRPProposal.pdf .

The Right Stakeholders

Having the *right mixture of stakeholders* in the Collaborative has also been critical to its success. "You have to have parties that are interested and committed, have no option but to work together, and are solution oriented." Mark Webb said. To foster fruitful cooperation, it was important that BMFP not just choose representatives from the relevant stakeholders, but select individuals who were able to see things from multiple perspectives, able to consider alternatives, and who could acknowledge when they were wrong. "If a person lacks these character traits, then even if you have the representative groups attending, conversations are probably going to be less than fruitful," he said.

Access to Local Experienced Biomass Users

Access to a network of experienced clustered biomass users has also been critical to the continued success of the collaborative. Having facilities in the area that are able to utilize biomass for heating purposes creates a market demand for biomass material that is the by-product of the collaboration's forest management activities. Demand for forest residue means that it can be utilized to manufacture wood pellets rather than left onsite to be burned in piles or accumulating and contributing to a greater wildfire threat.

Biomass Energy Case Studies

The following four case studies describe the experiences of two schools, a hospital, and an airport in converting to biomass energy systems within the Grant County cluster. The development of a local pellet mill is also described.

Grant Union JR/SR High School

Figure 2. Grant Union School

GENERAL INFORMATION	
FACILITY	Grant Union School
Building Area (ft^2)	12,000
Experience Total (years)	1
Project Type	Retrofit
EQUIPMENT SPECIFICATIONS	
Boiler Manufacturer	Hurst
Boiler Model	Hurst
Output MMBtu/hr	2.00
Biomass Percent of Building Heating	85%
Backup Unit	Propane
FUEL SPECIFICATIONS	
Composition	Ponderosa Pine wood pellets
Source	Forest stewardship contracts
Supply Radius (miles)	5
Delivery Frequency	Monthly
Quantity Delivered (tons)	20
Cost Per Ton Delivered	$ 165
Moisture Content	$\leq$ 5%
Fuel Storage Capacity (tons)	25
Annual Consumption (tons)	180
Fuel Replaced by Biomass	Heating Oil
Annual Biomass Fuel Cost	$ 29,700
Annual Heating Cost Savings	$ 49,260
PROJECT ECONOMICS	
Project Total Funding	$ 532,000
Quality Zone Academy Bond	$ 500,000
DOE Cool Schools Grant	$ 32,000
Other Non-Project Funding Malheur Lumber Discounted Pellets	$ 50,000
Project Total Cost	$ 532,000
Equipment Cost	$ 235,200
Installation Cost	$ 296,800
Annual O&M Costs	$ 1,200
Financial Analysis	
Annualized Rate of Return (10yr)	8.7%
Internal Rate of Return (25yr)	14.8%
Payback Period (years)	10.8

Project Background

Grant Union JR/SR School is a small 7-12th grade school located near the southern edge of John Day, Oregon. Grant Union School's shift to biomass began abruptly in 2011, when heavy rains and flooding swamped the school campus and forced the school's oil storage tank up and out of the ground. This disaster had a silver lining, however, as it was spring when the boiler was knocked out, so there was still some time to act before the arrival of the winter heating season. Grant Union was able to use this time to research what type of systems would best fit their current and future needs and to come up with funding. First, they used the flood as an opportunity to convert their old oil boiler to propane, which was demonstrated to be a cheaper alternative to replace and operate. Soon after, they began to put together a larger plan to put in a new biomass system.

The main goal of Grant Union School's biomass project was to reduce the yearly cost of heating the building, explained Mark Witty, Superintendent of Grant Union School. Another motivation was to act as a community partner by helping struggling local businesses by purchasing their timber products. Witty noted that helping the local community was important because both the economy and forest were in bad condition.

To determine which biomass model to purchase, the school utilized computer-modeling programs to compare various boiler alternatives. The school contracted with Wisewood, a local engineering firm that specializes in biomass energy, to provide technical recommendations on the project. The school initially calculated that they could cut their heating bill from $78,960 per year using 23,500 gallons of oil at $3.36 per gallon down to roughly $40,000 per year by installing a biomass system. They also contacted other local woody biomass facilities in Grant

County such as Blue Mountain Regional Hospital and the Regional Airport to learn about their experiences with biomass systems and to identify how much money they were spending/saving. The staff at Grant Union attended an open house at Blue Mountain Hospital to see their new pellet system first-hand and hear about how it was working.

Ultimately, the school chose to go with a wood pellet boiler. The conversion took a little over a year to complete and the boiler went online March 2012.

System Components

Today, a 2 MMBtu/hr Hurst biomass boiler heats Grant Union's 12,000 square foot seventh-through-twelfth grade school building. The boiler is housed in its own small building directly outside of the school alongside a twenty-five ton pellet storage silo. They generally fire the system up by the middle of October and run it into early May. The pellet boiler is designed to heat the building at around eighty-five to ninety percent capacity, so pellets are not the school's only heating source. The school uses the propane backup system during exceptionally cold periods in the winter or when the building needs to be heated quickly, but they are attempting to minimize its use by carefully tuning the biomass system.

Figure 3. Dennis Flippence, Head of Maintenance, Next to the Pellet Boiler

The school has not encountered any major frustrations using the new boiler. Currently, the system is not quite tuned correctly to maximize fuel efficiency, and there are continuing efforts to determine the best times to turn the system on and off. Compared to their old boiler, Mark Witty believes that there will be more labor involved with the biomass system, particularly cleaning the ash out, but they have a good delivery system, so this is not a large concern. The system produces very little ash—about a fifty-gallon trashcan per year—and requires very little maintenance, generally about two hours per week.

Project Economics

Much like the rest of John Day, money is tight at Grant Union School, so converting their heating system was no small task. They realized if they found the right funding package, biomass would reduce their heating costs and help the local economy—but it would take the right financial incentives.

After the flood in 2011 that forced the school's oil storage tank out of the ground, Grant Union began to look for funding resources. They were able to identify a Quality Zone Academy Bond (QZAB), which would cover $500,000 of the cost to convert to a biomass system. As part of the QZAB agreement, the school had to get a local company to give ten percent of the

Quality Zone Academy Bond

A tax credit bonds program providing interest-free loans to public schools for building renovations or repairs, equipment purchases, curriculum development, and/or school personnel training. Rather than receiving interest payments from schools, lenders receive tax credits issued by the federal government.

bond as a donation. Malheur Lumber stepped up and gave an in-kind donation that provides Grant Union with pellets for a reduced cost (essentially, a $33.00 discount per ton) until $50,000 in value is reached. Under the donation agreement, Malheur Lumber bills Grant Union School for the market value of the pellets ($165.00/ton) and a credit is applied reducing the total fuel cost until the $50,000 donation is reached. The Oregon Department of Energy's Cool Schools program also provided a $32,000 grant for the project. Through the QZAB zero interest loan and the other financial assistance, Grant Union was able to take much of the risk out of the project and get it off the ground.


Figure 4. Rear of the Hurst Pellet Unit

According to Superintendent Witty, financing was of key importance and ended up being the hardest part of getting the project on its way. "A biomass boiler is a much larger outlay of cash on the front end so [you] need to be able to view the savings over the long haul," he said. "We would not have been able to do the project without the incentive of a zero interest loan."

It took a significant amount of time to reach an agreement with Sterling Bank for the QZAB. Getting the QZAB agreement was difficult in part because of requirements like a balloon payment on the loan amount that the school must pay annually (approximately $33,000 per year) and because they had to convince Malheur Lumber to provide $50,000 worth of discounted pellets (which was required to qualify for the QZAB). The school struggled to sell the idea of a biomass system conversion for several months. Local banks in the county helped apply pressure on their district offices to get them to agree to the QZAB project. Ultimately, Sterling Bank took on the QZAB and now receives a tax credit, allowing Grant Union School to pay back the bond at zero percent interest.

In total, the project cost approximately $532,000. Grant Union School expects a savings of roughly $49,260 a year before debt service expenditures (a higher savings than was initially estimated). The school currently estimates that they will still save roughly $15,000 per year after paying off the bond.

There are various methods that can be employed to analyze a project's financial viability. One financial analysis tool is the annualized rate of return (ARR).[9] The purpose of the ARR is to identify the potential rate at which an investment will increase (or decrease) each year. Calculating a ten year ARR is valuable for investors because this timeframe best reflects their shorter term focus. The ARR is calculated using a project's return on investment (ROI), which acts as a multiplier at which an investment is estimated to grow over a set time period.


Figure 5. Pellet Silo and Boiler Housing Building

[9] ARR Formula: $((1+ROI)^{1/N})-1$
N = # of years ROI = Return on investment = B – C/P
B – C = Cumulative fuel cost savings added up over a set period of time P = Total project investment.

Another useful financial analysis calculation is the internal rate of return (IRR). The IRR estimates a facility's expected return from an investment over time (a measurement of the efficiency of the investment). The IRR is useful for facility owners and calculating it over a twenty-five year time period coincides with the typical projected life of a wood-energy system (twenty-five to thirty years). It is calculated as comparison of fuel savings for term to total project investment.[10]

A basic financial analysis of Grant Union's biomass project shows that it has a payback period of 10.8 years, a ten year ARR equal to 8.7%, and a twenty-five year IRR of 14.8% (assuming inflation varies by source of energy). In this analysis, inflation rates of 1.5% for wood and 5.5% for heating oil were used.[11] Overall, these calculations indicate that Grant Union's project is favorable from a financial investment perspective (current markets are looking for an ARR between five to ten percent and the project's IRR indicates positive growth). For additional financial analysis details, please see Appendices A and C.

Fuel Supply

Grant Union School's wood pellet fuel is supplied locally by Malheur Lumber Company's pellet and brick plant in John Day. The pellets are made using forestry residuals and small diameter trees that are removed from National Forest lands during stewardship contracting activities. The $50,000 grant from Malheur Lumber provides the school a discount (thirty-three dollars off per ton) on pellets they purchase from Malheur until $50,000 in value is reached. On average, the school burns around 180 tons of pellets when the system is running during the cold months of the year (or about one ton per day), representing an annual fuel cost of approximately $29,700 (without applying the discount). The design of the project was aided by having a supplier that was able to offer a set fuel ton price over a period of time.

The main reasons the school selected pellets, versus an alternative biomass fuel like woodchips, are because they are clean burning, efficient, require minimal maintenance, and are a local product. In addition, the local area does not have access to natural gas, so that was not an option. Malheur Lumber's pellet plant is located four miles from the school. The pellets are delivered on a monthly basis when the system is operational starting in October. If a local source of pellets were no longer available, the school could invest $25,000-$30,000 to convert the system to utilize woodchips.

Conclusion

Now that the project is complete and the school has some experience operating the system, they have been very satisfied with the results. "We are one hundred percent satisfied with the system so far," Witty said. The school likes using a heating source that is clean, less expensive, and locally produced. They are going to visit other school boards in Oregon to share their experience with the system. If things continue to work well over the next couple of years, Witty plans to pursue another QZAB to install another boiler to heat an additional school building.

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[10] IRR Formula: $PNW = 0 = F_a/(1 + R)^a$

PNW = Present Net Worth = 0 F = Income Each Year = Fuel Savings Each Year a = Year R = Rate of Return

[11] U.S. Energy Information Administration for all inflation estimates except wood. Wood inflation estimate was provided by local expert Andrew Haden (www.Wisewood.US)

Blue Mountain Hospital

Figure 6. Blue Mountain Hospital

GENERAL INFORMATION	
FACILITY	Blue Mountain Hospital
Building Area (ft^2)	50,000
Experience Total (years)	2
Project Type	Retrofit
EQUIPMENT SPECIFICATIONS	
Boiler Manufacturer	Viessmann-Köb
Boiler Model	Pyrot 540
Output MMBtu/hr	1.84
Biomass Percent of Building Heating	90%
Backup Unit	Heating Oil
FUEL SPECIFICATIONS	
Composition	Ponderosa Pine wood pellets
Source	Forest stewardship contracts
Supply Radius (miles)	3
Delivery Frequency	Bimonthly/Monthly
Quantity Delivered (tons)	20-25
Cost Per Ton Delivered	$ 165
Moisture Content	≤ 5%
Fuel Storage Capacity (tons)	50
Annual Consumption (tons)	260
Fuel Replaced by Biomass	Crude Oil
Annual Biomass Fuel Cost	$ 42,900
Annual Heating Cost Savings	$ 84,000
PROJECT ECONOMICS	
Project Total Funding	$ 450,000
ARRA Funding	$ 339,923
Bank Loan	$ 110,077
Project Total Cost	$ 450,000
Equipment Cost	$ 234,000
Installation Cost	$ 216,000
Annual O&M Costs	$ 1,200
Financial Analysis	
Annualized Rate of Return (10yr)	13.7%
Internal Rate of Return (25yr)	25.4%
Payback Period (years)	5.4

Project Background

Blue Mountain Hospital is a 50,000 square foot, 25-bed hospital located in John Day, Oregon. Six family practice physicians, a surgeon, and a family nurse practitioner work at the hospital, and residents and interns are also rotated through on a regular basis as part of the Oregon Health Sciences University Family Practice Residency program.

According to Bob Houser, CEO of Blue Mountain Hospital, the hospital began converting to a biomass system in 2009 with the main objectives to save money on oil consumption and help support the local pellet industry in John Day. There were also a number of environmental considerations that led the hospital toward selecting biomass as a fuel source including reduced carbon emissions and reduced fossil fuel dependence by using a locally produced, renewable fuel source.

With these goals in mind, the hospital began to research what type of biomass system would best fit their needs. Blue Mountain needed a constant supply of conditioned air and hot water throughout the year, so it was important to find a system that could meet this requirement. They visited Grant County Regional Airport and another hospital located in Burns, Oregon, to hear about the success they had achieved with their biomass units. Based on the recommendation of Andrew Haden, the lead project engineer and consultant for the hospital's project, the hospital ultimately decided to go with a Viessmann-KOB Pyrot 540 pellet boiler. After determining which type of boiler would best fit their needs, the hospital applied for a state grant, got bids, and broke ground.

The project took about two years to complete, which was a bit longer than anticipated because of a delay in manufacturing the pellet unit. The Viessmann-KOB Pyrot 540 pellet boiler started operating in April 2011, and, to date, it has heated and supplied hot water to the whole hospital complex and clinic space (totaling about 50,000 square feet) for almost two years. Houser said they have been quite pleased with the results thus far and have found biomass to be an alternative that is "cheaper, cleaner, and it supports the local timber industry."

System Components

The following are the major components of Blue Mountain Hospital's biomass system:

- Fifty-ton pellet silo
- 1.844 MMBtu/hr pellet boiler
- 1,500 gallon water/glycol storage tank integrated into the system to even out load conditions and reduce boiler cycling
- Two heating oil backup units


Figure 7. Steve Hill, Director of Facilities Services, Next to the Pellet Boiler

Before making the switch to biomass, Blue Mountain Hospital relied on two bunker fuel boilers along with one #2 heating oil boiler to meet the facility's heating and hot water needs. They replaced one of the hospital's old bunker fuel boilers with the new pellet boiler and decided to convert the remaining bunker fuel boiler to heating oil. They now have two heating oil boilers that act as backups.

The biomass boiler, which is tied into the hospital's existing hydronic heating system, is located directly outside of the hospital, housed in a steel container alongside a fifty-ton wood pellet silo. In total, the 1.844 MMBtu/hr Viessmann-KOB Pyrot 540 boiler provides roughly ninety percent of the hospital's total heat load. The system is operational year-round because it is also used to heat hot water when the building itself does not need to be heated. It is a very automated system that only needs to be checked infrequently by the hospital's maintenance staff. Generally, it takes less than two hours per week on average to maintain the system.


Figure 8. Pellet Silo and Biomass Housing Unit

The biggest challenge the hospital experienced with the system occurred soon after its installation and involved getting the first load of pellets into the storage unit. "[The fuel] was delivered in a regular farm truck and we had to get an elevator to put the pellets in the silo," said Houser. They also had some initial challenges with getting the boiler tuned and with a bad batch of fuel that caused a lot of ash caking. Fortunately, these glitches have been worked out over time and the system now performs very well.

Fuel Supply

Blue Mountain Hospital's wood pellet fuel is supplied locally by Malheur Lumber Company's pellet and brick plant in John Day. The pellets are made using forestry residuals and small diameter trees that are removed from National Forest lands during stewardship contracting activities.

There were numerous reasons why the hospital chose to go with pellet fuel. Possibly the most important factor was the close proximity of a pellet supplier – Malheur Lumber is only several miles away from the hospital. Because of this nearby fuel source, the hospital is able to fill the storage silo on an as-needed basis. Cost, availability, ease of handling, capital cost of fuel storage and conveying relative to the total project cost, and burning characteristics were also important decision factors.

Hospital officials have been very pleased with the pellet quality that Malheur Lumber produces. Originally, the hospital tried using pellets from another vendor in Oregon, but they had higher ash content and caused problems with "clinkers." Since switching to Malheur Lumber, the issues associated with fuel quality have been resolved. The fuel is very clean burning and has produced less than twenty gallons of ash in the past fifteen months of use.

The hospital consumes an average of 260 tons of pellets per year, which, at $165.00 per ton, costs $42,900 annually. Blue Mountain has a year-round need for the pellet system to meet the hospital's hot water and heating demand. Double the amount of pellets are consumed during winter, when there is a significant increase in demand for both building heating and hot water, compared to the summer.

Project Economics

The overall cost of the project was approximately $450,000. This included the cost of the pellet silo, enclosed pellet boiler, the container pad, the interconnections with the existing heating system, and the total installation cost.

To help fund the conversion project and cover some of the large capital costs, the hospital received $339,923 in state and federal stimulus money through the American Recovery and Reinvestment Act. The remaining $110,077 was financed through a loan from the Bank of Eastern Oregon.

The biggest funding challenge that Blue Mountain Hospital encountered during the development of the project was in completing all the mandatory documentation. According to Houser, there was a lot of extra documentation that was required in order to qualify for the grant money.

Figure 9. Heating Oil Boiler

On average, since converting to the pellet system, the hospital has saved $84,000 per year in heating costs. In addition to these financial savings, the hospital has found that using a new energy efficient pellet boiler has helped reduce their carbon emissions versus their old oil fired boilers, which were made in the 1950s prior to emission controls mandated by the Environmental Protection Agency. Also, on average, one to two hours per week are required for maintenance, which is about one third the amount of work required compared to their previous oil boiler.

There are various methods that can be employed to analyze a project's financial viability. One financial analysis tool is the annualized rate of return (ARR). The purpose of the ARR is to identify the potential rate at which an investment will increase (or decrease) each year. Calculating a ten year ARR is valuable for investors because this timeframe best reflects their shorter term focus. The ARR is calculated using a project's return on investment (ROI), which acts as a multiplier at which an investment is estimated to grow over a set time period.[12]

Another useful financial analysis calculation is the internal rate of return (IRR). The IRR estimates a facility's expected return from an investment over time (a measurement of the efficiency of the investment). The IRR is useful for facility owners and calculating it over a twenty-five year time period coincides with the typical projected life of a wood-energy system (twenty-five to thirty years). It is calculated as comparison of fuel savings for term to total project investment.[13]

A basic financial analysis of Blue Mountain Hospital's biomass project shows that it has a payback period of 5.4 years, a ten year ARR equal to 13.7%, and a twenty-five year IRR of 25.4% (assuming inflation varies by source of energy). In this analysis, inflation rates of 1.5% for wood and 5.5% for heating oil were used.[14]

Overall, these calculations indicate that the hospital's project is favorable from a financial investment perspective (current markets are looking for an ARR between five to ten percent and the project's IRR indicates positive growth). Compared to other biomass facilities in John Day that have a seasonal heating demand, the hospital's high year-round (non-seasonal) heating and hot water demand makes the economics of the project especially favorable. Additionally, because fuel oil has been so expensive, the hospital may beat its initial expected payback estimate and could have investment costs paid off in less than five years. It should be noted that these financial calculations do not deduct the cost associated the hospital's choice to convert to a pellet system versus merely replacing their aging oil boilers with similar units. Accounting for these factors would only improve the financial viability of the project. For additional financial analysis details, please see Appendices A and B.

Conclusion

Of the four biomass projects in the Grant County cluster, Blue Mountain Hospital's project is the most favorable from a financial investment perspective. In retrospect, now that the boiler has been operational for close to two years, there is not much that the hospital would have done differently in developing the project. So far, it has been "headache-free" and they have not experienced major frustrations using the system. They would have liked to prevent the delay in manufacturing the unit, however. "[We would have] ordered the unit quicker, before the manufacturer got behind, so it could be used sooner," said Houser. Things have gone quite smoothly, and, overall, Houser is very happy with how the system has worked out. "It has exceeded our expectations and is paying for itself. We are continuing to use our unit and have convinced several other businesses in the county to convert as well," he said.

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[12] ARR Formula: $((1+ROI)^{1/N})-1$
N = # of years   ROI = Return on investment = B – C/P
B – C = Cumulative fuel cost savings added up over a set period of time   P = Total project investment.
[13] IRR Formula: $PNW = 0 = F_a/(1 + R)^a$
PNW = Present Net Worth = 0   F = Income Each Year = Fuel Savings Each Year   a = Year   R = Rate of Return
[14] U.S. Energy Information Administration for all inflation estimates except wood. Wood inflation estimate was provided by local expert Andrew Haden (www.Wisewood.US)

Grant County Regional Airport

Figure 10. Grant County Regional Airport Airbase Building

GENERAL INFORMATION	
FACILITY	**Grant County Airport**
Building Area (ft^2)	14,000
Experience Total (years)	2
Project Type	New Construction
EQUIPMENT SPECIFICATIONS	
Boiler Manufacturer	Viessmann-Köb
Boiler Model	Pyrot 220
Output MMBtu/hr	0.75
Biomass Percent of Building Heating	50%
Backup Unit	Heat Pumps
FUEL SPECIFICATIONS	
Composition	Ponderosa Pine wood pellets
Source	Forest stewardship contracts
Supply Radius (miles)	6
Delivery Frequency	Seasonally
Quantity Delivered (tons)	20-25
Cost Per Ton Delivered	$ 165
Moisture Content	≤ 5%
Fuel Storage Capacity (tons)	30
Annual Consumption (tons)	32
Fuel Replaced by Biomass	N/A
Annual Biomass Fuel Cost	$ 5,280
Annual Heating Cost Savings	$ 7,520
PROJECT ECONOMICS	
Project Total Funding	$ 325,000
USDA Grant #1 Biomass Project	$ 29,700
USDA Grant #2	$ 147,650
Connect Oregon II Grant	$ 147,650
Project Total Cost	$ 225,000
Equipment Cost	$ 225,000
Installation Cost	$ 100,000
Avoided Capital Cost (Electric)	($ 100,000)
Annual O&M Costs	$ 500
Financial Analysis	
Annualized Rate of Return (10yr)	3.2%
Internal Rate of Return (25yr)	0.8%
Payback Period (years)	29.9

Project Background

Spread over 335 acres in John Day, Grant County Regional Airport, which is owned and operated by the County, houses a dozen general aviation aircraft at its base and serves a diverse cliental including doctors and business people and services such as medevac services, emergency services, and refueling needs. In terms of facilities, there are thirteen private hangars, a county hangar, a terminal building, and a Forest Service Helibase located at the airport. In the past, a flight school was also located at the airport. The airport acts as a hub for people who need to get to places quickly, which is especially important given John Day's remote location.

The airport is another John Day site that recently installed a new wood pellet system to heat its entire terminal building. All in all, the project took about two years to complete from planning to operation with the goals of acting as a demonstration program and providing financial savings on heating costs. As of November 2012, the airport has used the biomass system for a little over two years.

Unlike the other biomass energy projects in John Day, the airport was not a conversion project. The biomass project first originated about five years ago and coincided with the new terminal building construction. The old terminal was simply a converted home that badly needed updating. The setup was not at all suitable for their needs, so the county decided to build a new terminal. When the new airbase building was being constructed, they saw that Malheur Lumber, a

Figure 11. Patrick Bentz, Airport Manager, Next to the Pellet Boiler Container

local sawmill in John Day, was in the process of building a new pellet mill. The pellet mill was in very close proximity to the airport and would be a convenient fuel supplier, so the airport decided to go with a wood pellet biomass system.

The new 14,000 square foot airbase building is divided into three sections: a County side, a Federal side (for the Forest Service), and a common area that anyone is free to use. It is a multipurpose facility that Patrick Bentz, Regional Airport Manager, is trying to run like a business, so that it does not annually cost the county money. He said the new terminal building has hosted city meetings (with state Senators attending) and private celebrations. The Forest Service conducts wildfire-training exercises at the base (such as repel training) and many firefighting personnel are based there throughout the summer. The airbase building also houses Forest Service offices.


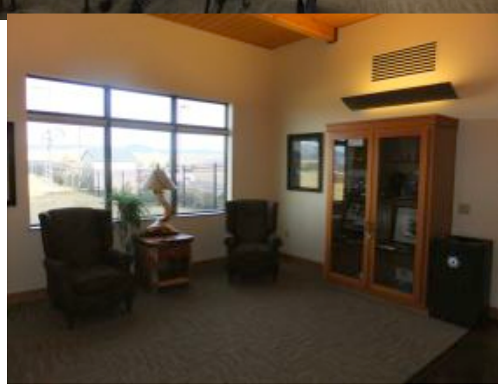


Figure 12. Various Sections of the Airbase

Project Economics

In total, funding for the entire new terminal building project was just over five million dollars, funded through a Connect Oregon II grant and a USDA grant. The biomass heating project ended up costing $325,000 ($225,000 when accounting for the $100,000 avoided cost of not installing a conventional electric boiler that would handle 100 percent of the terminal's heating). The airport received an additional $29,700 USDA grant specifically for the biomass project and the remainder of the project cost was covered by the larger Connect Oregon II and USDA grants. The Forest Service had a very old facility that was barely adequate, so they provided the grant to help remedy this issue. In the end, because of these grants, the project did not cost the county anything. Overall, using a pellet system to meet the building's heating demand saves the airport approximately $7,520 per year in heating costs versus relying on an electric boiler. The project has an expected payback period of close to thirty years.

There are various methods that can be employed to analyze a project's financial viability. One financial analysis tool is the annualized rate of return (ARR). The purpose of the ARR is to identify the potential rate at which an investment will increase (or decrease) each year. Calculating a ten year ARR is valuable for investors because this timeframe best reflects their shorter term focus. The ARR is calculated using a project's return on investment (ROI), which acts as a multiplier at which an investment is estimated to grow over a set time period.[15]

Another useful financial analysis calculation is the internal rate of return (IRR). The IRR estimates a facility's expected return from an investment over time (a measurement of the efficiency of the investment). The IRR is useful for facility owners and calculating it over a twenty-five year time period coincides with the typical projected life of a wood-energy system (twenty-five to thirty years). It is calculated as comparison of fuel savings for term to total project investment.[16]

A basic financial analysis of the Regional Airport's biomass project shows that it has a payback period of 29.9 years, a ten year annualized rate of return equal to 3.2%, and a twenty-five year internal rate of return of 0.8% (assuming inflation varies by source of energy). In this analysis, inflation rates of 1.5% for wood and 2.0% for electricity were used.[17]

Overall, these calculations indicate that the airport's biomass project is not as favorable from a financial investment perspective as the other three biomass projects in the Grant County biomass cluster (current markets are looking for an ARR between five to ten percent and the project's IRR indicates small positive growth). The pellet boiler was designed to meet only fifty percent of the terminal building's heat load, so the airport is not able to achieve large annual heating cost savings from which to pay off its investment. Also, electricity is relatively cheap in Oregon at about 0.08/kwh, and this reduces the fuel cost savings of biomass compared to more expensive alternatives like heating oil or propane. For additional financial analysis details, please see Appendix A.

Figure 13. Side View of the Pellet Unit

System Components

The biomass boiler is located directly outside of the terminal building, housed in a steel container alongside a thirty-ton wood pellet storage silo. The airport uses a 0.75 MMBtu/hr Viessmann-KOB Pyrot 220, which provides hot water heating and it can run cold water (using a condenser) to the new 14,000 square foot airbase building. The pellet unit provides fifty percent of the

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[15] ARR Formula: $((1+ROI)^{1/N})-1$
N = # of years   ROI = Return on investment = B – C/P
B – C = Cumulative fuel cost savings added up over a set period of time   P = Total project investment.
[16] IRR Formula: $PNW = 0 = F_a/(1 + R)^a$
PNW = Present Net Worth = 0   F = Income Each Year = Fuel Savings Each Year   a = Year   R = Rate of Return
[17] U.S. Energy Information Administration for all inflation estimates except wood. Wood inflation estimate was provided by local expert Andrew Haden (www.Wisewood.US)

airport's heating demand with the remaining half being met through a series of water source heat pumps that use a common loop operating between 70° and 85°.

As far as challenges are concerned, fine tuning the system and gaining experience in operating the unit under a variety of conditions have been the biggest challenges. Bentz explained that he has been learning the ins and outs of the system since he was hired as the airport's manager. Overall, the system is very automated and computer controls can be used to modulate heating in different sections of the building.

Fuel Supply

The airport's wood pellet fuel is supplied locally by Malheur Lumber Company's pellet and brick plant in John Day. The pellets are made using forestry residuals and small diameter trees that are removed from National Forest lands during stewardship contracting activities.

The airport has a convenient source of pellets with Malheur Lumber just three miles away from their location. There is a level indicator on the fuel storage silo that lets them know when it needs to be refilled. The system is turned on in late October and with three to four months of storage, the pellet silo is filled up once or twice a year. A local rancher delivers the pellets straight from Malheur Lumber to meet the airport's seasonal needs.

The airport consumes roughly thirty-two tons of pellets a year. At $165.00 per ton of pellets, it costs roughly $5,280 per year to heat with pellets.

Conclusion

Overall, Bentz has been happy with how the biomass system is working. He talked about how people in John Day are very dependent on forest activities and how there are a lot of brush piles in the forest that would normally just be burned in piles onsite. He noted that wildfire can be a threat and referred to a large wildfire near the town, which took Forest Service personnel and helicopters about a week to extinguish. He thinks using this biomass to produce pellets is a more productive use of forest treatment material and could help reduce the threat of these unnaturally severe fires.

Figure 14. Forest Service Training Equipment

Prairie City School

Figure 15. Prairie City School Staff at the Biomass Project Groundbreaking (photo by Wisewood Inc)

GENERAL INFORMATION	
FACILITY	Prairie City School
Building Area (ft^2)	70,000
Experience Total (years)	< 1
Project Type	Retrofit
EQUIPMENT SPECIFICATIONS	
Boiler Manufacturer	Biomass Combustion Systems
Boiler Model	463
Output MMBtu/hr	2.50
Biomass Percent of Building Heating	90%
Backup Unit	Propane
FUEL SPECIFICATIONS	
Composition	Ponderosa Pine wood pellets
Source	Forest stewardship contracts
Supply Radius (miles)	40
Delivery Frequency	Monthly
Quantity Delivered (tons)	20-25
Cost Per Ton Delivered	$ 160
Moisture Content	$\leq$ 5%
Fuel Storage Capacity (tons)	48
Annual Consumption (tons)	239
Fuel Replaced by Biomass	Propane
Annual Biomass Fuel Cost	$ 38,240
Annual Heating Cost Savings	$ 68,635
PROJECT ECONOMICS	
Project Total Funding	$ 655,000
Quality Zone Academy Bond	$ 655,000
Other Non-Project Funding Malheur Lumber Discounted Pellets	$ 68,000
Project Total Cost	$ 655,000
Equipment Cost	$ 375,000
Installation Cost	$ 280,000
Annual O&M Costs	$ 3,600
Financial Analysis	
Annualized Rate of Return (10yr)	9.5%
Internal Rate of Return (25yr)	16.4%
Payback Period (years)	9.5

Project Background

Located roughly twenty miles east of John Day, the Prairie City School campus has the newest biomass system within the Grant County biomass cluster. A wood pellet system currently provides heating (steam) to the entire main high school, middle school, and connected elementary school (totaling 70,000 square feet). The unit also provides hot water heat to the school's separate gymnasium and cafeteria.

Prairie City School District was in desperate need of a new heating system. Originally, there were a total of five boilers operating in the school buildings, providing adequate redundancy in case one of the boilers went down. However, as these boilers aged, the district began to run into issues maintaining the system. Eventually, the campus had only one boiler that was operational in each of the school buildings, and the boilers that still worked needed constant repair to prevent them from breaking down. All three of the schools were dependent on propane for their heating needs—which was very costly and hurting the district's budget. As a result, the district had two options: continue trying to maintain the remaining boilers with a reduced maintenance staff or replace the boilers.

The school chose the latter option and Dave Kerr, the former superintendent of Prairie School District #4, began researching alternative heating systems that would better fit the school's needs. Biomass seemed like it would be a good match because it would help reduce the school's heating costs, have improved price stability versus propane, support the local economy, and help continue the development of biomass energy in Grant County.

Kerr contacted Wisewood, Inc. (a Portland-based design/build firm that specializes in biomass energy) to learn more about what it would take for the school to put in a new biomass system. The former superintendent then worked to gain support of the school board for the biomass project. After gaining the board's approval, the school secured funding through a Quality Zone Academy Bond (the same type of bond that Grant Union School used to fund their biomass boiler project). The school then moved on to get the system engineered and they received competitive bids for the construction. Wisewood won the bid for the construction of the project.

When project construction began, Wisewood realized that getting the biomass boiler equipment would involve the longest lead time, so they made sure to order it early on to avoid any delay. Concurrently, Wisewood and its subcontractors focused on putting other infrastructure in place such as the trenching, hot water, steam line installation; building and silo erection; and building connections to existing heat distribution systems in the school and gymnasium. They found it relatively straightforward integrating the system into the existing heat distribution and controls at the school buildings.

Figure 16. Pellet Silo and Boiler Housing Building. (photo by Wisewood Inc)

Once the boiler was installed, Wisewood began work on fine-tuning parts of the system including the fuel settings, controls, and other scheduling. This work has been the most challenging over the course of developing the project. Getting fuel settings optimized to cover three district loads (the school building, gymnasium, and cafeteria) took longer than expected because of a new auto-ignition system and an auto-dialer to alert staff of any alarms triggered in the system.

From development to commissioning, the project took about nine months to complete. The school is still making small adjustments to the unit such as getting the controls dialed in, but it has been fully operational and has been producing heat since late October 2012.

Project Economics

Overall, the total cost of the biomass project was $655,000 and Prairie City School funded the entire project through a Qualified Zone Academy Bond (QZAB), which is a zero percent interest, balloon payment bond. The QZAB account to which annual installment payments are made is administered by a local branch of the Bank of Eastern Oregon. Prairie City School is able to keep any interest accumulated on the savings account, and this will eventually be used to make a balloon payment by the end of the twenty-year loan in addition to other capital improvements. Because the QZAB funding had been previously utilized by Grant Union School for its biomass project, Prairie City School did not have much difficulty finding a local bank to take on the bond.

Quality Zone Academy Bond
A tax credit bonds program providing interest-free loans to public schools for building renovations or repairs, equipment purchases, curriculum development, and/or school personnel training. Rather than receiving interest payments from schools, lenders receive tax credits issued by the federal government

Given the high up front capital cost of the biomass system, getting the zero percent QZAB loan was critical in financing the project.

Also, like Grant Union School in John Day, Malheur Lumber Company provided a $68,000 grant to Prairie City School, and supplies the pellets to the school at a discounted rate per ton until the grant value is reached. Under the grant agreement, Malheur Lumber bills Prairie City School for the market value of the pellets ($160.00/ton) and a credit is applied reducing the total fuel cost until the $68,000 donation is reached.

Overall, the new pellet system is expected to provide an annual savings of approximately $68,635 over the previous heating system.

There are various methods that can be employed to analyze a project's financial viability. One financial analysis tool is the annualized rate of return (ARR). The purpose of the ARR is to identify the potential rate at which an investment will increase (or decrease) each year. Calculating a ten year ARR is valuable for investors because this timeframe best reflects their shorter term focus. The ARR is calculated using a project's return on investment (ROI), which acts as a multiplier at which an investment is estimated to grow over a set time period.[18]

Another useful financial analysis calculation is the internal rate of return (IRR). The IRR estimates a facility's expected return from an investment over time (a measurement of the efficiency of the investment). The IRR is useful for facility owners and calculating it over a twenty-five year time period coincides with the typical projected life of a wood-energy system (twenty-five to thirty years). It is calculated as comparison of fuel savings for term to total project investment.[19]

A basic financial analysis of Prairie City School's biomass project shows that it has a payback period of nine and a half years, a ten year annualized rate of return equal to 9.5%, and a twenty-five year internal rate of return of 16.4% (assuming inflation varies by source of energy). In this analysis, inflation rates of 1.5% for wood and 5.6% for propane were used.[20]

Overall, these calculations indicate that the school's project is favorable from a financial investment perspective (current markets are looking for an ARR between five to ten percent and the project's IRR indicates positive growth). It should be noted that these financial calculations do not deduct the costs associated the school's choice to convert to a pellet system versus merely replacing their aging oil boilers with similar units, and accounting for these factors would only improve the financial viability of the project. For additional financial analysis details, please see Appendices A and D.

[18] ARR Formula: $((1+ROI)^{1/N})-1$
N = # of years   ROI = Return on investment = B – C/P
B – C = Cumulative fuel cost savings added up over a set period of time   P = Total project investment.
[19] IRR Formula: $PNW = 0 = F_a/(1 + R)^a$
PNW = Present Net Worth = 0   F = Income Each Year = Fuel Savings Each Year   a = Year   R = Rate of Return
[20] U.S. Energy Information Administration for all inflation estimates except wood. Wood inflation estimate was provided by local expert Andrew Haden (www.Wisewood.US)

System Components

There are several components that are part of Prairie City School's biomass system:

- 2.6 MMBtu boiler
- Forty-eight pellet silo and auger
- Heat exchanger
- Pumps
- Steam distribution lines
- Hot water distribution lines
- Existing propane units used as backups

Figure 17. Biomass Combustion Systems Pellet Boiler (photo by Wisewood Inc)

The school benefited from joining the larger biomass cluster in John Day, where three other biomass conversions are located, because the sites were able to share their experiences with one another. Prairie City School looked to the experience of Malheur Lumber's pellet mill and the three other biomass conversions in John Day to learn about how the technology functioned and how savings were being delivered to others in the community.

To determine which biomass model to purchase, Prairie City School entrusted Wisewood (which also developed the other biomass projects in John Day) to recommend which biomass unit would best meet the school's needs. They saw how well the boiler at Grant Union School was working, and ultimately decided to pursue a similar unit. Prairie City School has also been able to improve its maintenance efficiency by using the same boiler make as Grant Union School. The same maintenance staff splits time between Grant Union School and Prairie City, and having the same type of boiler installed at both of the school has helped reduce the learning curve in terms of knowing how to operate and maintain both the units.

Not everything has run smoothly, however. There have been some frustrations that the school has experienced with the new system. If a steam unit would have been available, one thing that Wisewood would have done differently in the development of the system is to have utilized more compact, efficient, and automated European biomass technology. According to Wisewood, "European biomass technology is two decades ahead of U.S. biomass technology, but was not yet ASME rated[21] to provide steam heat when this project was conceived, so we used a more basic U.S.-made unit. It is very robust and clean burning, but it doesn't have automatic de-ash, so that has to be performed manually every week."

Perhaps the most important lesson Prairie City learned while developing its biomass project was that the actual construction may not be as straightforward as the biomass technology itself would lead you to believe. For example, trenching and retrofitting older buildings are often required and other unforeseen issues can be encountered along the way.

[21] The American Society of Mechanical Engineers (ASME) sets the standards for the design and construction of boilers. To sell boilers in the U.S., European companies must first receive ASME certification.

Fuel Supply

Prairie City School's wood pellet fuel is supplied locally by Malheur Lumber Company's pellet and brick plant in John Day. The pellets are made using forestry residuals and small diameter trees that are removed from National Forest lands during stewardship contracting activities. Compared to using propane and spending money that gets exported out of the state, purchasing biomass fuel means that more money stays within the local economy and benefits the community.

As mentioned earlier, Malheur Lumber Company provided a $68,000 grant to Prairie City School and delivers the pellets at a discounted rate until the grant value is reached. The school consumes 239 tons of pellets per year at $160.00 per ton—representing $38,240 in annual fuel costs (without applying the discount).

Figure 18. Combustion of Pellet Fuel
(photo by Wisewood Inc)

There were a number of reasons the school went with pellets over another biomass feedstock such as woodchips. Most importantly, the school has a local supply of pellet fuel readily available twenty miles away at Malheur Lumber Company; consequently, in addition to providing cost savings on delivery, the school also viewed going with pellets as a way to help benefit the community (local job creation at Malheur Lumber's pellet mill, for example). Additionally, pellets are a cleaner fuel and take up less space compared to wood chips. As a school, it was also important that the system require minimal maintenance, so a pellet system made the most sense. In addition, pellets are very economical versus propane. Lastly, emission reductions were an important consideration as well as the ability to use harvested forest residuals that would otherwise be left unused or burned in piles. According to Wisewood, "In Grant County, there are forest fires every year, which can be seen as a waste of resources. By utilizing forest residuals instead of fossil fuels, we get to capture some of that energy."

Conclusion

Because Prairie City School's new pellet unit has only been running for a couple of months, it remains to be seen how it will work in the long run. So far, the school is very happy with how the new pellet unit is working. The system is using the amount of fuel that was expected and the school now needs very little propane to heat its campus. Pellets are a much cheaper fuel source versus propane and the system will save the school a significant amount of money in heating costs. Because there are many similarities between the biomass project at Prairie City School and the one at Grant Union School, it is expected that the new system will achieve similar positive results over time.

Looking forward, Prairie City School plans to use the new pellet system for the next thirty or more years. The single pellet boiler does the work of three fossil fuel units, and they expect it will provide significant heating cost savings over time as the cost of propane and oil continue to rise.

Malheur Lumber

Figure 19. Malheur Lumber Yard

GENERAL INFORMATION	
FACILITY	Malheur Lumber
Facility Type	Pellet Mill
Project Total Cost	$6,500,000
ARRA Funding	$5,000,000
Experience Total (years)	2
FUEL SPECIFICATIONS	
Products Sold	Bulk and Bagged Pellets Bundled Fuel Bricks
Pellet Composition	Ponderosa Pine
Pellet Moisture Content	5-6%
PROJECT ECONOMICS	
Raw Material Sources	Stewardship Contracts Timber Sales
Fuel Supply Public/Private	50/50
Raw Material Supply Radius (miles)	100-150
Pellet Delivery Radius (miles)	200-250
Bulk Truck Delivery Capacity (tons)	28
Currently Profitable? (yes/no)	No
Profitability Threshold (tons delivered/month)	750-1000

Pellet Mill Project Overview

Malheur Lumber Company (a wholly-owned subsidiary under Ochoco Lumber Company of Prineville, Oregon) began the construction of its sawmill located in John Day in 1983. The mill employs a total of ninety people both in production and management. Most of their lumber (cut from pine logs) is sent to secondary manufacturers that make housing materials such as doors, windows, moldings, cabinets, and furniture.

Malheur Lumber also has a pellet mill on site and acts as the pellet fuel producer and distributor for all three of the local biomass facilities clustered in John Day (located just a couple of miles away) plus Prairie City School (located about twenty miles from the mill). The construction of the pellet mill began in April 2010, and it was completed in December that same year. This study was conducted the second year that the pellet mill had been in operation. At that time, five people were employed at the mill and thirteen expected to be employed after business expansion. John Rowell, the Plant Manager at Malheur Lumber, expressed hopes to run the pellet mill year-round if fuel demand for the pellets could be increased enough.

Figure 20. Pellet Drying Equipment

Pellet Mill Beginnings

Mike Billman, the Timber Manager at Malheur Lumber, worked as the project manager for the pellet mill project while it was under construction and he summarized the experience. He explained that the project came about during the stimulus money era with American Recovery and Reinvestment Act (ARRA) grants. Proposals were sent by all of the National Forests requesting ARRA funds to carry out thinning projects and other restoration activities. The Malheur National Forest put in its own proposal, but they also requested money to construct a pellet plant in Grant County or Harney County (the neighboring county). Grant County is quite distant from pulp and paper markets, and it was thought that a pellet plant would help grow the market and the value for fiber in Grant County locally. In the end, Malheur Lumber was selected as the grant recipient and the project went forward. Billman stated that having Malheur Lumber handle the project was based on the Forest Service's desire to create a local market for biomass. They ended up receiving a five million dollar federal recovery grant to build the mill.

Figure 21. Bagged Pellet Fuel

The stimulus money provided the necessary funding to complete the plant. Malheur was awarded the grant in February 2010 and had to have product out the door by December. This accelerated schedule that was part the funding requirements led to some issues in the design and construction of the plant. As a sawmill, Malheur Lumber did not have much experience or knowledge about pellet mills and the design and construction of the plant proved challenging.

Despite the challenges, Malheur Lumber was able to complete the project, installing a new drying system, two fuel brick-making machines, and one pellet-making machine. The mill already had boilers onsite that were upgraded for the pellet mill addition.

The sawmill tries to use every part of a log that they can to minimize wasted material. Malheur Lumber has a biomass boiler onsite which creates the steam that is used to produce and dry the pellets. The boiler burns "stewardship biomass"[22] coming from federal lands as well as mill waste. In the woods, operating on stewardship sales, saw logs are sorted for the sawmill and fiber logs sorted for the production of pellets and fuel bricks.

Fuel Supply and Delivery

Malheur Lumber's harvested fuel comes from stewardship contracts[23] as well as timber sales on federal lands and private timber sales. It depends on where the most competition is (there is more competition in the north, so the radius does not stretch as far north), but generally the company stays within a 100 to 150 mile radius for their fuel supply (which comes from a mixture of public and private land). The pellets are made using forestry residuals and small diameter trees that are removed from National Forest lands during timber sales and stewardship contracting activities. Malheur also produces compressed wood bricks, which can be used to replace firewood in a regular wood stove and have benefits including handling, cleanliness, no bugs, and better storage.

[22] Forestry residuals and small diameter trees that are removed from National Forest lands during forest restoration activities as outlined by stewardship contracts. For more information: http://www.fs.fed.us/restoration/documents/stewardship/stewardship_brochure.pdf

[23] Stewardship contracting includes natural resource management practices seeking to promote a closer working relationship with local communities in a broad range of activities that improve land conditions. When using the Integrated Resource Timber Contract (FS-2400-13) for a stewardship contract, the cost of required service type restoration work activities will approximately be equal to the value of the products being removed. For more information: http://www.fs.usda.gov/detail/malheur/home/?cid=STELPRDB5403809

Malheur Lumber delivers finished pellets (which are about six percent moisture content) to the ultimate consumers or people come and pick the fuel up. The market is generally within a 200 mile radius, although some material is delivered as far away as 250 miles. To the west sales are limited to a distance of about 150 miles because of more competitors.


Figure 22. Storage Yard

Malheur contracts with several companies to deliver the pellet fuel to biomass boilers (like the ones in John Day), and they also contract with other hauling companies to ship non-bulk products such as bagged pellets and bundled bricks, which are utilized for residential use. One of the bulk delivery trucks delivers other products (such as grain or construction materials) in addition to the pellet fuel. Since Malheur Lumber is located in a rural area, transportation is a big issue and it is important to find trucks that are hauling other products in addition to the pellets because it is not economical to pay for a dedicated haul of the bulk pellet fuel. It has been key to find haulers with the capability, that have other types of deliveries they are performing, and with compatible operations that makes it easy to deliver pellets as an extra product in addition to their other delivery materials. This approach can make transportation much more challenging when confined to a certain delivery area for pellet shipments.

John Rowell said that they would like to own a bulk delivery truck, but that would require a lot more deliveries to make it economical (600 to 1,000 tons monthly during the heating season within a 100 to 150 mile radius). Currently, this does not seem realistic, and contracting with companies that have other deliveries has been a more cost-effective approach.

Marketing

From a market perspective, Billman stated that marketing the products has been somewhat challenging, but overall demand for the fuel has been good. Bulk pellet sales account for around twenty-five percent of Malheur Lumber's total volume. Bagged sales for residential users (while difficult to track and estimate) represent around sixty percent of the total volume (a rough estimate based on the total volume shipped indicates the company has between 1,500 to 2,000 residential users within a 200 mile radius). Net sales are between $650,000 and $1,000,000.


Figure 23. Pellet Processing Equipment

Rowell believes that bulk sales fit nicely into Malheur Lumber's business plan. Selling bulk pellets to facilities in John Day is a big part of the company's business, and with the talk of new local biomass boiler installations, he expects bulk sales to grow. Larger sites like Blue Mountain Hospital with a high year-round demand for bulk pellets are especially attractive customers; however, large industrial applications are limited in the region. To keep expanding their customer base, Malheur Lumber markets its various products using the company's website, advertisements in local magazines and newspapers, direct mailing, word of mouth, and by making cold calls.

There is considerable competition in stores for packaged wood pellet fuel so that market is much tougher to get into and appears less profitable. It is also very difficult to deliver to individual residential users, according to Rowell. A primary barrier to establishing a residential bulk pellet market is that many homes in the U.S. have forced-air systems, electric heating, or pellet stoves. Consequently, many residential heating systems in the U.S. are not candidates for bulk pellet usage. The residential market for bulk pellets is more established in Europe because there are more houses that are central heated with hot water and can utilize pellet boilers to heat the water.

The model Malheur Lumber would like to follow is to find distributors who deliver two to four tons of fuel, per season, to people's homes. Such distributors would likely have to make multiple deliveries to some of these customers. This is already being done to a certain extent, but the hope is to do it at a larger scale.

Malheur Lumber has a storage yard where products are bagged, packed, and shipped to retailers in different states and locations. John Rowell said that the company hopes to expand into strategically located storage sites, like resale facilities, so they would not have to worry about storing fuel onsite.

Challenges

There were a number of challenges that Malheur Lumber ran into delivering pellets to the geographically clustered biomass facilities in John Day and to Prairie City School:

- The person who handles the pellet deliveries likes to deliver twenty-eight tons at a time because it is much more expensive to do partial deliveries to different facilities – the more tonnage per delivery, the less per ton the delivery costs are.
- Fuel storage capacity has been an issue with some of the sites; a couple of the pellet installations in John Day only have around thirty tons of fuel storage.
- Low storage capacity means that pellet deliveries to the facilities need to be timed carefully just before they run out. Sometimes by the time one of the facilities calls, they are getting low on pellets.
- Bigger silos that are forty or fifty tons help avoid delivery issues because it can take more than a week to schedule a delivery.
- John Day's low population density limits Malheur Lumber's bulk pellet sales. It difficult to sell a large volume of pellets in John Day compared to other pellet plants that are located near bigger populations.
- During the summer, very few people purchase pellets. Some facilities like Blue Mountain Hospital require a year-round supply of pellets, but these are rare. The company tries to encourage people to stock fuel and buy year-round by offering discounts during the summer. This helps reduce the demand spike that occurs toward winter when people are rushing to purchase fuel. Additionally, to help encourage bulk fuel purchases and increase demand and efficiency, Malheur Lumber offers a discount to consumers that buy in bulk versus smaller amounts.

Conclusion

Currently, Malheur Lumber is still working on making the pellet portion of its operation profitable. Rowell estimated that it would take 750 to 1,000 tons a month year-round to turn a profit on the pellet fuel); this could be met through bagged or bulk pellet sales as long as the product is priced accordingly (such as adding an additional cost for bagged pellets to cover packaging). Overall, they are happy that they have successfully overcome challenges related to the pellet plant. Rowell is optimistic that the pellet plant will be profitable within another year based on how business has expanded annually. Looking forward, Malheur Lumber is planning to continue developing, building on the infrastructure, becoming more efficient, and growing their customer base.

Biomass Facility Conversions: Best Practices and Lessons Learned

Based on an examination of the biomass facilities and pellet mill within the Grant County cluster, we believe that the following list represents some of the key lessons learned that were common across the sites.

Project Finance and Economics

- Biomass can save facilities twenty-five to fifty percent in annual heating costs for those sites that are dependent on heating oil or propane and do not have access to natural gas
- The ability to tour and learn from other business in similar situations prior to purchasing an energy system is critical to developing purchase confidence in a biomass system – particularly if those others are local.
    - In John Day, most of the facility managers interviewed purchased their systems based on anecdotal evidence (e.g., word of mouth from other facility managers that have installed biomass systems).
- Creative, non-grant financing methods can help take the risk out of biomass conversions and increase adoption.
    - Both Grant Union School and Prairie City School took advantage of long-term, zero interest loans that covered the capital cost upfront and did not need to rely on grants for their biomass projects.
- If payback periods for conversions are too long, facilities will not adopt biomass systems.
    - Wisewood Inc. has found it more difficult to sell biomass projects to conventional businesses because these entities look for a three to five year payback. Public institutions, on the other hand, have been a better market because they are willing to take on longer financing (e.g. ten year paybacks).
- Investment in the development of new low-cost biomass energy systems should be a priority as the current costs are out of line with the value. The relatively large capital costs are a barrier to project development and the lack of standardization (e.g., each system is a reinvention/customization) has prevented efficiencies and cost decreases.

Fuel Delivery

- Clustered biomass facilities that are in close proximity to a biomass fuel producer/distributor can improve delivery efficiencies by minimizing fuel transportation distances.
- There appears to be a conflict between what biomass energy facilities want (convenience, fuel delivery on an as needed basis) versus what some biomass fuel producers/distributors desire (large installed storage capacity and predictable fuel delivery scheduling).
    - Lead-time is required for pellet fuel delivery and how much fuel a facility can take in one shot is very important. Malheur Lumber has found that they cannot deliver fuel immediately because their delivery contractors are only available on certain days and get scheduled out weeks ahead. The key is to make sure that sites have enough storage capacity to take a whole truckload at one time. John Rowell of Malheur Lumber believes that facilities should have a minimum of fifty tons of fuel storage (or a two week window for delivery).

    - Bulk delivery provides some fuel cost rate savings over smaller, more frequent deliveries; however, the customers have had to incur the capital costs of on-site storage and the additional operations and maintenance obligations. By charging reduced bulk rates for their pellets compared to bagged, Malheur Lumber tries to encourage increased delivery efficiency, but it is possible that a greater return could be achieved if they charged more based upon greater customer service (smaller, more frequent deliveries and less storage investment by the customer).
- Creative ability in distribution is extremely valuable – that is the ability to provide "just in time" or close, small deliveries of biomass, economically can reduce the capital costs of storage at all locations
- There is a need for new fuel distribution methods/models that are more customer-oriented (e.g. selling convenience) while also being profitable for distributors. Changes to current fuel distribution business models could potentially result in large savings or greater returns, depending upon the perspective (supplier vs. user).
    - For example, biomass fuel distributors could learn from the experience of heating oil and propane distributors for successful best practices and models that could be emulated.
    - Would a biomass user (e.g., a school) be willing to pay $10,000-15,000 per year to reduce risk and increase confidence in the system with expanded services (quicker response from the supplier, assistance with waste management/ash disposal, routine maintenance oversight or review, etc)? If a project is evaluated as saving $25,000 in energy costs, would the customer be willing to forego some of these savings to invest in more services from the supplier or another business? It is possible that the customer does not really care if they saved $25,000 per year versus $15,000-20,000 per year if they knew the latter gave them less issues, greater confidence in the system, quicker responses, support in their waste (e.g. ash disposal), support in the operations (e.g. expertise in burning), etc? The business opportunity is in generating additional revenue by offering an expansion of services beyond fuel delivery, which would be attractive to consumers who desire a more hands-off heating system like oil or propane.

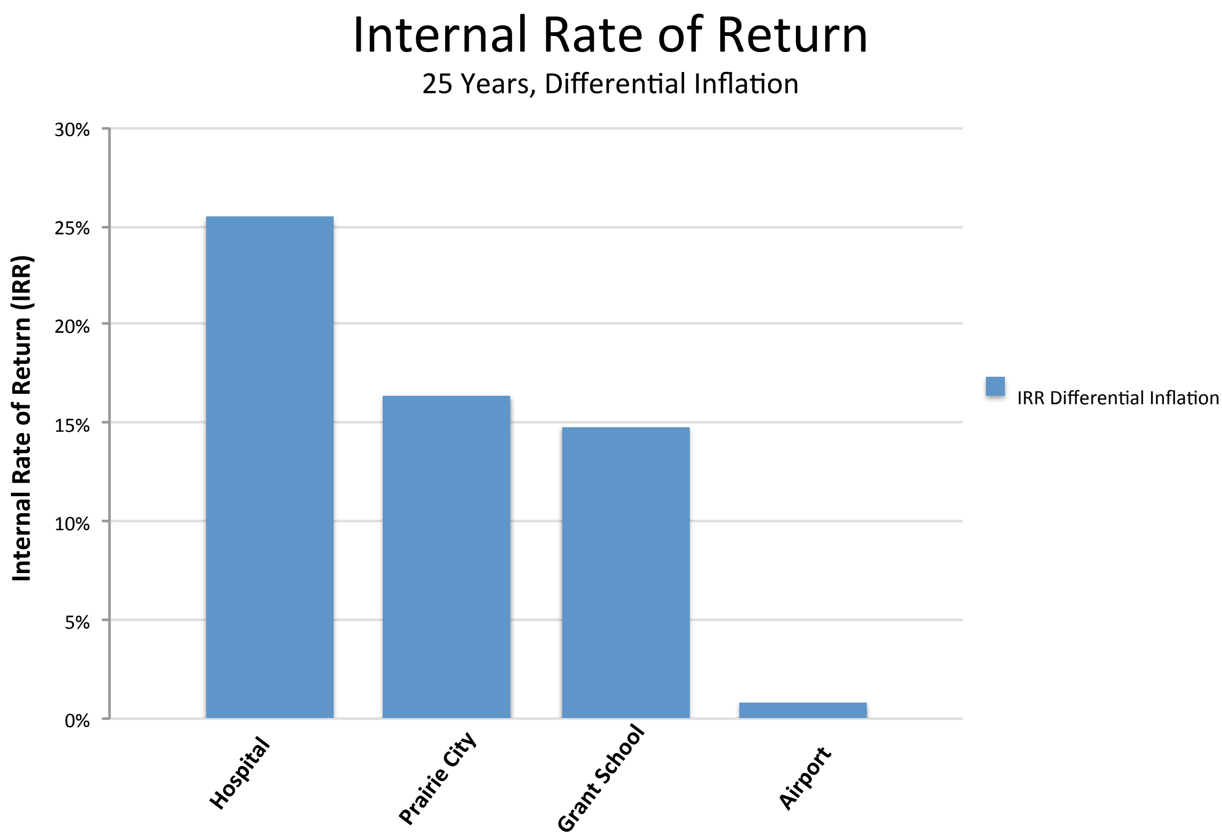
Design Best Practices

Wisewood Inc. helps develop heating, cooling, combined heat and power, and district energy biomass projects for a wide variety of clients in the Pacific Northwest and was involved in the development of the biomass conversions in the Grant County cluster. The following is a list of some of the best practices for biomass energy conversions as outlined by Wisewood's President, Andrew Haden:

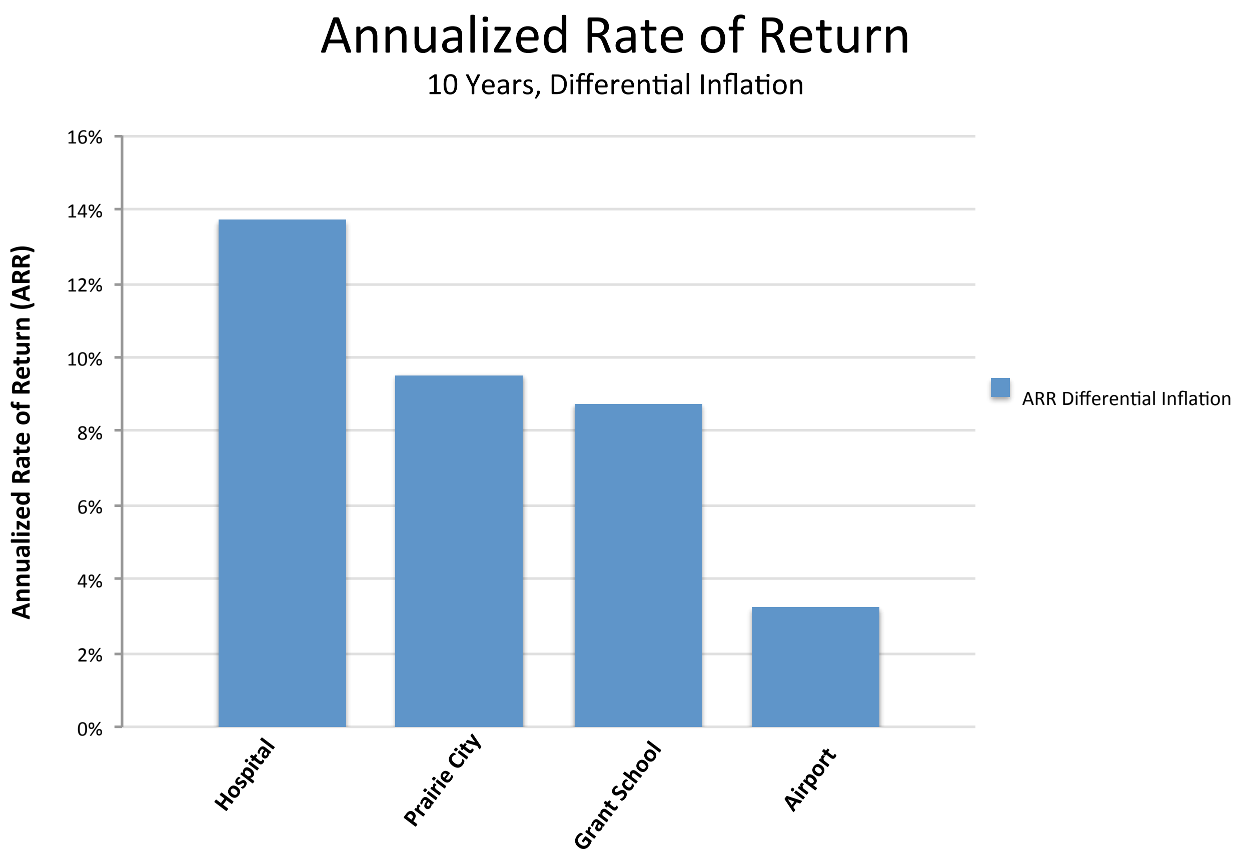
- Start with assessing the situation on the ground. Look at access space in existing buildings to determine if there is enough room for a new biomass boiler, fuel storage, and conveyance. Alternatively, is there space adjacent to the building's existing boiler room to accommodate the square footage of a system?
- Assess the existing heating system to make sure that a biomass system can be integrated.
- Determine what it would cost to interconnect with existing HVAC systems.
- Talk with facility staff to understand their needs, capacity, and if they have experience with biomass systems (these types of systems are more hands on).

- Look at the wood fuel resources (pellets or chips, for example) that are available in the area. Also, determine if there is truck access for fueling.
- Model the heat load and the percentage that would be covered by biomass (eighty to ninety percent covered by biomass is what Wisewood aims for). When you can accurately determine the proper boiler size for a facility, your project cost estimates will be much more accurate.
- Determine if it would be possible to purchase a European made biomass system. European biomass technology is higher quality (more efficient, compact, automated, and have great safety records) versus current U.S. manufactured biomass systems.
- It should be noted that biomass is not currently competitive with natural gas. Biomass systems do not have a good payback when sites have access to natural gas. The exception to this rule would be for very large systems, like a college campus.

Appendix A: Financial Analysis Graphs



Examining the IRR graph above, Blue Mountain Hospital will likely have the greatest return on investment (25.4%) over a twenty-five year time period and Grant County Regional Airport will experience the lowest return (0.8%). Prairie City School's IRR of 16.4% was close to the IRR of Grant Union School's biomass project (14.8%). The average twenty-five year IRR across the four facilities equals 14.4%. Overall, aside from the airport's conversion, the projects appear to be financially attractive with the calculated IRRs indicating positive growth across facilities.



Examining the ARR graph above, of the four John Day biomass facilities, Blue Mountain Hospital will likely experience the highest expected growth rate each year based on a ten year time period. Blue Mountain has the highest ARR equal to 13.7% and Grant County Regional Airport has the lowest ARR at 3.2%. Both Grant Union School's and Prairie City School's biomass projects were fairly close to one another in terms of calculated ARR (8.7% versus 9.5% respectively). The average ten year ARR across the four facilities equals 8.8%. Three of the four facilities are within the five to ten percent ARR range that investors typically look for, indicating that these projects are favorable from a financial investment perspective.

Appendix B: Blue Mountain Hospital Project Financial Data

NOTE: Tables and graphs in Appendix A-C are the intellectual property of Wisewood, Inc.

Blue Mountain Hospital District

1,800 MBH Hot Water Boiler

Project	Blue Mountain Hospital District	**Boiler Type**	1,800 MBH Hot Water Boiler	**Contact**	Andrew Haden
Location	John Day, OR	**Description**	Retrospective Analysis	**Phone**	(503) 608-7366
Contact	Bob Houser	**Fuel Type**	Wood Pellets	**Email**	andrew@wisewood.us
Date	1/3/13	**Workbook Version**	v3.1		

Years of HDD data	1	**Description:**	Fahrenheit-based heating degree days for a base temperature of 65F
Years of energy use data	1	**Station:**	Airport: Grant County, OR, US (118.97W,44.40N)
Fuel type	Heating Oil	**Station ID:**	KGCD

Heating Oil Consumption	2010	Year 2	Year 3	Year 4	Year 5
Gallons	42,000	0	0	0	0

Heating Oil cost, $/gal.	$3.50	Annual Heating Oil use, gal.	42000	Anticipated building efficient gains	0%
Wood fuel cost, $/ton	$165.00	Operating hours/day	24	Calculated heat load (Gal./HHD)	6.27
MC, wet weight basis	5%	Wood Boiler Efficiency	85%	Estimated reduction in Heating Oil use	91%
Energy of heating oil, Btu/gal, LHV	129000	Existing Boiler Efficiency	70%	Boiler output, high-fire (MBH)	6278
Energy of wood, mmBtu/ton, LHV	15.6			Boiler output, low-fire (MBH)	1256
Heating Oil cost, $/mmBtu	$27.13			Current efficiency corrected fuel cost, $/mmBtu	$38.76

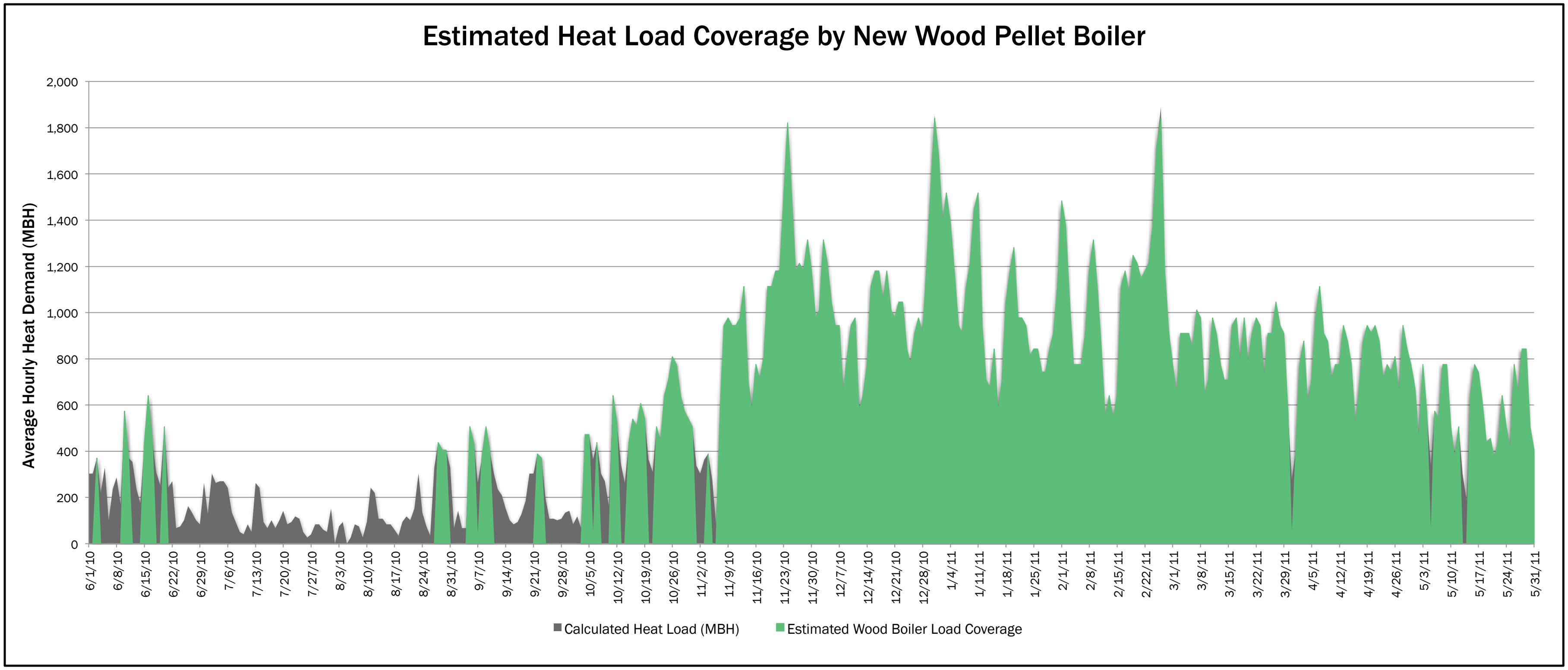
Current Estimated Energy Use / **Projected Energy Use**

Month	Heat Demand [HDD]	Current Est. Heating Oil Use [gal/mo]	Percent of annual use	Heat input [MMBtu]	Estimated Current Heating Oil Bill	Projected wood fuel use, [tons]	Projected Heating Oil use, [gal]
June	245	1,534	4%	139	$ 5,368.81	9.5	140
July	109	686	2%	62	$ 2,400.04	4.2	63
August	115	719	2%	65	$ 2,516.42	4.5	66
September	209	1,309	3%	118	$ 4,580.51	8.1	120
October	391	2,455	6%	222	$ 8,592.29	15.2	224
November	766	4,806	11%	434	$ 16,820.08	29.8	439
December	910	5,709	14%	516	$ 19,982.07	35.4	522
January	989	6,205	15%	560	$ 21,716.78	38.4	567
February	962	6,035	14%	545	$ 21,123.91	37.4	552
March	770	4,832	12%	436	$ 16,912.30	29.9	442
April	714	4,479	11%	404	$ 15,678.24	27.8	409
May	515	3,231	8%	292	$ 11,308.54	20.0	295
Yearly Total, or Average	6695	42,000	100%	3793	$ 147,000.00	260.2	3838

Blue Mountain Hospital District

1,800 MBH Hot Water Boiler

Project	Blue Mountain Hospital District	**Boiler Type**	1,800 MBH Hot Water Boiler	**Contact**	Andrew Haden
Location	John Day, OR	**Description**	Retrospective Analysis	**Phone**	(503) 608-7366
Contact	Bob Houser	**Fuel Type**	Wood Pellets	**Email**	andrew@wisewood.us
Date	1/3/13	**Workbook Version**	v3.1		



Blue Mountain Hospital District

1,800 MBH Hot Water Boiler

Project Blue Mountain Hospital District
Location John Day, OR
Contact Bob Houser
Date 1/3/13

Boiler 1,800 MBH Hot Water Boiler
Description Retrospective Analysis
Fuel Type Wood Pellets
Workbook Version v3.1

Contact Andrew Haden
Phone (503) 706-6187
Email andrew@wisewood.us

DEBT SERVICE	
Total Installation Cost	$ 486,500
Grants	$ 225,000
Total Project Cost	$ 261,500
Debt Leverage	80.0%
Project Equity	20.0%
Loan Amount	$ 209,200
Amount of Equity	$ 52,300
Annual Rate	5.0%
Term (Years)	15.00

FUEL COSTS	Heating Oil	Wood	Electricity
Unit	(mmBtu)	(mmBtu)	(kWhr)
Cost per unit	$38.76	$10.59	$0.08
Escalation Rate	6.0%	1.5%	3.0%

O&M COSTS	Labor		Electricity
Labor (hrs/wk)	1	Operating hours	6000
$/hr	$30	Max output kW (thermal)	1840
Wk/yr	40	Average output kW (thermal)	854
Total/yr	$1,200	Max. electrical draw (kW)	5
Annual increase	2%	Average draw (kW)	2.3
		Annual use (kWhr)	13928
		Annual cost	$1,114

30 YR ACCUMULATED CASH FLOW	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 15	Year 20	Year 30
EXISTING HEATING SYSTEM OPERATING COSTS													
Projected Heating Oil Cost	$ 147,000	$ 155,820	$ 165,169	$ 175,079	$ 185,584	$ 196,719	$ 208,522	$ 221,034	$ 234,296	$ 248,353	$ 332,353	$ 444,763	$ 796,503
O&M Cost	$ 500	$ 510	$ 520	$ 531	$ 541	$ 552	$ 563	$ 574	$ 586	$ 598	$ 660	$ 728	$ 888
TOTAL	**$ 147,500**	**$ 156,330**	**$ 165,689**	**$ 175,610**	**$ 186,125**	**$ 197,271**	**$ 209,085**	**$ 221,608**	**$ 234,881**	**$ 248,951**	**$ 296,427**	**$ 445,492**	**$ 797,391**
PROPOSED HEATING SYSTEM OPERATING COSTS													
Heating Oil Cost (Peak and Low Load)	$ 13,434	$ 14,240	$ 15,094	$ 16,000	$ 16,959	$ 17,977	$ 19,056	$ 20,199	$ 21,411	$ 22,696	$ 30,372	$ 40,644	$ 72,788
Wood Fuel Cost	$ 42,935	$ 43,579	$ 44,233	$ 44,897	$ 45,570	$ 46,254	$ 46,947	$ 47,652	$ 48,366	$ 49,092	$ 52,886	$ 56,973	$ 66,120
O&M Cost	$ 1,200	$ 1,224	$ 1,248	$ 1,273	$ 1,299	$ 1,325	$ 1,351	$ 1,378	$ 1,406	$ 1,434	$ 1,583	$ 1,748	$ 2,131
Electrical Cost	$ 1,114	$ 1,148	$ 1,182	$ 1,218	$ 1,254	$ 1,292	$ 1,330	$ 1,370	$ 1,411	$ 1,454	$ 1,685	$ 1,954	$ 2,626
TOTAL	**$ 58,683**	**$ 60,191**	**$ 61,758**	**$ 63,387**	**$ 65,082**	**$ 66,847**	**$ 68,685**	**$ 70,599**	**$ 72,595**	**$ 74,675**	**$ 86,526**	**$ 101,319**	**$ 143,664**
PROJECT RELATED DEBT													
Beginning Principal Balance	$ 209,200	$ 199,505	$ 189,326	$ 178,637	$ 167,414	$ 155,630	$ 143,257	$ 130,265	$ 116,623	$ 102,300	$ 19,195	$ -	$ -
Principal Repayments	$ (9,695)	$ (10,180)	$ (10,689)	$ (11,223)	$ (11,784)	$ (12,373)	$ (12,992)	$ (13,642)	$ (14,324)	$ (15,040)	$ (19,195)	$ -	$ -
Interest Payments	$ (10,460)	$ (9,975)	$ (9,466)	$ (8,932)	$ (8,371)	$ (7,782)	$ (7,163)	$ (6,513)	$ (5,831)	$ (5,115)	$ (960)	$ -	$ -
Ending Principal Balance	$ 199,505	$ 189,326	$ 178,637	$ 167,414	$ 155,630	$ 143,257	$ 130,265	$ 116,623	$ 102,300	$ 87,260	$ 0	$ -	$ -
TOTAL DEBT PAYMENT	**$ 20,155**	**$ 20,155**	**$ 20,155**	**$ 20,155**	**$ 20,155**	**$ 20,155**	**$ 20,155**	**$ 20,155**	**$ 20,155**	**$ 20,155**	**$ 20,155**	**$ -**	**$ -**
ANNUAL OPERATING COST SAVINGS (OR LOSS)	**$ 68,662**	**$ 75,985**	**$ 83,777**	**$ 92,068**	**$ 100,888**	**$ 110,269**	**$ 120,246**	**$ 130,854**	**$ 142,132**	**$ 154,121**	**$ 226,331**	**$ 344,172**	**$ 653,727**
Cash Investment	$ (52,300)	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -			
Income	$ 68,662	$ 75,985	$ 83,777	$ 92,068	$ 100,888	$ 110,269	$ 120,246	$ 130,854	$ 142,132	$ 154,121	$ 226,331	$ 344,172	$ 653,727
Net Cash Flow	**$ 16,362**	**$ 75,985**	**$ 83,777**	**$ 92,068**	**$ 100,888**	**$ 110,269**	**$ 120,246**	**$ 130,854**	**$ 142,132**	**$ 154,121**	**$ 226,331**	**$ 344,172**	**$ 653,727**
ACCUMULATED CASH FLOW	$ 16,362	$ 92,347	$ 176,124	$ 268,192	$ 369,080	$ 479,349	$ 599,595	$ 730,449	$ 872,581	$ 1,026,701	$ 2,005,186	$ 3,518,930	$ 8,511,759

Net Present Value (NPV)		10 YR NPV	15 YR NPV	20 YR NPV	30 YR NPV
NPV Discount Rate	6.0%	$ 711,712	$ 1,167,960	$ 1,695,987	$ 2,807,213

Appendix C: Grant Union JR/SR School Project Financial Data

Grant Union Sr/Jr High School

2,200 MBH Steam Boiler

WISEWOOD inc

Project	Grant Union Sr/Jr High School	**Boiler Type**	2,200 MBH Steam Boiler	**Contact**	Andrew Haden
Location	John Day, OR	**Description**	Retrospective Analysis	**Phone**	(503) 608-7366
Contact	Mark Witty	**Fuel Type**	Wood Pellets	**Email**	andrew@wisewood.us
Date	1/3/13	**Workbook Version**	v3.1		

Years of HDD data	1	**Description:**	Fahrenheit-based heating degree days for a base temperature of 65F
Years of energy use data	1	**Station:**	Airport: Grant County, OR, US (118.97W,44.40N)
Fuel type	Heating oil	**Station ID:**	KGCD

Heating Oil Consumption	2010	Year 2	Year 3	Year 4	Year 5
Gallons	23,500	0	0	0	0

Heating oil cost, $/gal.	$3.36	Annual Heating oil use, gal.	23500	Anticipated building efficient gains	0%
Wood fuel cost, $/ton	$165.00	Operating hours/day	10	Calculated heat load (Gal./HHD)	3.79
MC, wet weight basis	5%	Wood Boiler Efficiency	80%	Estimated reduction in Heating oil use	94%
Energy of heating oil, Btu/gal, LHV	129000	Existing Boiler Efficiency	80%	Boiler output, high-fire (MBH)	7568
Energy of wood, mmBtu/ton, LHV	15.6			Boiler output, low-fire (MBH)	1892
Heating oil cost, $/mmBtu	$26.05			Current efficiency corrected fuel cost, $/mmBtu	$32.56

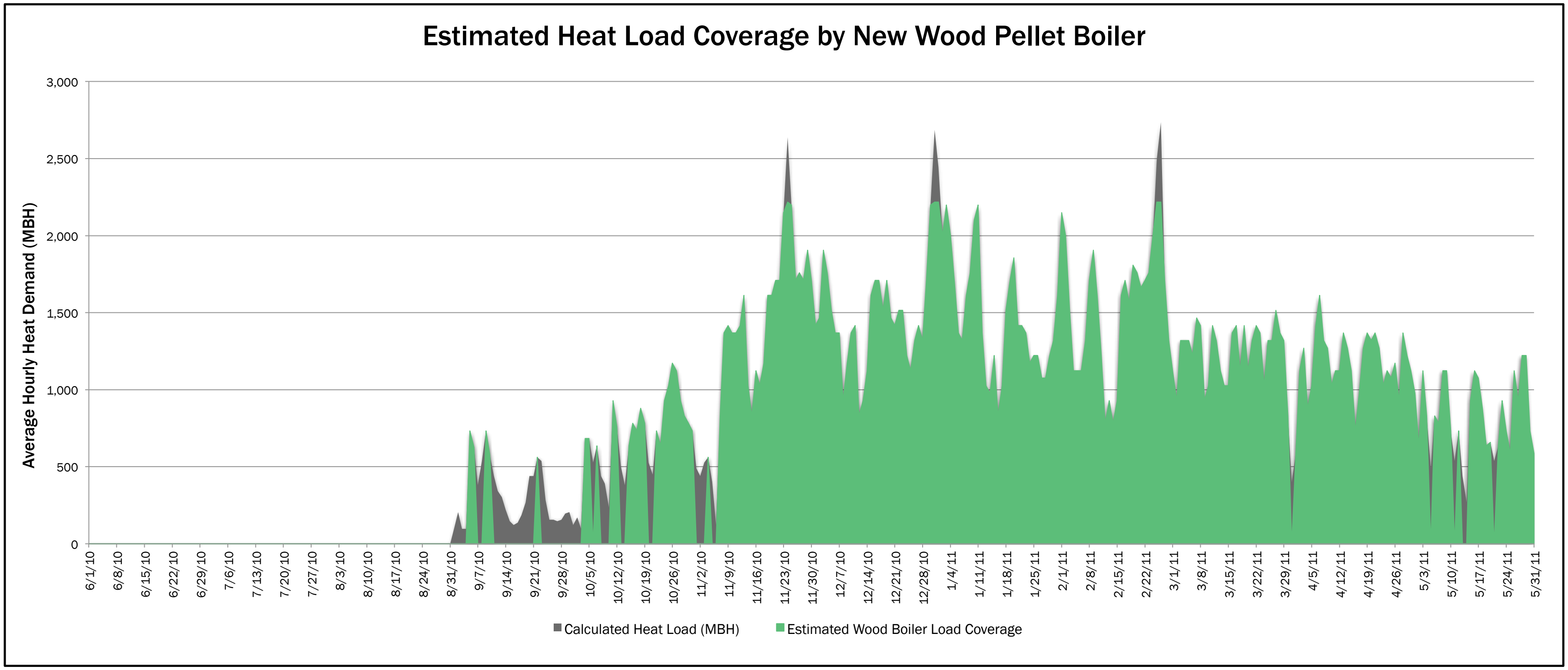
Current Estimated Energy Use / **Projected Energy Use**

Month	Heat Demand [HDD]	Current Est. Oil Use [gal/mo]	Percent of annual use	Heat input [MMBtu]	Estimated Current Heating oil Bill	Projected wood fuel use, [tons]	Projected Heating oil use, [gal]
June	0	0	0%	0	$ -	0.0	0
July	0	0	0%	0	$ -	0.0	0
August	0	0	0%	0	$ -	0.0	0
September	187	708	3%	73	$ 2,377.34	5.5	39
October	391	1,482	6%	153	$ 4,979.94	11.6	82
November	766	2,901	12%	299	$ 9,748.62	22.7	160
December	910	3,447	15%	356	$ 11,581.26	27.0	190
January	989	3,746	16%	387	$ 12,586.66	29.3	206
February	962	3,644	16%	376	$ 12,243.04	28.5	201
March	770	2,917	12%	301	$ 9,802.07	22.8	161
April	714	2,704	12%	279	$ 9,086.83	21.2	149
May	515	1,951	8%	201	$ 6,554.23	15.3	107
Yearly Total, or Average	6204	23,500	100%	2425	$ 78,960.00	183.9	1294

Grant Union Sr/Jr High School

2,200 MBH Steam Boiler

Project	Grant Union Sr/Jr High School	**Boiler Option**	2,200 MBH Steam Boiler	**Contact**	Andrew Haden
Location	John Day, OR	**Description**	Retrospective Analysis	**Phone**	(503) 608-7366
Contact	Mark Witty	**Fuel Type**	Wood Pellets	**Email**	andrew@wisewood.us
Date	1/3/13	**Workbook Version**	v3.1		



Grant Union Sr/Jr High School

2,200 MBH Steam Boiler

Project	Grant Union Sr/Jr High School	**Boiler Option**	2,200 MBH Steam Boiler
Location	John Day, OR	**Description**	Retrospective Analysis
Contact	Mark Witty	**Fuel Type**	Wood Pellets
Date	1/3/13	**Workbook Version**	v3.1

Contact Andrew Haden
Phone (503) 608-7366
Email andrew@wisewood.us

DEBT SERVICE	
Total Installation Cost	$ 475,000
Grants	$ -
Total Project Cost	$ 475,000
Debt Leverage	100.0%
Project Equity	0.0%
Loan Amount	$ 475,000
Amount of Equity	$ -
Annual Rate	0.0%
Term (Years)	15.00

FUEL COSTS	Oil	Wood	Electricity
Unit	(mmBtu)	(mmBtu)	(kWhr)
Cost per unit	$32.56	$10.59	$0.08
Escalation Rate	6.0%	1.5%	3.0%

O&M COSTS	Labor		Electricity
Labor (hrs/wk)	1	Operating hours	6000
$/hr	$30	Max output kW (thermal)	2218
Wk/yr	40	Average output kW (thermal)	1267
Total/yr	$1,200	Max. electrical draw (kW)	15
Annual increase	2%	Average draw (kW)	8.6
		Annual use (kWhr)	51431
		Annual cost	$4,114

30 YR ACCUMULATED CASH FLOW	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 15	Year 20	Year 30
EXISTING HEATING SYSTEM OPERATING COSTS													
Projected Heating Oil Cost	$ 78,960	$ 83,698	$ 88,719	$ 94,043	$ 99,685	$ 105,666	$ 112,006	$ 118,727	$ 125,850	$ 133,401	$ 178,521	$ 238,901	$ 427,836
O&M Cost	$ 2,000	$ 2,040	$ 2,081	$ 2,122	$ 2,165	$ 2,208	$ 2,252	$ 2,297	$ 2,343	$ 2,390	$ 2,639	$ 2,914	$ 3,552
TOTAL	**$ 80,960**	**$ 85,738**	**$ 90,800**	**$ 96,165**	**$ 101,850**	**$ 107,874**	**$ 114,259**	**$ 121,024**	**$ 128,194**	**$ 135,791**	**$ 161,420**	**$ 241,815**	**$ 431,388**
PROPOSED HEATING SYSTEM OPERATING COSTS													
Heating Oil Cost (Peak and Low Load)	$ 4,349	$ 4,610	$ 4,887	$ 5,180	$ 5,491	$ 5,820	$ 6,169	$ 6,539	$ 6,932	$ 7,348	$ 9,833	$ 13,159	$ 23,565
Wood Fuel Cost	$ 30,337	$ 30,792	$ 31,254	$ 31,722	$ 32,198	$ 32,681	$ 33,172	$ 33,669	$ 34,174	$ 34,687	$ 37,367	$ 40,255	$ 46,718
O&M Cost	$ 1,200	$ 1,224	$ 1,248	$ 1,273	$ 1,299	$ 1,325	$ 1,351	$ 1,378	$ 1,406	$ 1,434	$ 1,583	$ 1,748	$ 2,131
Electrical Cost	$ 4,114	$ 4,238	$ 4,365	$ 4,496	$ 4,631	$ 4,770	$ 4,913	$ 5,060	$ 5,212	$ 5,368	$ 6,224	$ 7,215	$ 9,696
TOTAL	**$ 40,000**	**$ 40,864**	**$ 41,754**	**$ 42,672**	**$ 43,619**	**$ 44,596**	**$ 45,605**	**$ 46,647**	**$ 47,724**	**$ 48,837**	**$ 55,007**	**$ 62,377**	**$ 82,110**
PROJECT RELATED DEBT													
Beginning Principal Balance	$ 475,000	$ 443,333	$ 411,667	$ 380,000	$ 348,333	$ 316,667	$ 285,000	$ 253,333	$ 221,667	$ 190,000	$ 31,667	$ -	$ -
Principal Repayments	$ (31,667)	$ (31,667)	$ (31,667)	$ (31,667)	$ (31,667)	$ (31,667)	$ (31,667)	$ (31,667)	$ (31,667)	$ (31,667)	$ (31,667)	$ -	$ -
Interest Payments	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Ending Principal Balance	$ 443,333	$ 411,667	$ 380,000	$ 348,333	$ 316,667	$ 285,000	$ 253,333	$ 221,667	$ 190,000	$ 158,333	$ (0)	$ -	$ -
TOTAL DEBT PAYMENT	**$ 31,667**	**$ 31,667**	**$ 31,667**	**$ 31,667**	**$ 31,667**	**$ 31,667**	**$ 31,667**	**$ 31,667**	**$ 31,667**	**$ 31,667**	**$ 31,667**	**$ -**	**$ -**
ANNUAL OPERATING COST SAVINGS (OR LOSS)	**$ 9,293**	**$ 13,207**	**$ 17,380**	**$ 21,827**	**$ 26,565**	**$ 31,612**	**$ 36,987**	**$ 42,710**	**$ 48,803**	**$ 55,288**	**$ 94,486**	**$ 179,438**	**$ 349,277**
Cash Investment	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -			
Income	$ 9,293	$ 13,207	$ 17,380	$ 21,827	$ 26,565	$ 31,612	$ 36,987	$ 42,710	$ 48,803	$ 55,288	$ 94,486	$ 179,438	$ 349,277
Net Cash Flow	**$ 9,293**	**$ 13,207**	**$ 17,380**	**$ 21,827**	**$ 26,565**	**$ 31,612**	**$ 36,987**	**$ 42,710**	**$ 48,803**	**$ 55,288**	**$ 94,486**	**$ 179,438**	**$ 349,277**
ACCUMULATED CASH FLOW	$ 9,293	$ 22,500	$ 39,880	$ 61,706	$ 88,271	$ 119,883	$ 156,870	$ 199,580	$ 248,383	$ 303,670	$ 692,869	$ 1,476,989	$ 4,121,507

Net Present Value (NPV)		**10 YR NPV**	**15 YR NPV**	**20 YR NPV**	**30 YR NPV**
NPV Discount Rate	6.0%	$ 205,692	$ 386,577	$ 659,982	$ 1,247,897

Appendix D: Prairie City School Project Financial Data

Prairie City School District

2,600 MBH Steam Boiler

Project	Prairie City School District	**Boiler Option**	2,600 MBH Steam Boiler	**Contact**	Andrew Haden
Location	Prairie City, OR	**Description**	Retrospective Analysis	**Phone**	(503) 608-7366
Contact	Ryan Gerry	**Fuel Type**	Wood Pellets	**Email**	andrew@wisewood.us
Date	1/3/13	**Workbook Version**	v3.1		

Years of HDD data	1	**Description:**	Fahrenheit-based heating degree days for a base temperature of 65F
Years of energy use data	1	**Station:**	Airport: Grant County, OR, US (118.97W,44.40N)
Fuel type	Propane	**Station ID:**	KGCD

Propane Consumption	2010	Year 2	Year 3	Year 4	Year 5
Gallons	50,000	0	0	0	0

Propane cost, $/gal.	$2.25	Annual Propane use, gal.	50000	Anticipated building efficient gains	0%
Wood fuel cost, $/ton	$160.00	Operating hours/day	10	Calculated heat load (Gal./HHD)	8.06
MC, wet weight basis	5%	Wood Boiler Efficiency	80%	Estimated reduction in Propane use	95%
Energy of Propane, Btu/gal, LHV	84000	Existing Boiler Efficiency	75%	Boiler output, high-fire (MBH)	8731
Energy of Wood, mmBtu/ton, LHV	15.6			Boiler output, low-fire (MBH)	2183
Propane cost, $/mmBtu	$26.79			Current efficiency corrected fuel cost, $/mmBtu	$35.71

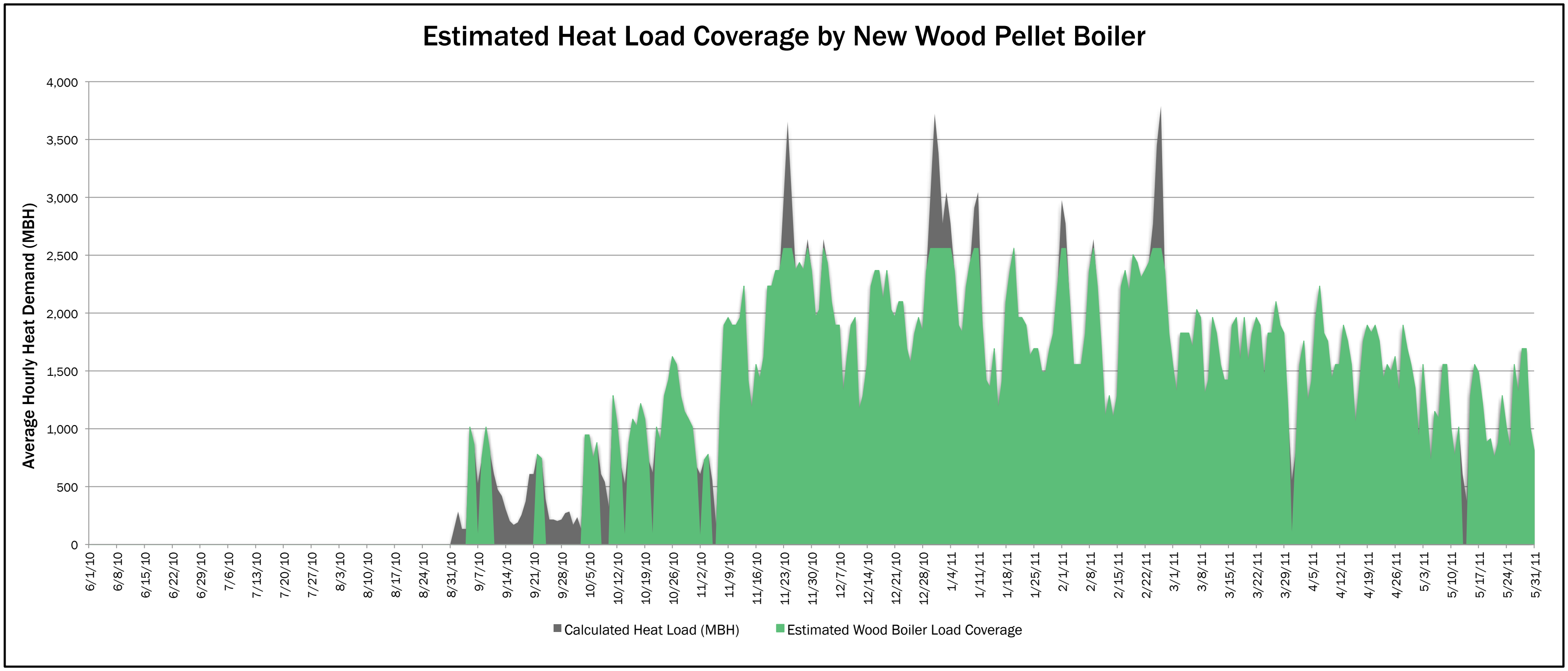
Current Estimated Energy Use / **Projected Energy Use**

Month	Heat Demand [HDD]	Current Est. Propane Use [gal/mo]	Percent of annual use	Heat input [MMBtu]	Estimated Current Propane Bill	Projected wood fuel use, [tons]	Projected Propane use, [gal]
June	0	0	0%	0	$ -	0.0	0
July	0	0	0%	0	$ -	0.0	0
August	0	0	0%	0	$ -	0.0	0
September	187	1,505	3%	95	$ 3,387.17	7.2	82
October	391	3,153	6%	199	$ 7,095.28	15.1	171
November	766	6,173	12%	389	$ 13,889.56	29.5	334
December	910	7,334	15%	462	$ 16,500.65	35.1	397
January	989	7,970	16%	502	$ 17,933.13	38.1	432
February	962	7,753	16%	488	$ 17,443.55	37.1	420
March	770	6,207	12%	391	$ 13,965.72	29.7	336
April	714	5,754	12%	363	$ 12,946.67	27.5	312
May	515	4,150	8%	261	$ 9,338.28	19.8	225
Yearly Total, or Average	6204	50,000	100%	3150	$ 112,500.00	239.0	2708

Prairie City School District

2,600 MBH Steam Boiler

Project	Prairie City School District	**Boiler Option**	2,600 MBH Steam Boiler	**Contact**	Andrew Haden
Location	Prairie City, OR	**Description**	Retrospective Analysis	**Phone**	(503) 706-6187
Contact	Ryan Gerry	**Fuel Type**	Wood Pellets	**Email**	andrew@wisewood.us
Date	1/3/13	**Workbook Version**	v3.1		



Prairie City School District

2,600 MBH Steam Boiler

Project	Prairie City School District	**Boiler Option**	2,600 MBH Steam Boiler	**Contact**	Andrew Haden
Location	Prairie City, OR	**Description**	Retrospective Analysis	**Phone**	(503) 608-7366
Contact	Ryan Gerry	**Fuel Type**	Wood Pellets	**Email**	andrew@wisewood.us
Date	1/3/13	**Workbook Version**	v3.1		

DEBT SERVICE	
Total Installation Cost	$ 655,000
Grants	$ -
Total Project Cost	$ 655,000
Debt Leverage	100.0%
Project Equity	0.0%
Loan Amount	$ 655,000
Amount of Equity	$ -
Annual Rate	0.0%
Term (Years)	20.00

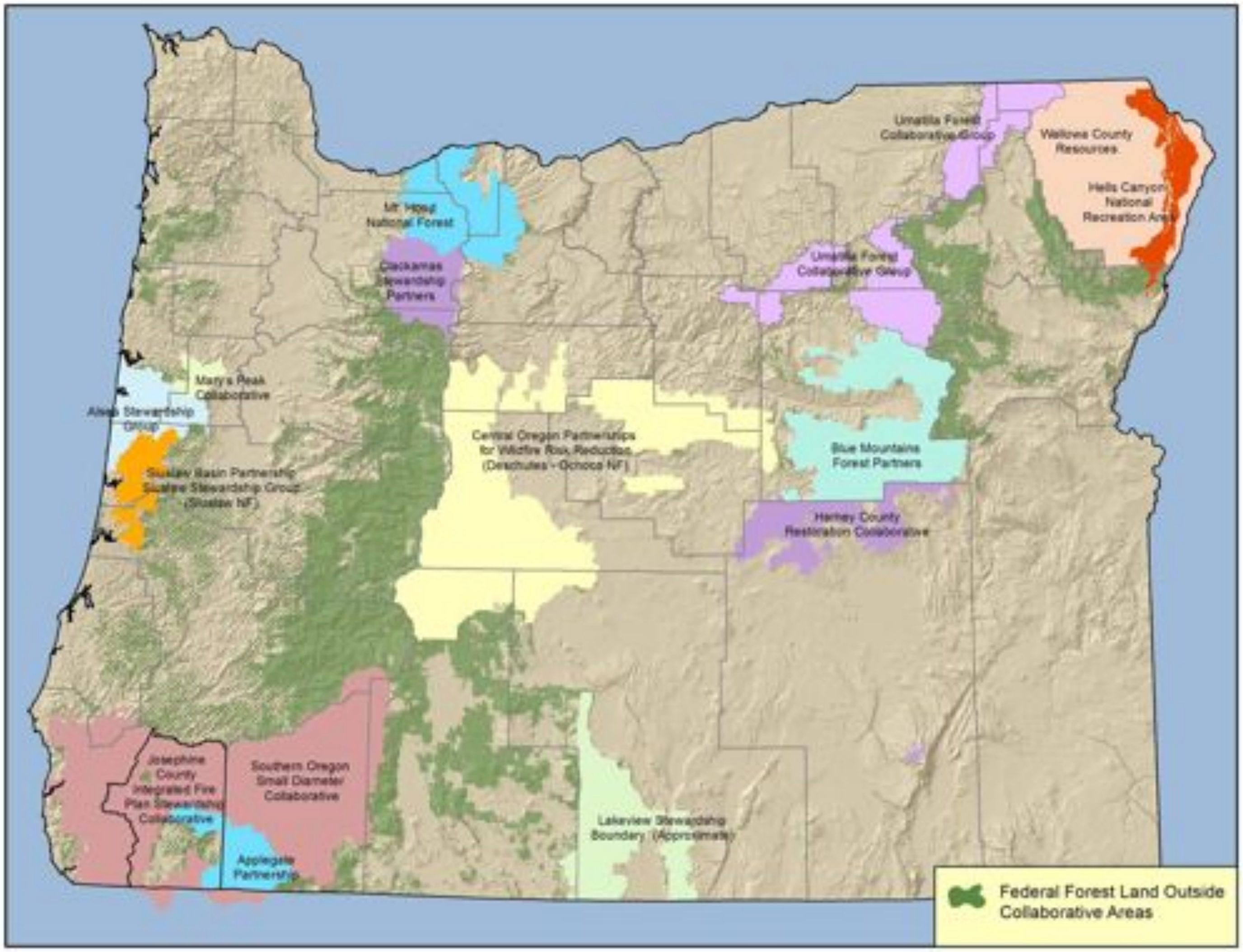
FUEL COSTS	Propane	Wood	Electricity
Unit	(mmBtu)	(mmBtu)	(kWhr)
Cost per unit	$35.71	$10.27	$0.08
Escalation Rate	3.0%	1.5%	3.0%

O&M COSTS	Labor		Electricity
Labor (hrs/wk)	3	Operating hours	6000
$/hr	$30	Max output kW (thermal)	2559
Wk/yr	40	Average output kW (thermal)	1683
Total/yr	$3,600	Max. electrical draw (kW)	15
Annual increase	2%	Average draw (kW)	9.9
		Annual use (kWhr)	59200
		Annual cost	$4,736

30 YR ACCUMULATED CASH FLOW	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 15	Year 20	Year 30
EXISTING HEATING SYSTEM OPERATING COSTS													
Projected Propane Cost	$ 112,500	$ 115,875	$ 119,351	$ 122,932	$ 126,620	$ 130,418	$ 134,331	$ 138,361	$ 142,512	$ 146,787	$ 170,166	$ 197,269	$ 265,114
O&M Cost	$ 2,000	$ 2,040	$ 2,081	$ 2,122	$ 2,165	$ 2,208	$ 2,252	$ 2,297	$ 2,343	$ 2,390	$ 2,639	$ 2,914	$ 3,552
TOTAL	**$ 114,500**	**$ 117,915**	**$ 121,432**	**$ 125,054**	**$ 128,785**	**$ 132,626**	**$ 136,583**	**$ 140,658**	**$ 144,855**	**$ 149,177**	**$ 162,935**	**$ 200,183**	**$ 268,665**
PROPOSED HEATING SYSTEM OPERATING COSTS													
Propane Cost (Peak and Low Load)	$ 6,094	$ 6,276	$ 6,465	$ 6,659	$ 6,858	$ 7,064	$ 7,276	$ 7,494	$ 7,719	$ 7,951	$ 9,217	$ 10,685	$ 14,360
Wood Fuel Cost	$ 38,246	$ 38,820	$ 39,402	$ 39,993	$ 40,593	$ 41,202	$ 41,820	$ 42,447	$ 43,084	$ 43,730	$ 47,110	$ 50,751	$ 58,898
O&M Cost	$ 3,600	$ 3,672	$ 3,745	$ 3,820	$ 3,897	$ 3,975	$ 4,054	$ 4,135	$ 4,218	$ 4,302	$ 4,750	$ 5,245	$ 6,393
Electrical Cost	$ 4,736	$ 4,878	$ 5,024	$ 5,175	$ 5,330	$ 5,490	$ 5,655	$ 5,825	$ 5,999	$ 6,179	$ 7,164	$ 8,305	$ 11,161
TOTAL	**$ 52,676**	**$ 53,646**	**$ 54,637**	**$ 55,647**	**$ 56,679**	**$ 57,731**	**$ 58,805**	**$ 59,902**	**$ 61,021**	**$ 62,163**	**$ 68,241**	**$ 74,985**	**$ 90,812**
PROJECT RELATED DEBT													
Beginning Principal Balance	$ 655,000	$ 622,250	$ 589,500	$ 556,750	$ 524,000	$ 491,250	$ 458,500	$ 425,750	$ 393,000	$ 360,250	$ 196,500	$ -	$ -
Principal Repayments	$ (32,750)	$ (32,750)	$ (32,750)	$ (32,750)	$ (32,750)	$ (32,750)	$ (32,750)	$ (32,750)	$ (32,750)	$ (32,750)	$ (32,750)	$ -	$ -
Interest Payments	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Ending Principal Balance	$ 622,250	$ 589,500	$ 556,750	$ 524,000	$ 491,250	$ 458,500	$ 425,750	$ 393,000	$ 360,250	$ 327,500	$ 163,750	$ -	$ -
TOTAL DEBT PAYMENT	**$ 32,750**	**$ 32,750**	**$ 32,750**	**$ 32,750**	**$ 32,750**	**$ 32,750**	**$ 32,750**	**$ 32,750**	**$ 32,750**	**$ 32,750**	**$ 32,750**	**$ -**	**$ -**
ANNUAL OPERATING COST SAVINGS (OR LOSS)	**$ 29,074**	**$ 31,519**	**$ 34,045**	**$ 36,657**	**$ 39,356**	**$ 42,145**	**$ 45,028**	**$ 48,006**	**$ 51,084**	**$ 54,264**	**$ 71,814**	**$ 125,198**	**$ 177,853**
Cash Investment	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -			
Income	$ 29,074	$ 31,519	$ 34,045	$ 36,657	$ 39,356	$ 42,145	$ 45,028	$ 48,006	$ 51,084	$ 54,264	$ 71,814	$ 125,198	$ 177,853
Net Cash Flow	**$ 29,074**	**$ 31,519**	**$ 34,045**	**$ 36,657**	**$ 39,356**	**$ 42,145**	**$ 45,028**	**$ 48,006**	**$ 51,084**	**$ 54,264**	**$ 71,814**	**$ 125,198**	**$ 177,853**
ACCUMULATED CASH FLOW	$ 29,074	$ 60,593	$ 94,638	$ 131,295	$ 170,650	$ 212,796	$ 257,823	$ 305,830	$ 356,914	$ 411,178	$ 734,010	$ 1,317,401	$ 2,845,137

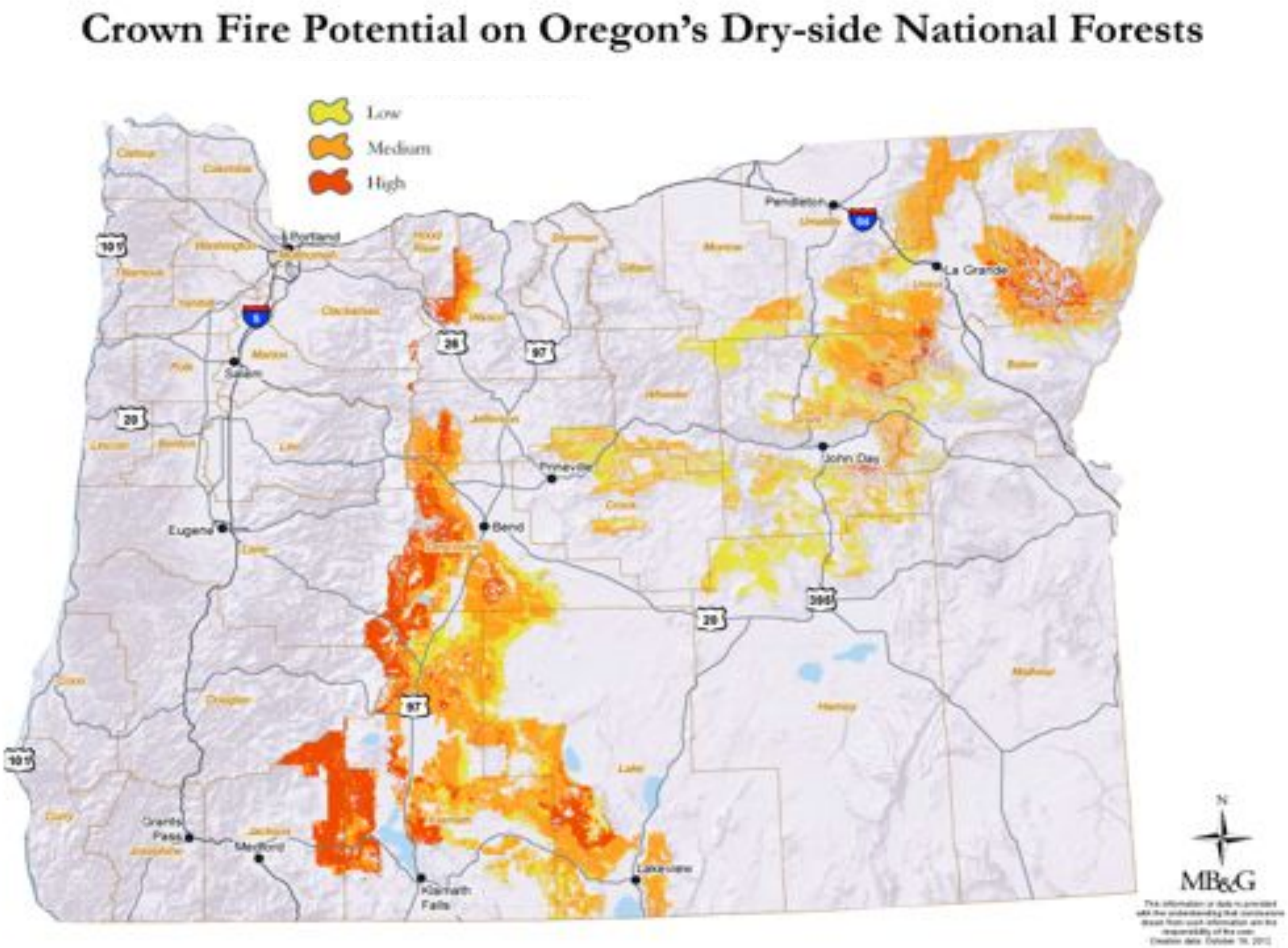
Net Present Value (NPV)		**10 YR NPV**	**15 YR NPV**	**20 YR NPV**	**30 YR NPV**
NPV Discount Rate	6.0%	$ 292,823	$ 443,718	$ 647,944	$ 992,704

Appendix E: National Forest Collaborations Map[24]



[24] Source: http://orsolutions.org/beta/wp-content/uploads/2012/06/LOCAL_COLLABORATIVES_and_federal_forest_map_Nov_20111.pdf

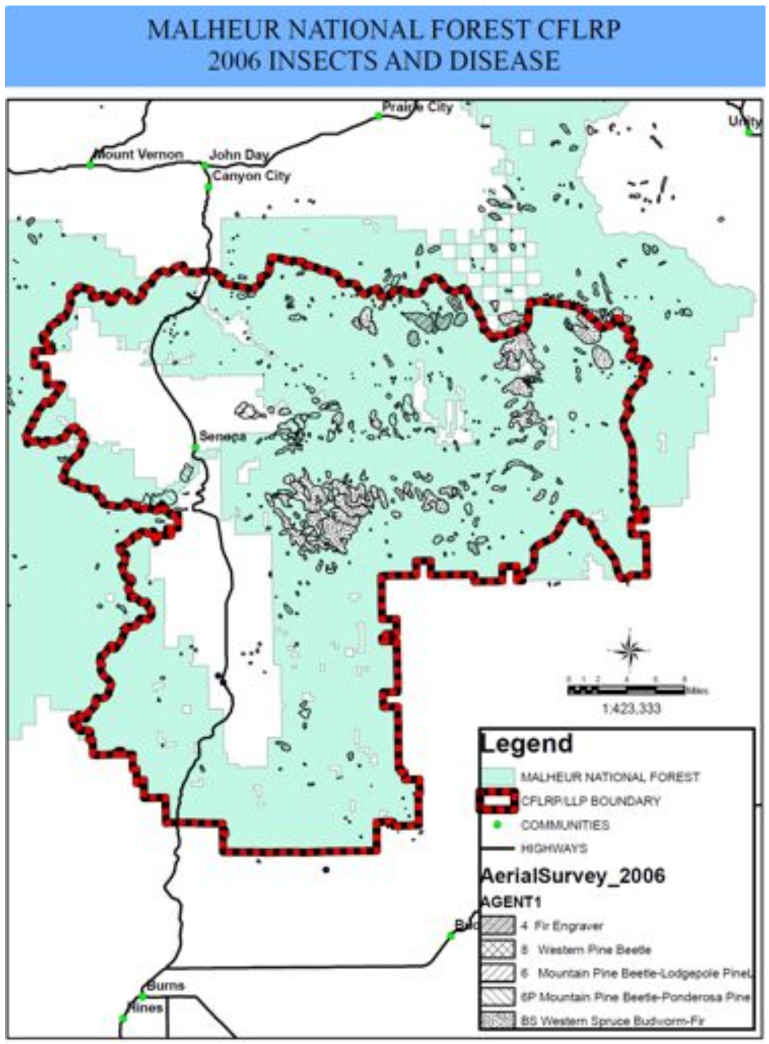
Appendix F: Oregon’s Dry-Side National Forests Crown Fire Potential[25]



25 Source: Krumenauer, Matt, et al. “National Forest Health Restoration.” 26 Nov. 2012. <http://orsolutions.org/beta/wp-content/uploads/2011/08/OR_Forest_Restoration_Econ_Assessment_Nov_2012.pdf>.

Appendix G: Malheur National Forest Insects and Disease Map (2006)[26]

Map 3. 2006 Insects and Disease.

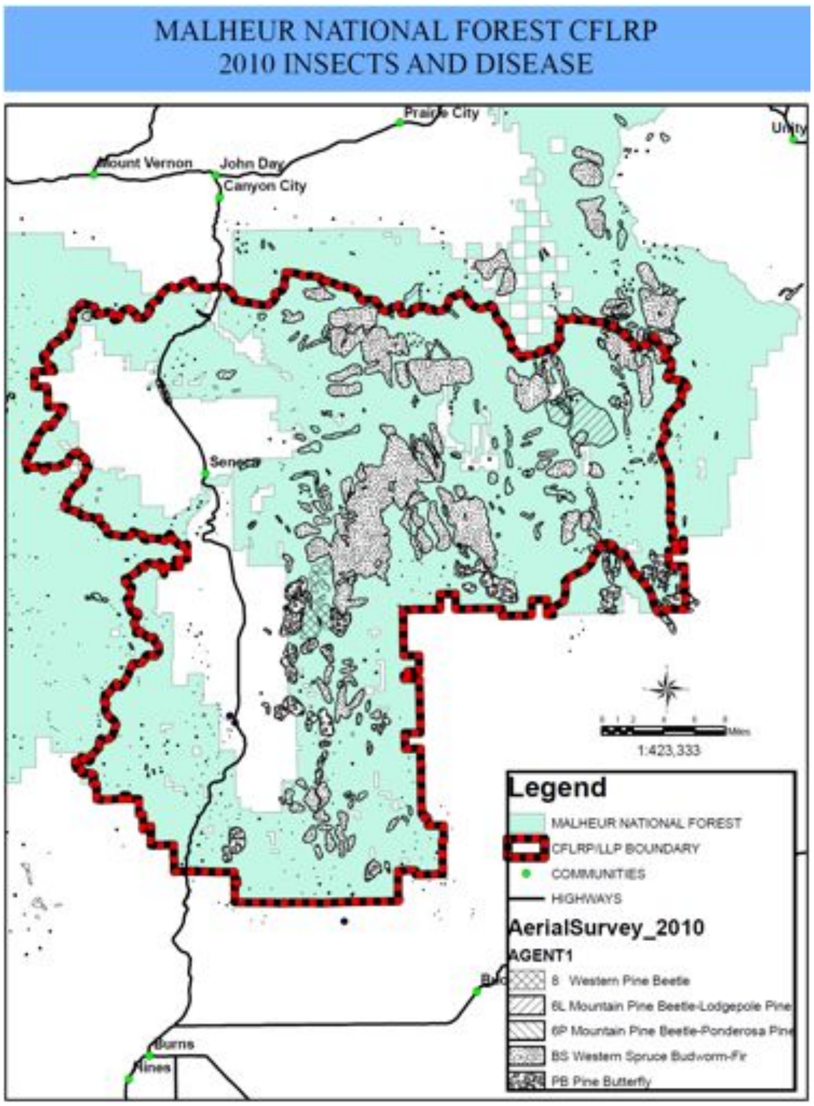


Map 4. 2010 Insects and Disease.

[26] Source: "Southern Blues Restoration Coalition." USDA Forest Service, 2011. <http://www.fs.fed.us/restoration/documents/cflrp/2011Proposals/Region6/Malheur/2011SouthernBluesResCoalitionCFLRPProposal.pdf>.

Appendix H: Malheur National Forest Insects and Disease Map (2010)[27]

SOUTHERN BLUES RESTORATION COALITION
COLLABORATIVE FOREST LANDSCAPE RESTORATION PROGRAM PROPOSAL PAGE 44 OF 45



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27 Source: "Southern Blues Restoration Coalition." USDA Forest Service, 2011. <http://www.fs.fed.us/restoration/documents/cflrp/2011Proposals/Region6/Malheur/2011SouthernBluesRestorationCoalitionCFLRPProposal.pdf>.

Appendix I: Pellet Specifications[28]

Twin Ports Testing Inc.

Twin Ports Testing, Inc.
1301 North 3rd Street
Superior, WI 54880
p: 715-392-7114
p: 800-373-2562
f: 715-392-7163
www.twinportstesting.com

Analytical Test Report

Report No: USR:W212-0112-01
Issue No: 1
This report replaces all previous issues

Client:	MALHEUR LUMBER COMPANY
	PO Box 160
	John Day OR 97845
Attention:	John Rowell
PO No:	MP0153 It 1

Signed: Kevin Anderson

Kevin Anderson
IT Manager

Date of Issue: 2/2/2012

THIS DOCUMENT SHALL NOT BE REPRODUCED EXCEPT IN FULL

Sample Details

Sample Log No:	W212-0112-01	**Sample Date:**	
Sample Designation:	120117SWPPP	**Sample Time:**	
Sample Recognized As:	Pellets	**Arrival Date:**	1/26/2012

Test Results

	METHOD	UNITS	MOISTURE FREE		AS RECEIVED
Moisture Total	ASTM E871	wt. %			2.65
Ash	ASTM D1102	wt. %	0.29		0.28
Volatile Matter	ASTM D3175	wt. %			
Fixed Carbon by Difference	ASTM D3175	wt. %			
Sulfur	ASTM D4239	wt. %	0.025		0.025
SO_2	Calculated	lb/mmbtu			0.054
Net Cal. Value at Const. Pressure	ISO 1928	GJ/tonne			
Net Cal. Value at Const. Pressure	ISO 1928	J/g			
Gross Cal. Value at Const. Vol.	ASTM E711	J/g	20829		20218
Gross Cal. Value at Const. Vol.	ASTM E711	Btu/lb	8955		8693
Carbon	ASTM D5373	wt. %			
Hydrogen	ASTM D5373	wt. %			
Nitrogen	ASTM D5373	wt. %			
Oxygen	ASTM D3176	wt. %			
Chlorine	ASTM D6721	mg/kg	107		104
Fluorine	ASTM D3761	mg/kg			
Mercury	ASTM D6722	mg/kg			
Bulk Density	ASTM E873	lbs/ft^3			42.68
Fines (Less than 1/8")	TPT CH-P-06	wt.%			0.33
Durability Index	Kansas State	PDI			98.7
Sample Above 1.50"	TPT CH-P-06	wt.%			0.0
Maximum Length (Single Pellet)	TPT CH-P-06	inch			1.088
Diameter, Range	TPT CH-P-05	inch	0.251	to	0.254
Diameter, Average	TPT CH-P-05	inch			0.252
Stated Bag Weight	TPT CH-P-01	lbs			40.0
Actual Bag Weight	TPT CH-P-01	lbs			40.3

Comments

[28] Source: Malheur Lumber Company. http://ochocolumber.com/wp-content/uploads/2012/09/Test-120202-PP-Pellet-Bag.pdf .