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FEASIBILITY STUDY

System Sizing, Fuel Selection and Combined Heat and Power Study for Sandpoint, Idaho

Prepared for:

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EXECUTIVE SUMMARY

Background

The city of Sandpoint, Idaho hired the Biomass Energy Resource Center (BERC) to study the economic and logistic feasibility for the installation of a biomass-fired heating system, as well as evaluating the feasibility of a combined heat and power (CHP) system. The potential of producing electricity on-site using biomass fuels was considered, as was the feasibility of employing biomass heating technology at the proposed location. The biomass CHP plant is proposed to be located on the city owned 2.89 acres of land at the industrial park near the city airport. The industrial park has been dedicated to job creation through support of incubating businesses. The city plans to use heat from the biomass CHP project to provide space heating to nearby city-owned buildings. A public – private partnership has been proposed between the city, Panhandle Area Council, Bonner Business Center, and Wilcox Cleaners, LLC as the anchor loads for the biomass CHP plant. The city is making plans to invite other potential businesses to construct buildings and make use of the thermal energy and electricity production at the site. For instance, talks have begun with greenhouse growers of vegetables. This project will be the model for the expansion. The city expects a net return on sale of the heat to various users. Using that money, and purchasing a favorable loan rate from Panhandle Area Council or securing funding from the Sandpoint's urban renewable agency (SURA) the city would like to build a larger CHP in nearby parcel, connect the first CHP unit with the new unit and provide heat and electricity to the public airport and to other nearby businesses. The plan is that the net revenue of each new unit helps pays for the next, larger unit as the renewable energy zone expands throughout the city. The city has secured $250,000 in grant funding from the Renewable Energy Enterprise Zone (REEZ), and $65,000 from the Energy Efficiency and Conservation Block Grant (EECGB), for the implementation of the biomass energy project. The EECGB portion of the funding is earmarked for the on-site electrical generation portion of the project and would be available for the CHP installation.

Heating

The analysis for this study focused on evaluating the feasibility of providing biomass heating to three existing buildings in the vicinity of a proposed biomass energy plant. Heating demand loads were calculated for the Sandpoint City Shop, Bonner Business Center, Lead Loc, and Top Dawg Powder Coatings. The capital costs of using hot water and a water-to-air heat exchanger from the biomass plant to raise the entering air temperature that feeds the powder coater at Top Dawg Powder Coatings determined to be cost prohibitive and therefore the analysis focused on the first three city owned buildings. The facilities were estimated to utilize 1,630 decatherms of natural gas and approximately 124,000 kWh of electricity for space heating and domestic hot water (DHW). A biomass boiler with a capacity of 850,000 Btu per hour was determined to meet the peak heating requirements.

Electrical

The analysis focused on incorporating a small CHP unit and net-metering the generated electricity to the Bonner Business Center, which has the largest electrical load. The city of Sandpoint received a $65,000 EECBG grant for the installation of a biomass CHP unit. The utilities provider for the city of Sandpoint, Avista Utilities, limits the size of net-metering systems to 25 kW in the state of Idaho. While connecting an on-site electrical generation system to the Idaho power grid was found to be do-able, producing electricity using a *CPC BioMax 25* gasifier or a *Talbotts BG25 TCS Biomass to Power System* was found not to be feasible as the technology is in a pre-commercial stage at this time. In addition, the capital cost of installing the CHP system was estimated to exceed $500,000 and is significantly higher than the $65,000 EECBG funding. The cost of generating electricity with biomass was found to be more expensive than purchasing electricity from the grid. Another consideration is that the CHP system would require trained in-house staff with the skills to operate and maintain the equipment which would incur further operation and maintenance costs and devalue the economic feasibility of the project. The analysis determined that a 25 kW biomass CHP system is not feasible for this particular project.

Assessing Technology Options

Several in-house tools were used to estimate heating fuel consumption and calculate a recommended system size for an 850,000 Btu per hour biomass heating system. Two technology options were considered – a fully automated woodchip stoker boiler and a fully automated wood pellet stoker boiler. BERC's life cycle cost analysis (LCC) tool was used to study the economic viability of each of the two technology options and the results were used to compare the two options and make recommendations on which technology to pursue.

Woodchip Heating

Heating with woodchips was estimated to save the city of Sandpoint $17,941 or 63 percent over heating with natural gas and electricity in the first year of operation. The capital cost of the woodchip system, energy plant building, and piping infrastructure was estimated to be $411,250. Over the 30-year period studied, the woodchip heating system would cost $493,693 (2010 dollars) less to own, fuel, operate, maintain, and salvage than the existing heating systems.

Wood Pellet Heating

Heating with wood pellets was estimated to save the city of Sandpoint $2,398 or 8 percent over heating with natural gas and electricity in the first year of operation. The capital cost of the wood pellet system, energy plant building, and piping infrastructure was estimated to be $390,000. Over the 30-year period studied, the wood pellet heating system would cost $44,143 (2010 dollars) less to own, fuel, operate, maintain, and salvage than the existing heating systems.

Fuel Quality, Supply, and Price

Not all biomass heating systems will require the same quality of fuel, so matching the right fuel source and quality to the right system and application is extremely important. Biomass heating systems will function and perform better with a high quality fuel that the particular system is designed to use. Detailed discussion of fuel quality and supply was included in this report.

The price paid for wood fuels can be affected by numerous factors, but the primary factors which influence pricing are:

- Wood source production costs (varies widely depending on whether the wood is a by-product of some more lucrative activity);
- Regional balance of supply and demand; and
- Trucking distance from point of generation to end market.

Woodchip Price

It was assumed here that the wood chip plant would use mill chips, since other varieties of wood chips were not found to be widely available in the region. Mill chips produced in region can be purchased in Sandpoint, Idaho for approximately $25 per green ton (at approximately 42 percent moisture content).

Wood Pellet Price

After talking with Lignetics Inc., a wood pellet manufacturer capable of supplying wood pellets to the proposed biomass plant, it was determined that bulk wood pellets would be available at $160 per ton delivered (at approximately 4.5 - 5.4 percent moisture content).

Conclusions

A woodchip heating system appears to be more cost-effective than a wood pellet heating system, both from the life cycle cost and fuel cost savings perspective. While both wood fuels are less expensive to heat with than natural gas and electricity on a dollar per Btu basis, woodchips were less expensive than wood pellets and therefore woodchips were found to be the most economical heating fuel for the Sandpoint biomass heating plant. However, while the woodchip heating system would be the more cost-effective option, the wood pellet system may be easier to own and operate.

In making a decision between utilizing woodchips and wood pellets, some important differences between the two should be considered. The wood pellet heating systems require less operator attention, less equipment space and less staff time than the woodchip system. Woodchips, however, will likely be more stable in pricing in the future than wood pellets.

Another important consideration is the scalability of the overall project. As the city is planning to use the initial project as a model for expansion and will be scaling up biomass energy production with additional units a woodchip based plant would be more appropriate.

Recommendations

The economics for the installation of a biomass heating system at the proposed location in Sandpoint's Airport Industrial Park look favorable. The results presented here will inform the city's decision to proceed with the release of a RFP for design, permitting and construction of the facility.

Once a system is selected, BERC will work with the City to develop and send out a Request for Proposal (RFP). After a selection of the vendor has been determined by the City with the guidance of BERC, the precise location, layout and interconnection work will be designed and performed by an engineering team in cooperation with the equipment vendors' specifications. The new biomass heating plant building should be placed closer to the road from which the biomass fuel would be delivered, not only for the ease of unloading biomass fuel into the storage bin, but it would keep the heat distribution lines shorter and would therefore lower the total capital costs. The proposed site allows for future expansion to serve more buildings in the area.

Sandpoint's decision-makers should plan to tour existing wood heating systems in the area. Additionally, the project managers should develop relationships with potential wood fuel suppliers in the early stages of the project to ensure success.

INTRODUCTION

The city of Sandpoint, Idaho hired the Biomass Energy Resource Center (BERC) to study the economic and logistic feasibility for the installation of a biomass-fired heating system, as well as evaluating the feasibility of a combined heat and power (CHP) system. BERC will be involved in the developing of the performance specified RFP and selection of the vendor. The new biomass energy plant is proposed to be located on the city owned 2.89 acres of land at the industrial park near the city airport - an engineered led study will confirm whether this location is adequate for the current and future needs of the project. The industrial park has been dedicated to job creation by supporting new businesses. The city plans to use heat from the biomass CHP project to provide space heating to a number of city-owned buildings in the vicinity. Current facilities considered in this analysis are: City Shop, Bonner Business Center, Lead Lok, and Top Dawg Powder Coatings.

The city intends to invite other businesses to construct facilities on site and make use of the thermal energy and electricity production. This project can then be used as a model for expansion as the city expects a net return on sale of the heat to new and existing users. By utilizing the savings and purchasing a favorable loan rate from the Panhandle Area Council or securing funding from the Sandpoint's urban renewable agency (SURA) the city would like to build a larger CHP in nearby parcel and connect the first CHP unit with new users. The plan is that the net revenue of each new unit helps pays for the next, larger unit as the renewable energy zone expands throughout the city. The biomass CHP project would potentially have the benefits of long term savings on energy costs, decreased carbon emissions from the city's energy usage, and increased energy security from a locally available and renewable energy source.

This report summarizes the preliminary cost estimates and assesses the economic feasibility of a new biomass system as compared to the status quo option of continuing to provide heating to city facilities using natural gas and electricity. The findings will enable the city to make a decision whether to further explore the potential for biomass to be an energy source. If, there are plans to move forward with the biomass project, BERC will help develop a RFP based on performance specifications suited for the site located in Sandpoint as well as assist in the selection of the wood-chip boiler vendor.

Recommendations are given at the end of this report for next steps in project development.

City of Sandpoint, Idaho

The city of Sandpoint, Idaho has secured grant funding for a biomass combined heat and power (CHP) project at its Airport Industrial Park. Up until the 1950's, part of Sandpoint's heat and electricity needs were supplied by the "Power House" on Sand Creek. It used waste from the local lumber mills as its renewable energy source. The proposed project seeks to "return to the past" and to re-localize energy production and utilize local, renewable fuels to provide local jobs, energy savings and environmental stewardship.

Biomass Energy Resource Center (BERC)

The Biomass Energy Resource Center (BERC) is a national not-for-profit organization based in Montpelier, Vermont working to develop energy projects using sustainable biomass resources for environmental benefit and local economic development. BERC utilizes staff expertise in community and institutional-scale biomass energy systems to help institutions and communities get biomass projects initiated and built for their heating and combined heat and power needs. In the short time since its inception in 2001, BERC has established itself as a national leader in biomass heating and power generation from forest and agricultural sources.

Study Objectives

This study's purpose is to consider was to size the necessary woodchip boiler as well as determine the logistic and economic feasibility of installing the preliminarily sized 850,000 Btuh biomass-fueled heating and/or CHP system. It compares various fuels available in the area, provides rough estimates of project costs including initial capital and ongoing operation and maintenance (O&M) costs, and gives a preliminary assessment of economic feasibility for all energy options identified. The system will serve select buildings, the layout of which is discussed later in the report.

Scope of Work

The following data was collected from the Sandpoint City Shop, Bonner Business Center, Lead Lok, Inc. and Top Dawg Powder Coatings facilities':

- Master site plans and engineering drawings
- Heating requirements on hourly, weekly, monthly, yearly basis as available, and consumption of heating fuels and power (natural gas and electricity)
- Location and types of present heating distribution systems
- Present price of fuel and energy used with average annual cost
- Site-specific restrictions which may affect the integration of a biomass heating system

This report summarizes the following findings:

- An overview of the advantages of biomass
- An overview of the biomass fuel supply analysis in the region and biomass fuel specifications
- Site assessments and descriptions of the existing facilities, heating systems and energy demand
- Review of the present and future heating requirements of the existing buildings
- Conceptual design and description of biomass technology options of the central biomass heating plant including plant location, building construction needs, and biomass storage and material handling, and heat distribution piping
- An overview of environmental impacts, emission control equipment, and air emission permitting requirements in the state of Idaho
- A life cycle cost analysis for each option identified showing estimated costs and projected savings over the 30 year period, compared to the cost of natural gas and electric systems

- Recommendations for next steps that Sandpoint decision makers may want to take to pursue the biomass energy concept further

Methodology

BERC collected the data on the facilities and existing heating systems. A site visit was performed to gain additional information and confirm the logistics. Initial meetings and conference calls were held with the Idaho Department of Environmental Quality (DEQ), local biomass fuel suppliers, and local schools utilizing biomass systems, foresters, and facility managers of Sandpoint City Shop, Bonner Business Center, Lead Loc, and Top Dawg Powder Coatings.

A life cycle cost analysis was performed on this data and the results were analyzed. BERC assessed the viability of three options for biomass energy and compared the results to the Status Quo option of continuing to heat the existing facilities with natural gas and electricity. The biomass options evaluated are: space heating with woodchips, space heating with wood pellets, and combined heat and power (CHP) technology. The types of technology employed to use biomass fuels are discussed further in this report. The assessment of each of these options was based on BERC's years of experience with wood energy stoker and gasification technology as well as the performance specifications and project cost data provided by several system vendors. BERC conducted economic analyses of the options using a proprietary life cycle cost (LCC) analysis tool.

ADVANTAGES OF BIOMASS

There are numerous environmental and socio-economic advantages of using sustainably procured biomass fuel for energy production instead of fossil fuels, such as natural gas, heating oil, or propane. Several benefits to using biomass energy are listed below, followed by a more in-depth discussion of some of the most compelling reasons to choose biomass energy.

- Increased flexibility and reliability over other energy sources;
- Low heating fuel price escalation (biomass fuel prices have historically escalated at a slower rate than fossil fuel prices);
- Support of local fuel supply will lead to increased economic opportunity in the region and state;
- Support of local economies will contribute to the overall fiscal health of the community through additional purchases, jobs, and an increased tax base; and
- Decreased susceptibility to interruptions in fuel supply.

Dollars Remain in the Local Economy. Unlike fossil fuels that come from outside the region, wood fuel is a local and regional resource. The businesses associated with wood supply (logging operations, trucking companies, and sawmills) tend to be locally owned and operated, retaining profits in the regional economy. These activities contribute to the federal, state, and local tax base. Conversely, most fossil fuel dollars leave not only the local community, but the country. Fuel supply is increasingly an issue of national security, especially for places that rely heavily on heating fuels during much of the year.

In Europe, where district heating is far more commonplace than in the US, an Austrian study completed in the Styria Region[1] showed how the use of biomass energy directly impacted their community. When heating with imported fossil fuels, 25 cents of every dollar left the region, and 59 cents of every dollar left the county entirely, leaving the region with only 16 cents of each dollar. However, when they switched to locally sourced wood, 52 cents of every dollar stayed in the region, 48 cents stayed in Austria, and no money left the county.

More Local Jobs. Conventional energy systems require labor in fuel extraction, processing, delivery, operation, and maintenance as well as in system construction and installation. Fossil fuel supply is based on energy resources outside the community, thus, all jobs associated with extraction and processing are outside the local and regional economies. By contrast, jobs associated with biomass fuel extraction, processing, fuel transportation and distribution, and reforestation are all within the local and regional economies, and provide direct support to the forest products industry and agricultural sectors.

In the same Austrian study as mentioned previously, it was shown that just nine jobs were created from the use of fossil fuel heating, whereas 135 jobs were created as a result of biomass district heating.

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[1] Waldverband Steiermark; Regionalenergie Steiermark

Combustion of biomass, instead of fossil fuels, for energy can have a positive impact in moderating global climate change. Carbon dioxide (CO_2) buildup in the atmosphere is a significant contributor to global climate change. When fossil fuels such as coal, oil, or natural gas, are extracted and burned, they release carbon sequestered from geologic carbon sources thus increasing the net atmospheric carbon load. Conversely, when biomass is burned, the CO_2 released is considered to be within the short-term biogenic carbon cycle which avoids the addition of new carbon to the atmosphere. However, biomass energy only supports a net reduction in carbon emissions if the carbon released during biomass harvesting and combustion is re-sequestered by new forest growth in approximately the same timeframe it took to grow the original stock. Forests can support climate mitigation as "carbon-negative" sources if sustainable harvesting and land management practices allow them to sequester the carbon that is emitted through combustion, the fossil fuels needed to harvest and transport the biomass fuel, and a margin for uncertainty.

Enabling support for the local forest products industry and practicing quality forestry. With only developed markets for the best trees, forests are often "high-graded" or harvested to remove only the highest grade wood. Markets for low-grade wood can help create new incentives for quality forestry and preserve current land use practices. Harvesting the low-grade trees can help improve the forest quality over time through sustainable forestry practices.

Lower cost. While all of these benefits are important from a public policy perspective, probably the most compelling reason for a facility or any consumer to decide on switching to biomass energy is that the cost of biomass fuel is generally much less than the cost of fossil fuels on a Btu basis. These hard-dollar savings often make the investment in biomass heating technology a win-win for facilities and customers looking to reduce operating costs and energy expenditures, combining environmental stewardship and good economics. At the heart of this new application of wood energy is the attraction of using a renewable, locally produced energy source that can save money.

When exploring the conversion from fossil fuels to wood pellet or woodchip heat, an important consideration for building owners is the fuel-cost savings from using biomass. The chart below compares the cost of fossil fuels and biomass.

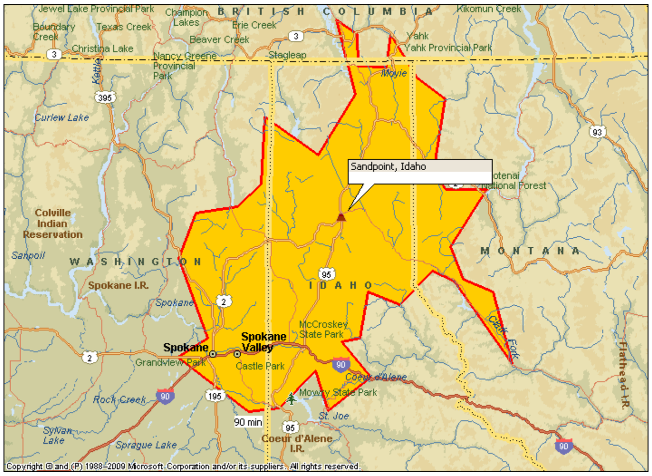
Table 1: Fuel Comparison Chart

Fuel Type	Unit	Cost per Unit	Btu per Unit (dry)	Moisture Content	MMBtu per Unit (wet)	Cost per MMBtu Delivered	Average Seasonal Efficiency	MMBtu per Unit After Combustion	Cost per MMBtu After Combustion
Natural Gas	decatherm	$8.826	1,000,000	0%	1.000	$8.83	80%	0.800	$11.03
Woodchips	ton	$25	14,000,000	42%	8.120	$3.08	70%	5.68	$4.40
Wood Pellets	ton	$160	14,000,000	5%	13.300	$12.03	80%	10.64	$15.04
Electricity	kWh	$0.10	3,412	0%	0.003412	$29.62	100%	0.003412	$29.62

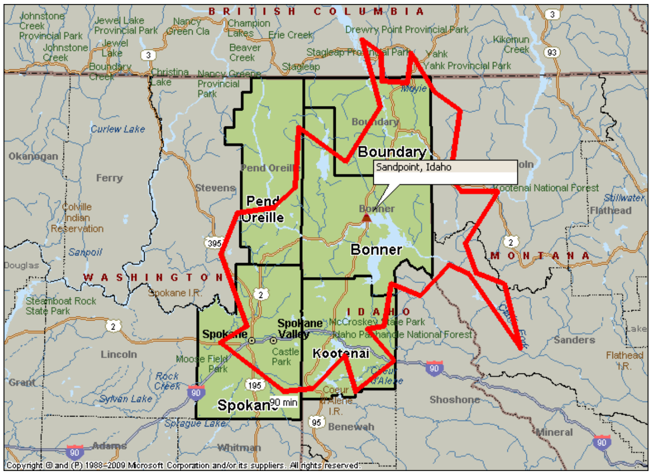
WOOD FUEL SUPPLY ASSESSMENT

The city initially explored the possibility of sourcing biomass feedstocks from the McFarland Pole Company. The local company produces large quantities of "hog-fuel" (cedar peelings currently sold as mulch). During BERC's site it was determined that the "hog-fuel" was not a suitable option for the project. The "hog-fuel" is a more appropriate fuel for utility scale biomass boilers, while the systems being evaluated here are of a much smaller scale and require a cleaner, more refined, biomass fuel. Both woodchips and wood pellets were examined in the following section of this report as possible biomass fuels for the City of Sandpoint's CHP plant.

Wood fuels, both chips and pellets, should be sourced from within a cost-effective delivery range of the facility in Sandpoint, Idaho. Despite the relatively small amount of fuel required to meet the heating load for this project, a 90-minute drive-time zone surrounding Sandpoint was used to conservatively define the supply area from which wood fuels would be procured to feed the heating plant. This area encompasses the majority of the counties of Bonner, Boundary, and Kootenai, Idaho plus the counties of Pend Oreille and Spokane, Washington.



A 90-minute drive time zone surrounding Sandpoint, Idaho.



The counties identified using the 90-minute drive time zone.

Wood fuels can come in all shapes and sizes. Not all energy systems will require the same quality of wood fuel, so matching the right fuel source and quality to the right system and application is extremely important. Following is information on woodchip and pellet fuel quality, sources, availability, pricing, and potential suppliers in the region.

Wood Pellets

Wood pellets are a viable fuel option for the proposed heating plant. Pellets are a manufactured fuel usually made from wood fibers sourced as by-products from the forest products industry, such as sawdust and shavings. Pellets are made by drying these wood fibers and extruding the material through pellets dies under pressure. The resulting pellets can be packaged into 40 pound bags and sold to the residential heating market or distributed in bulk to larger heating customers.

Wood Pellet Quality

As compared to woodchips, pellets are clean, consistent, and uniformly-sized fuel. However, pellet fuel quality can vary considerably. There are many different species and sources of wood and many ways in which the wood can be harvested, processed, loaded, transported and received, all of which can impact the overall quality of the pellet and thereby the successful operation of the pellet heating system. The performance of biomass heating systems is optimized by using a high quality fuel designed for the heating equipment. This results in fewer mechanical jams, less ash produced (and therefore less time spent on removing ash), and longer periods of maintenance-free burn time.

The Pellet Fuels Institute (PFI) is a national organization that promotes the use of pellet fuels and has established voluntary standards governing the quality of pellet fuels sold on the market. The following table illustrates the pellet fuel quality parameters for the four main grades of pellet fuels as designated by PFI:

	Likely Source Materials	Size	Moisture Content	Btu Value	Ash Content	Bulk Density	Fines Content
Super Premium	Wood fiber	6-8mm	<6%	>8,000 Btu/lb	<0.5%	40-46lbs/ft^3	>0.5%
Premium	Wood fiber	6-8mm	<8%	>8,000 Btu/lb	<1.0%	40-46lbs/ft^3	>0.5%
Standard	Wood fiber	6-8mm	<8%	>8,000 Btu/lb	<2.0%	38-46lbs/ft^3	>0.5%
Utility or Industrial	Wood fiber, bark, grass, other	6-8mm and larger	<10%	>8,000 Btu/lb	<6.0%	38-46lbs/ft^3	>0.5%

Acceptable grades of pellets for the City of Sandpoint's energy plant would be Premium or Super Premium. Standard grade pellets could be used but are not recommended. Utility grade pellets should be never be used because of the high amount of ash produced.

Wood Pellet Availability

Wood pellet production is limited at this time with only one pellet manufacturer in the region, Lignetics, Incorporated, but that is not to say that new manufacturing plants will not come on-line in the future. It is likely that, as demand for wood pellet fuels continues to grow, production could ramp up to meet growing demand. Additionally, there are other pellet manufacturers in the general area, though outside of the ideal 90-minute drive time radius. Regardless, the existing pellet manufacturer in the region is capable of supplying the quantity of wood pellets needed for Sandpoint.

A critical factor when considering wood pellet heating at this scale, however, is whether the manufacturer is equipped to supply wood pellets in bulk quantities. Typically wood pellet manufacturers package their wood pellets into 40-pound bags for the residential and small commercial heating markets; a pellet heating system of the size being considered here, however, would require bulk quantities of wood pellets. This avoids the staff time that would be required to manually move, open, and empty 40-pound bags of pellets. But, in order to be able to deliver pellets in bulk quantities, the pellet manufacturer needs to be equipped with a way to handle and store bulk quantities of loose pellets at their plant and they will need a special kind of delivery truck (similar to a grain truck) that can convey loose pellets into a silo. Fortunately, the pellet manufacturer in this region has a thirty-year history of supplying bulk quantities of wood pellet fuel to energy users such as schools and hospitals. Twenty to twenty-five tons at a time would be delivered to an on-site storage silo (identical to those used for storing grain), from where the pellets are automatically conveyed into the boiler.

Wood Pellet Suppliers

One wood pellet supplier was identified within the 90-minute drive-time radius from Sandpoint: Lignetics, Incorporated. This pellet manufacturer has a plant located in Kootenai, Idaho (less than 10 minutes from Sandpoint) that produces 100,000 tons of Super Premium grade wood pellets a year, which is more than sufficient to meet the needs of Sandpoint. They supply both bagged and bulk quantities of wood pellets. While the manufacturer does not own the trucks used for bulk delivery, they have long-standing and straightforward relationships with trucking companies.

BERC staff met with representatives from Lignetics Inc. and had several follow-up conversations to collect information on this potential fuel supplier. The table below shows some of this information. Additionally, a second wood pellet manufacturer that is outside of the ideal 90-minute drive time radius is included as a backup option. This is Eureka Pellet Mills based in Superior, Montana (2 hours and 15 minutes from Sandpoint). The following tables show information on both wood pellet suppliers.

Company	Contact Person	Phone Number	Mill Location	Drive Time (mins.)	Approx. Annual Woodchip Production (GT)	Estimated Price per Ton (not delivered)
Lignetics, Inc.	Kenneth Tucker	(208) 263-0564	Kootenai, ID	10	100,000	$140 - $150
Eureka		(406) 822-	Superior,	134	50,000	

Pellet Mills	4971	MT

Lignetics, Inc. is the best option for pellet supply for Sandpoint because of their high-grade pellets and close proximity. This company also has extensive experience with supplying bulk quantities of wood pellets to energy users. While they do not own bulk delivery trucks, they can easily help with contracting this out. Typically, these pellets would be delivered in a grain truck that carries 24 tons of pellet and belly-dumps (by gravity) these pellets into a holding area on-site. From this holding area, they would be conveyed by an auger system into the on-site storage silo where they would be stored until needed; they are then automatically conveyed from the silo into the boiler. The silo should be sized to hold a full truckload, plus whatever fuel is leftover at the time of delivery, to optimize both efficiency and cost. It is important to note that this delivery system will require that Sandpoint install the auguring system at their plant site, which will increase capital cost somewhat. Lignetics, Inc. President, Ken Tucker, advised that spending the money upfront on a system that can move pellets quickly will be beneficial, since the delivery trucks will charge on a per-hour basis, rather than a per-ton basis. Slow-moving equipment will hold the delivery truck up, translating to higher pellet fuel costs for Sandpoint.

Wood Pellet Pricing

In the case of bulk delivery, the customer is charged per ton delivered typically including a per-load fee scaled to the distance of the delivery. Since part of the wood pellet price is the cost of delivery, a closer supplier may be more economical. Regional pellet prices currently average around $145 per ton (this is the price for pellets only, not including delivery); this price was confirmed by Lignetics, Inc., who gave an estimate of $150 per ton. Delivery will add to this cost. Typically, delivery will be charged on a per-hour basis at a rate of about $120 per hour that the truck is in use (this includes time spent loading, transporting, and unloading the pellets); the average bulk pellet delivery takes about an hour or two, so this would translate into $5 to $10 more per ton delivered. Therefore, the total delivered cost would be $155 to $160.

Woodchips

Woodchips are similar to pellets in that they can be fed automatically to a combustion system however woodchips are a less-refined fuel that is lower in cost. Woodchips, like wood pellets, are also a viable option to fuel the City of Sandpoint Heating Plant.

Woodchip Quality

There are many sources of wood that can be processed into chips and there are equally as many ways that wood can be harvested, processed, loaded, transported and received. All of these factors will impact the overall quality of the woodchip as a fuel. Biomass energy systems will function and perform better with a high quality fuel. Systems that are fueled with consistent, uniform sized woodchips experience fewer mechanical jams of the fuel feeding equipment (typical high-quality chips vary in size from 1” x 1” x 1/8” thick to 2 ¼” x 2 ¼” x ¼” thick). Chips that are relatively square and flat are easily conveyed, augured, and feed into the system smoothly. Systems that are fed lower moisture content woodchips (between 35 and 50 percent moisture) typically require less fuel to produce the same amount of heat. Systems that are fed cleaner woodchips (bark-, foliage-, dirt- and debris-free) produce less ash and can burn longer without maintenance and removal of ash.

Woodchip Fuel Sources

Woodchip fuel will come to Sandpoint from two main sources: residues from sawmills and wood harvested as part of integrated timber harvests, stewardship contracting, or wild land/urban interface (WUI) thinning. Numerous other sources for woodchips exist (wood recycling yards, arborist companies, etc.); however, these sources tend to produce lower-quality chips poorly suited to the needs of a community wood energy system. For this reason these sources have been excluded from further examination. Following is more detailed discussion on what are likely to be the sources of woodchips for Sandpoint.

<u>Sawmill Residues</u>

Residues, such as sawdust, bark, and chips, are generated at sawmills and other wood processing plants when round logs are sawed into square boards. Typically, at larger sawmills, these residues are blown directly into box trailers and transported to various markets (mulch markets, pellet manufacturing, pulpmills, and power plants). When one trailer is full, that material is delivered and a new empty trailer is put in place. Smaller mills tend to accumulate stock-piles of these materials on-site and periodically ship to the same markets.

While sawdust and bark can be used as a biomass boiler fuel, woodchips are preferred for community-energy systems like the one being considered in Sandpoint. The woodchips from sawmills (often called “mill” or “paper” chips) are ideal for wood heating systems because the sawlogs are de-barked before they are cut into lumber. The absence of bark in the resulting chips lowers the amount of ash content in the fuel. Another advantage of mill chips is most sawmills screen the chips for consistent size (smaller fines are removed and larger pieces are screened out and re-chipped).

<u>Woodchips from Integrated Timber Harvest, Stewardship Contracting and WUI Activities</u>

When timber is harvested for sawlogs, posts, pulpwood, and firewood, there is generally a significant amount of non-merchantable wood typically left as “slash” in the woods. If cut-to-length harvesting is used, this material is left scattered on the forest floor throughout the harvested area.

Although it is possible to go back in after a cut-to-length harvest to gather the slash, it is generally not considered cost-effective. If, however, the timber harvest uses whole-tree harvesting techniques, this slash wood is accumulated at the landing or roadside where it can easily be accessed and chipped for fuel (rather than the alternative of burning these large slash piles as a disposal method). Chipped slash is commonly used to produce low-quality "hog" fuel for large industrial boilers because it often contains large amounts of bark, needles, and dirt in addition to the desired "white" wood material. If this slash is to be processed into a higher quality boiler fuel, certain operational measures need to be taken to minimize the bark, needle, and dirt content and to maximize the white wood content.

In addition to integrated timber harvesting, woodchip fuel can be produced as part of stewardship contracting work in which small diameter trees are thinned in an effort to lower fuel hazard and restore more natural forest conditions. A large majority of forests (both public and private) surrounding the City of Sandpoint are overstocked with small-diameter trees. The USDA Forest Service conducts stewardship contract thinning work in the Coeur d'Alene, Kaniksu, and Kootenai National Forests. Without markets for small diameter wood (7 inches diameter at breast height [DBH]) the only options are to lop and scatter this thinned wood, masticate it (meaning mechanical in-woods mulching), or pile and burn it. Small diameter roundwood can be chipped to produce quality woodchip fuel suitable for community-scale energy plants.

Similar to stewardship contracting, thinning wooded areas surrounding communities to reduce hazards of forest fires can also yield woodchip fuel. Thinning in the wild land/urban interface (WUI) zone around communities is a vital activity that is often hampered without a local paying market for the material that is removed.

Woodchip Fuel Availability

BERC assessed the availability of woodchips from both the sawmills and harvesting sources described above. The quantity of woodchips available as residues from sawmills was estimated by surveying sawmills in the region surrounding Sandpoint. The potential for wood to be sourced from harvesting was a more detailed calculation, using data collected by the USDA Forest Service Forest Inventory Analysis (FIA) program. The availability of woodchips from each source is described in more detail below.

Sawmill Residues

There are a handful of sawmills located within the target 90-minute drive time zone around Sandpoint; however, most of these sawmills are very small and produce little or no chips. The largest generator of high quality chips in the region is Idaho Forest Group (IFG) who owns three sawmills within the region surrounding Sandpoint, with a total production capacity of over 150,000 green tons of woodchips annually. (Please see more details on this potential woodchip supplier in the next section.) This is a sufficient quantity to supply Sandpoint and this company is interested in supplying woodchips to energy users. It is likely that this will be the type of woodchip fuel that is predominantly available in the region, compared to harvested low-grade wood (discussed below).

Assessment of In-Forest Wood Resources

This region of Idaho and some neighboring portions of Washington are heavily forested and almost 65%, on average, of the total area of each county is classified as timberland. It was assumed for the purposes of this assessment that about 80% of this timberland was physically accessible and appropriate for harvesting and that, further, another 80% of this accessible timberland was actively managed. This means that the five counties encompassing a 90-minute drive time from Sandpoint, Idaho are covered with more than 2 million acres of timberland that is actively managed and accessible for harvest. The table below shows this timberland by county.

Timberland Area within Sandpoint Supply Area

County	Total Area	Total Timberland	% Timberland	Estimated Physically Accessible & Actively Managed Timberland
Bonner, ID	1,228,800	976,229	79%	624,787
Boundary, ID	817,920	670,048	82%	428,831
Kootenai, ID	842,240	523,818	62%	335,244
Pend Oreille, WA	912,000	707,759	78%	452,966
Spokane, WA	1,139,840	307,650	27%	196,896
TOTAL	4,940,799	3,185,504	64%	2,038,723

Currently on the more than 2 million acres of accessible and actively managed timberland shown in the table above, there are more than 159 million green tons of standing inventory (shown in the table below). At this level of stocking, these forests are considered over-stocked, which poses a threat for forest fires. To bring these forests down to a healthier, less fire-prone stocking level would require removing enough material to return the average stocking level to about 60 green tons per acre. The following table shows the current standing inventory, in green tons (GT), on the timberland that is estimated to be accessible and actively managed for harvesting; the current and excess stocking per acre; and the total excess inventory, or the quantity of forest material that could be removed to bring forests in the region back to healthy stocking levels.

Forest Inventory Stocking on Accessible and Actively Managed Timberland in Sandpoint Supply Area

County	Current Inventory (GT)	Current Inventory (GT) Per Acre	Excess (GT) per Acre	Total Excess Inventory (GT)
Bonner, ID	45,577,000	73	13	8,089,807
Boundary, ID	35,828,350	84	24	10,098,507
Kootenai, ID	27,484,338	82	22	7,369,726
Pend Oreille, WA	38,497,524	85	25	11,319,578
Spokane, WA	11,722,112	60	0	0
TOTAL	159,109,324			36,785,970

As can be seen in the table above, the forests in this region are over-stocked (on average by 17 GT per acre), so there is a potential to remove more than 36 million GT of material to bring these forests back to healthy stocking levels. If the required thinning work to achieve this desired lower stocking level were spread evenly over the next 20 years there would be about 1.8 million green tons available annually within the ideal 90-minute drive time radius.

In addition to quantifying the standing inventory and the desired reduction, these forests are growing, adding new wood volumes each year. On average, net annual growth rates for these forests are about 1.95 percent, meaning that nearly 2 million new green tons of wood grow annually. To be conservative, the annual growth was estimated here on healthy stocking levels (not on the current stocking levels reported above). The table below shows the healthy inventory level and the total net annual growth of new wood (across all stand-size classes) calculated on top of the desired, healthy standing inventory.

County	Healthy Inventory (GT)	Net Annual Growth of Low-Grade Wood (GT)
Bonner, ID	31,239,328	609,167
Boundary, ID	21,441,536	418,110
Kootenai, ID	16,762,176	326,862
Pend Oreille, WA	22,648,288	441,642
Spokane, WA	9,844,800	191,974
TOTAL	101,936,128	1,987,754

As can be seen above, the forests of this region would grow about 1.9 million green tons of new wood each year at healthy stocking levels (at current over-stocked levels, that growth would be much greater). Again, this is the total new growth across all stand sizes, and large-diameter wood would not likely be made into woodchips for fuel, since this material is more highly marketable. It can be assumed, however, that about 11 to 14 percent, or 218,000 to 278,000 green tons annually, of this new net annual growth would be small- to medium-diameter wood that could be made into woodchip fuel.

This exercise and the results presented above show that the forests surrounding Sandpoint have ample material that could be used as woodchip fuel. These potentially available quantities can become a point of reference for understanding the impact of Sandpoint's proposed heating plant on the surrounding forest resource; as was shown here, the anticipated demand for woodchips from this heating plant, about 250 green tons annually, would be well-within the region's capacity to supply wood fuel.

An important factor in considering the actual availability of this material will be whether there is the workforce and infrastructure necessary to harvest, process and deliver woodchip fuel. As is discussed in the next section on woodchip fuel suppliers, evidence suggests there is a lack of chipping contractors in this northern part of Idaho (there appears to be more chip contractors located in the southeastern part of Idaho) that chip this material into fuel-quality woodchips; this may be a limiting factor in gaining access to fuel from harvested low-grade wood.

Woodchip Fuel Suppliers

Sandpoint's best option for procuring woodchip fuel will be the Idaho Forest Group sawmills due to both their capacity (and interest) to supply woodchips of the right quality for this heating system and their proximity to Sandpoint. As is shown below, there are three mill locations. All three mill locations are within a 90-minute drive time, which will help to keep costs down. It is most likely that Sandpoint would purchase cedar chips from the Laclede Mill, which is the closest mill to Sandpoint. BERC staff met with Idaho Forest Group representatives and had several follow-up conversations to collect the information included in the table below.

Another category of potential fuel suppliers, in addition to the sawmills already discussed, are in-woods chipping contractors. As was explained above, there is a lack of these contractors based in the area surrounding Sandpoint. Therefore, none are included in the table below as potential fuel suppliers.

Company	Contact Person	Phone Number	Mill Location	Drive Time (min)	Approx. Annual Woodchip Production (GT)	Estimated Price (per GT, delivered)
Idaho Forest Group	Bruce Brewer	(208) 762-2905	Moyie Springs, ID	45	37,500	\$19 - \$25
			Laclede, ID	15	50,000	\$19 - \$25
			Chilco, ID	35	75,000	\$19 - \$25

Woodchips from the Laclede mill are the best option among those listed in the table above for Sandpoint. The delivery charge will be minimal, since this mill is only 15 minutes from Sandpoint, and the chips are of good quality for fuel. These will be de-barked cedar chips that are blown directly into storage bins from the chipper, from where they are dumped loaded onto walking floor trucks; therefore, these woodchips will be low in bark content (no more than 2-5 percent) and free of debris.

It is recommended that representatives of Sandpoint talk with any potential fuel suppliers (either wood pellet or woodchip, depending on which fuel is chosen) while this project is being engineered to verify the information above, since involving fuel suppliers at the conceptual and early design stages will ensure a successful project in the end.

Woodchip Fuel Pricing

The price paid for woodchip fuels can be affected by numerous factors, but the primary factors are:

- Wood source production costs (varies widely depending on whether the wood is a by-product of some more lucrative activity);
- Regional balance of supply and demand; and
- Trucking distance from point of generation to end market.

Woodchips in this part of the country average a price of just under $40 per green ton (at 42 percent moisture). BERC staff talked with wood fuel suppliers in the area surround Sandpoint and confirmed that woodchips of the quality recommended for Sandpoint would range in price from $35 to $50 per bone dry ton, or $19 to $25 per green ton (at 42 percent moisture content). This cost includes delivery charges, which are charged on a per-green ton basis.

Currently, Idaho Forest Group sells 50 to 60 truck loads a day of wood residues in the form of woodchips, sawdust, shavings, bark and other by-products. Woodchips are typically sold to paper mills in Canada and Washington State and to a plant in Montana that produces medium density fiberboard (MDF). Idaho Forest Group takes in a variety of tree species including Ponderosa pine, Idaho white pine, western hemlock, firs, and western red cedar. Fortunately, the red cedar woodchips are not desired by pulpmills, so this would be the species that goes to Sandpoint. Therefore, since there is minimal competition for this species of woodchip, there would be minimal competition for it from other customers, which should result in predictable availability, stable prices, and steady price increases, rather than dramatic fluctuations due to supply and demand.

Fuel Supply Conclusions and Recommendations

Both wood pellets and woodchips are available to Sandpoint in sufficient quantities for prices that match regional averages. Typically, a competitive bid process is recommended for selecting fuel suppliers. Both a primary and backup fuel supplier can be selected from the pool of responses. However, in the case of Sandpoint, identifying backup suppliers may be more challenging. But, backup suppliers can be found, though outside of the ideal 90-minute drive time radius. Sandpoint should develop a good relationship with their primary supplier, selected from within the 90-minute drive time radius, but should also make alternate potential suppliers aware of this project. In the event the primary supplier was unable to supply fuel for any reason, these backup suppliers could be at the ready.

Both Lignetics, Inc. and Idaho Forest Group are interested in supplying wood fuel to Sandpoint and both would be willing to enter into longer-term, multi-year contracts if deemed mutually beneficial. Of course, with longer term supply contracts, suppliers will require additional contract conditions to make sure they are still getting a fair deal in future years. For example, an agreed-upon price escalation from year to year can be included and diesel fuel surcharges that protect the supplier against spikes in off-road and on-road diesel fuel prices are encouraged in contracts lasting longer than 12 months. In return, Sandpoint will be given a stable and predictable wood fuel price when these markets can be somewhat volatile.

When comparing its options for biomass fuels, Sandpoint should consider a variety of factors including heat load, project costs, site considerations, and fuel costs to determine which the best option is. The table below compares the costs of delivered woodchips to delivered wood pellets; this will aide in the decision on a purely fuel-cost basis (the overall economics of each option will consider capital costs, maintenance costs, and fuel cost savings).

	Delivered Price ($/GT)	Moisture Content	Seasonal Efficiency	Energy Value (MMBtu/GT)	Cost ($/MMBtu)
Wood Pellets	$160	5%	80%	13.30	$15.04
Woodchips	$25	42%	70%	8.12	$4.40

Additionally, other characteristics of each fuel can be compared. For example, wood pellets will be more uniform in size and therefore will convey more easily. They are also more energy-dense that woodchips, and so take up less storage space than woodchips. But, pellets are more costly on a Btu basis, as can be seen in the table above. Whether this additional cost is warranted will be shown in the analysis of the overall economics of each option later in this report.

Lastly, if Sandpoint decides to install a wood energy system, representatives of the project should begin talking with potential wood fuel suppliers in the early stages of project development so that any plans made for fuel storage capacity and fuel deliveries are consistent with the delivery frequency and volume the suppliers are capable of.

SITE ASSESSMENT

BERC staff visited Sandpoint and collected information on the size of buildings, their uses, existing energy systems, and current and future energy demands. Upon the preliminary evaluation it was determined that the best possible layout was a centralized energy system serving the energy loads of the existing buildings nearby. Total energy needs for these buildings including space heating, domestic hot water (DHW), and electricity use were quantified on an annual, hourly, and peak hourly basis.

The proposed site at the Sandpoint industrial zone has ample space to construct a biomass boiler building and associated equipment and has plenty of room for tractor trailer access to accommodate biomass fuel deliveries.

City Shop

The City Shop building is comprised of 10,000 square feet. The facility is currently being heated by a 266,000 Btu/hr natural gas boiler (Burnham Series 2 boiler). DHW is supplied by a 40,000 Btu/hr "Ruudglas" natural gas heater of 50 gallon capacity. In 2008 the City Shop building used approximately10,313 therms of natural gas for space heating, and 250 therms of natural gas for DHW. Additionally, on location are two auxiliary buildings estimated at 10,000 square feet each. The auxiliary buildings provide parking for city machinery and trucks. In the wintertime the trucks and heavy machinery use plug-in electric heating coils to keep the engine blocks from freezing. The additional capital costs, including reconstruction, modification to existing buildings, and additional equipment, of converting the auxiliary buildings to provide biomass heating to off-set the use of plug-in electric heating coils would be cost prohibitive and therefore the analysis does not take the auxiliary buildings into consideration at this time.

Bonner Business Center (BBC)

The BBC building is comprised of 10,600 square feet. The building serves as a business incubator hosting six separate commercial/industrial bays, ten offices, a commercial kitchen and additional work space. The entire facility is currently being heated by electrical heaters with individual meters, and DHW is supplied by electric hot water heaters. In 2008 the BBC used approximately 91,239 kWh of electricity for space heating and an estimated 7,325 kWh for DHW. Natural gas is only used for kitchen equipment. TRI STATE HVAC&R has provided an estimate of $30,000 for modifications, labor and equipment, required to integrate the new biomass system into the BBC.

Lead Lok, Inc.

The Lead Lok, Inc. building is comprised of 11,900 square feet. The facility has two 300,000 Btu/hr rooftop forced hot air units, fueled by natural gas. The two natural gas units provide heating to the manufacturing area while the general offices and DHW are heated by electricity. In 2008 the facility used approximately 3,495 therms of natural gas and an estimated 18,240 kWh of electricity for space heating, as well as 7,325 kWh for DHW. TRI STATE HVAC&R has provided an estimate of $32,000 for modifications, labor and equipment, required to integrate the new biomass system into the Lead Lok building.

Top Dawg Powder Coatings

The facility operates a 1 million Btu (MMBtu) natural gas furnace in 4-5 hour intervals per day. The furnace provides heat at 450 F° for a cycle of 45 minutes. The hot water from the central plant can pre-heat air only up to maximum of 150 F. Connecting the facility with the proposed biomass energy plant would present significant technical challenges. The additional cost of heat distribution piping, energy transfer station, and heat exchangers necessary to provide thermal energy to the Top Dawg Powder Coating facility would be cost prohibitive. The facility's energy demand is therefore not included LCC analysis in this study.

TECHNOLOGY OPTIONS

The biomass-fueled technologies that were considered in this feasibility analysis are: space heating with a stoker boiler using woodchips; space heating with a stoker boiler using wood pellets; or biomass combined heat and power (CHP) to produce energy for space heating and electricity. Consideration was given to biomass CHP technologies and several system vendors were evaluated. However, it is recommended that the CHP technology not be pursued at this time as the technology is not yet commercially available, and would be cost prohibitive, at the small scale suitable for the Sandpoint location.

Option 1 – Status Quo

As previously described, this report considered four options at the proposed location in Sandpoint's Industrial Park. The first option – dubbed 'Status Quo' – is continuing to heat all the facilities with natural gas and electricity as is presently done; this was considered the base option for this analysis for comparison to all alternative energy options. The facilities can instead be converted to use an alternate fuel to save money while meeting their energy demand, which defines the next three options: woodchip heating, wood pellet heating, and biomass CHP. Each of these options is explained in greater detail below.

Option 2 - Heating with Woodchips

A first alternative to the 'Status Quo' option is to install a fully automated woodchip boiler in a newly constructed energy plant at Sandpoint's Airport Industrial Park. This boiler would be connected to all three buildings to deliver heat using a hot water distribution network. The existing natural gas heating systems would remain in place to serve as backup, for this report BERC has assumed that the electrical heating would also remain as backup; typically, facilities will rely on their backup systems about 10-15 percent of the time such as during start up or maintenance periods or at peak heating demands when supplemental heat is required. The existing electrical powered equipment producing domestic hot water (DHW) would need to be replaced with new indirect-fired hot water delivery systems.

Fully Automated Woodchip Boilers

Fully automated systems generally require very little operator attention – for our analysis, BERC has assumed about one hour daily during the peak heating season and about 30 minutes in shoulder months. This time is an average and will consist of visual inspection of the system, removing stringers or ash. They are a good match for buildings where the maintenance staff has a large work load and does not want to spend much time on the heating plant. These systems are best suited to facilities with significant heat loads and high conventional fuel costs since the capital cost of the system can be relatively high.

Equipment provided and installed by the vendor includes the automated equipment to unload the woodchip storage bin, the fuel handling equipment that carries woodchip fuel to the boiler (conveyors and augers), the combustion chamber and boiler, combustion air supply fans, boiler connection to the stack, controls, safety devices and emissions control equipment.

In modern woodchip boilers, the energy released by biomass combustion is transferred via water to a heat distribution medium. A biomass boiler has a modular design based on direct combustion technology. Different biomass boilers have different combustion zones and different fuel and ash handling requirements. Also, since the woodchips are delivered by self-unloading live bottom tractor trailer trucks, the chip storage site must be carefully located for truck access. Newer boilers will include computer diagnostics and controls, including remote connection to the boiler for both an operator and the boiler manufacturer with alarms that can alert the operator to various fault conditions and to eliminate the need for continuous supervision. With biomass fuels in particular, ash handling in the boiler can become a significant use of time; automatic ash removal is an option to be considered. Automatic ash removal is when the ash is augured out to a drum either in the building or outside of the building. The ash would be disposed of – either using it as a soil enhancer, if allowed, or taken to a landfill.

Seasonal, or year-round average, boiler efficiency is the difference between the total energy flow rate in from the fuel and the heat that goes out into the boiler water. This efficiency is typically in the range of 65-75 percent in the boiler size range for this project. One of the parameters influencing the woodchip boiler efficiency is the moisture content of the biomass fuel; with each additional ten percent moisture content in the biomass fuel the boiler efficiency is lowered by about two percent.

Fully automated systems employ a chip storage bin, typically below-grade that can hold one and a half to two tractor loads of chips (20-25 tons per trailer). The bin should be sized to store three to five days worth of woodchips if the system were operating at peak load. While the storage bin could be sized to hold a lesser amount of fuel, this design limits the amount of tractor-trailer traffic in and around the city of Sandpoint. A self-unloading truck loads the bin with no need for on-site staff assistance. From the chip storage bunker, the fuel is fed automatically to the boiler. No operator intervention is required for fuel handling. Vendor systems vary in terms of capacity and automation features.

Option 3 - Heating with Pellets

The second biomass energy alternative and the third option overall is to provide heat with wood pellets using a fully automated wood pellet heating system. Building on Option 2, with biomass being used for space heating, the main difference would be in the initial capital costs of the biomass system, a smaller energy plant building, and the increased costs of the biomass fuel.

Commercially available pellet heating systems use manufactured biomass s fuel, wood pellets, to provide clean and efficient heat. Pellet boilers have been demonstrated in a variety of facilities throughout United States, Canada, and Europe to reduce heating costs for small businesses and office buildings and complexes.

Pellet boilers are relatively simple systems that are easily installed and operated. An additional benefit to using a pellet boiler for heat is that pellets made from a variety of feedstocks can be used. Currently, wood pellets and corn are the most widely available pellet fuel, although there is growing interest in and availability of grass and agricultural residue pellets.

Pellets are typically stored in a standard outdoor silo, like a metal grain silo. Wood pellets can be delivered in trucks similar to those that deliver agricultural grain. The boiler is automatically stoked with pellets via auger systems, like those used for conveying feed and grain on farms, set to provide the right amount of fuel based on the building's demand for heat. Pellet boilers are fully automatic in fuel feed and ash removal allowing for higher efficiency. The boilers average 80 percent efficiency during the heating season and run at 85-90 percent efficiency at peak load, during which time the boiler burns at optimal load capacities. Unlike a natural gas or propane boiler, which does not lose efficiency with low heat loads, biomass boiler efficiencies vary with changing load and ambient temperatures.

Space requirements for an indoor pellet boiler system are similar to those for an oil boiler system, estimated at approximately 350-700 square feet. Outdoor pellet boilers typically require approximately 200-300 square feet of space. An additional consideration is the need for adequate space for a 30-ton storage silo located adjacent to the boiler with good access for delivery trucks.

Pellet boiler systems typically have lower capital costs in comparison to woodchip systems, although fuel is more expensive on a dollar per Btu basis. The maintenance time for these systems is said to be about 15-30 minutes per day during the heating season, but is often less than that; the financial analysis of operation and maintenance costs assumes 30 minutes per day in peak season to be conservative. Round-the-clock maintenance and supervision of the system is not required, the 30 minutes per day figure is an estimate and daily maintenance on weekends is not required; all maintenance can be performed during the maintenance staff's regular hours.

There are several vendors with proven track records of reliability and performance and numerous demonstrations in United States of wood pellet boilers replacing fossil fuel heating systems, reducing reliance on fossil fuels, and saving building owners' money. The equipment, if properly used, has a high rate of reliability.

Option 4 - Combined Heat and Power

The fourth option considered here, is to heat and produce electricity on site using a biomass-fired CHP system. This option builds on the biomass heating system, with biomass being used for space heating; however in this CHP option, biomass would also be used to produce electricity on site. The main advantage of this technology is the increased self-reliance that comes from a decentralized (i.e. on-site rather than from the grid) energy conversion process.

CHP applications are an efficient way of utilizing sustainably procured biomass feedstocks. Large power generation projects, for example, have an overall efficiency of about 25 percent; meaning that only one-quarter of the available energy in biomass fuel is recovered for energy while three-quarters of the available energy is lost as heat. A CHP project that is sized to the heating load but produces electricity as a secondary product captures the greatest portion of potential energy available in biomass fuels with efficiencies as high as 75 percent or more. Therefore the CHP system would be sized to the heat load in order to maximize efficient use of the woody biomass resource; heat would be the primary product produced and electricity would be a secondary product. Sizing the Sandpoint CHP plant to the correct heat load of the existing facilities nearby indicates a small electrical generation turbine of up to 25 kW would be appropriate. These systems, however, are in the early stage of demonstration and testing and are not commercially available in the US market. Currently, there are no installed examples of such technology or manufacturers ready to offer warranties to put such equipment into use, in this country.

An example of a good fit for biomass CHP technology would be an industrial firm, or a large energy user, with year-round energy requirements, above-average electricity costs, 24/7 multiple shift operation, skilled staff available on-site and plentiful fuel available at negative cost, such as a waste which is a problem to dispose of. An example of a bad fit for this technology would be an office building open only five days per week where electricity is purchased from the grid at affordable rates, there is only one shift operation, and where the energy requirements are relatively low. Commercially available CHP systems are on the market in much larger sizes then the current energy demand analyzed for the existing facilities at the Sandpoint's Industrial Park, and should therefore be considered once the Sandpoint Renewable Energy Zone expands and additional heat loads are added.

The Sandpoint CHP plant would require 5 lbs. of green woodchips per kWh used at a price of $25 per ton, making the cost of fuel $0.065 per kWh generated. Including an estimated $0.07 per kWh generated for general operating and maintenance costs, the total direct cost per kWh will be about $0.135 per kWh used. This estimate does not include any costs associated with financing the system or depreciation of value. Because wood pellets are more expensive on an energy-content basis, the cost of generating power with wood pellets would exceed $0.135 per kWh.

Biomass Boiler Sizing

Boiler capacity was estimated based on the peak heating degree days (HDD) per day. The consumption of natural gas and electricity for space heating is directly linked to the HDD in the area, the total of which were 7,312 during 2008. The peak HDD on the coldest day was 71 (5.35 percent) and the total for the coldest month was 1,328 (18.16 percent) of the yearly HDD. Boiler capacity was estimated based on the peak HDD per day.

For heating only option BERC recommends an 850,000 Btu per hour boiler to cover 85-90 percent of the heating energy required, using either woodchips or wood pellets respectively. 85-90 percent is chosen as the design criteria because a wood-fired boiler has a turndown rate as low as 20 percent, but then becomes too inefficient to run. The backup system will run during those times – which are mainly during shoulder months.

Woodchip Fuel Storage

At peak load the biomass boiler would require 171 pounds of woodchips (0.08 green tons) per hour, meaning that 8 green tons of woodchips would be required to meet the system's peak requirements for four days. Average daily consumption of woodchips would be about 2.06 green tons, or the equivalent of about a truck load every 12 days (each truck can deliver about 25 tons of woodchips at a time).

With an average density of 30 pounds per cubic foot, meeting this demand for woodchip fuel will require 2150 cubic feet of fuel storage space. The actual footprint of the bin will vary by vendor as the bins are designed slightly differently for the various fuel conveyance systems. An engineering team should design the specific dimensions of the fuel storage area upon selection of a system vendor.

Wood Pellet Storage

There are an increasing number of wood pellet manufacturers who are either beginning to offer or are expanding an existing bulk delivery service. These companies can deliver bulk pellets using grain or feed type trucks that deliver the pellets into a storage silo via auguring equipment or pneumatic blower systems. The bulk delivery of the wood pellets can be accommodated with 20-25 ton truck deliveries. The suggested capacity of the storage system is 30 tons.

Wood pellets are most commonly stored in a storage silo, or storage bins, which can be located either outdoor or indoor. There are number of options for storing the wood pellets inside. The most common options are a pellet storage room, a sheet steel tank, a fabric tank (flexible tank) and an earth tank (buried plastic tank adjacent to the basement wall) near the boiler. The pellet delivery system from the tank to the boiler could be either with an auger or with a vacuum suction system. The exact dimensions of the storage will depend on the vendor and will vary according to design specifications. From the storage area the wood pellets are conveyed to the boiler using automatically controlled augers set to provide the right amount of fuel based on the demand for heat.

Energy Plant Building

During BERC's site visit, it was determined that a new central energy building would be constructed on the city owned 2.89 acres of land at the industrial park near the city airport. The biomass boiler plant will have direct access from the main road for easier biomass fuel deliveries.

The new biomass boiler building considered here is a pre-fabricated steel structure with estimated construction costs of approximately $80 per square foot. BERC estimates that the dimensions will be about 50 feet by 20 feet for a woodchip plant and 30 feet by 20 feet for a wood pellet plant. A next level detailed layout of a new energy plant would be designed in collaboration with the selected equipment vendor(s) and an engineering team before moving this system design concept further.

The plant location should be carefully considered and placed if future expansion is a viable option. BERC suggests locating the building toward the entrance of the lot. Storage would be installed in the back, behind the building for ease of truck access. The location would then allow the building to be expanded and boilers added when/if the system is expanded. A preliminary map of the proposed layout has been included in Appendix A.

ENVIRONMENTAL IMPACTS

Climate Change

Global climate change is the most pressing environmental challenge of our time, and the major cause of climate change is emissions of CO_2 from burning fossil fuels such as oil, natural gas, coal, and propane.

One of the most important environmental benefits of using sustainably produced wood for energy in place of fossil fuels is its positive impact in moderating long-term global climate change.

Fossil fuel combustion takes carbon that was locked away underground (as crude oil, natural gas, propane, or coal) and transfers that carbon to the atmosphere as new CO_2.

When wood is burned, on the other hand, it recycles carbon that was already in the natural carbon cycle, which is recaptured through sustainable forest growth. Consequently, the net long-term effect of burning wood fuel is that no new CO_2 is added to the atmosphere—as long as the forests from which the wood came are sustainably managed.

Since wood burning is carbon neutral and burning fossil fuels contributes to climate change, when wood replaces fossil fuel, the net impact is that, over the long term, CO_2 levels in the atmosphere are reduced from what they otherwise would have been. If a natural gas or heating oil system is converted to wood, net CO_2 emissions for heating are reduced by 75-90 percent depending upon how much of the fossil fuel use is replaced. For this reason, heating with biomass is a powerful tool for an institution or community interested in meaningfully addressing climate change through increased use of renewable energy.

In the heating only option, by consuming the equivalent of 2,054 decatherms of natural gas, at 120.59 pounds of CO_2 emitted per decatherm of natural gas, Sandpoint's three city buildings will contribute over 124 tons of CO_2 to the atmosphere annually. This is the equivalent to the annual emissions from 20 cars. By switching to a carbon neutral fuel all three buildings can significantly reduce their carbon footprint and positively impact this issue of both global and local importance.

Air Emissions

Although biomass systems have a positive impact on climate change (lower CO_2) and local economy impacts from converting to biomass systems, it is important to discuss and address concerns about air emissions and air quality. Any community interested in biomass systems wants to know the answer to the question, what comes out the chimney? The answer unfortunately is not simple. All combustion processes – whether natural gas, propane, coal or wood – produce flue gas components, all with different characteristics.

The emissions from wood-fired boilers are different from emissions of natural gas, propane or oil boilers. Modern school or community wood systems are not just a bigger version of a residential stove. They also are vastly different from the outdoor wood boilers that have primitive combustion technology, low stacks and emit dense smoke which disperses poorly. These inefficient outdoor boilers are causing concern all across the country.[2] Modern school or community wood systems are significantly different systems that have highly engineered sophisticated combustion technologies, PM control devices and properly sited stacks enabling them to burn cleaner and emit far less particulate matter.

In terms of health impacts from wood combustion, particulate matter (PM) is the air pollutant of greatest concern. (Note: PM is not a climate change issue.) Particulates are pieces of solid matter or very fine droplets, ranging in size from visible to invisible.

Relatively small PM, 10 micrometers or less in diameter, is called PM_{10}. Small PM is of greater concern for human health than larger PM, since small particles remain airborne for longer distances and can be inhaled deep within the lungs. Particulate matter exacerbates asthma, lung diseases and increases mortality among sensitive populations.

Increasingly, concern about very fine particulates (2.5 microns and smaller) is receiving more attention by health and environmental officials for the same reasons. Work investigating woodchip and pellet boiler emissions of very fine particulates is ongoing. Based on air emissions tests performed on small scale woodchip fired boilers, typical two to three million Btu input units without particulate control systems produce 0.12 – 0.15 lbs/MMBtu/hr of PM_{10}.

Oxides of sulfur (SOx), oxides of nitrogen (NOx), carbon monoxide (CO), and volatile organic compounds (VOCs) are other air pollutants of concern emitted during fuel combustion. Modern wood systems emit more SO_2 than natural gas, but have less than two percent the SO_2 emissions of fuel oil and about 50 percent the SO_2 emissions of propane. Wood, propane and fuel oil combustion have similar levels of NOx emissions, while natural gas produces lower levels of nitrogen oxides. All fuel combustion processes produce carbon monoxide (CO). The level produced by wood combustion depends very much on how well the system is tuned. Wood combustion produces significantly more CO than oil, natural gas and propane. This, in addition to PM, is a good reason to make sure the stack is tall enough to disperse any emissions away from ground level.

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[2] Newly manufactured indoor residential woodstoves are required to meet strict US EPA particulate emissions standards, 4.1 grams per hour for catalytic stoves and 7.5 g/hr for noncatalytic stoves. Certification tests are conducted in EPA approved laboratories. The New York State Attorney General's office found that average emissions during laboratory testing of these primitive outdoor wood boilers was 71.6 g/hr or roughly ten times the particulate emission rate from indoor woodstoves. Citation: http://www.vtwoodsmoke.org/about.html

Emission Rate Comparison

	PM10[3]	CO	NOx	SO_2	TOC	CO_2
Wood Pellet Boiler (Test Report)	n/a	0.51	n/a	0.272	n/a	n/a
Woodchip Boiler	0.1	0.73	0.165	0.0082	0.0242	Gross 220 (net 0)
Oil Boiler	0.014	0.035	0.143	0.5	0.0039	159
Propane Boiler	0.004	0.021	0.154	0.016	0.005	137
Natural Gas Boiler	0.007	0.08	0.09	0.0005	0.01	118

Emissions rates, given in pounds of pollutant per MMBtu, were provided by Resource Systems Group in a report titled, *Air Pollution Control Technologies for Small Wood-fired Boilers* (2001).

VOCs are one component of total organic compounds (TOC) shown in the table above. VOCs are a large family of air pollutants, some of which are produced by fuel combustion. Some are toxic and others are carcinogenic. In addition, VOCs elevate ozone and smog levels in the lower atmosphere, causing respiratory problems. Both wood and oil combustion produce VOCs – wood is higher in some compounds and oil is higher in others. VOC emissions can be minimized with good combustion practices.

Control Devices for PM

As described above, fine particulate matter is the pollutant of greatest concern with regard to wood systems. Even with the greater climate change benefits of wood energy, the $PM_{2.5}$ issue needs to be considered as the regulatory framework is changing The National Ambient Air Quality Standard for $PM_{2.5}$ has recently been changed, with the standard becoming tighter. The region of Sandpoint Idaho is expected to be in compliance with the revised standards based on EPA designations. The AP42 uncontrolled PM emission factor (EPA accepted measurement of emissions) is 0.29 lb/MMBtu for wet wood, which can be reduced to 0.20 lb/ MMBtu by installing a mechanical collector. Some uncontrolled small wood-fired boilers of modern design with a gasifier or staged combustion have uncontrolled emission rates of between 0.1 and 0.2 lb/MMBtu. However, because of the variability of fuel and combustion conditions manufacturers will not guarantee these emission rates.

Currently, the four most common air pollution control devices used to reduce PM emissions from wood-fired boilers are mechanical collectors (cyclones and core separators), wet scrubbers, electrostatic precipitators (ESPs), and fabric filters. Such devices can reduce PM emissions by 70 to 99.9 percent. Core separators and water scrubbers of size suitable for 850,000 Btu/hr boilers are not commercially available in US. The three pollution control devices recommended for Sandpoint Idaho are discussed below.

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[3] Without emission control equipment with the exception of PM10; the PM10 is given after emissions moved through a baghouse. Emissions given on a heat input basis.

Multicyclones

Multicyclones, or multiple tube cyclones, are mechanical separators that use the velocity differential across the cyclone to separate particles. Cyclones are less efficient collectors than multicyclones because a multicyclone uses several smaller diameter cyclones to improve efficiency. Overall efficiency ranges from 65 percent to 95 percent but multicyclones, like cyclones, are more efficient in collecting larger particles and their collection efficiency falls off at small particle sizes. The AP42 lists multicyclone controlled emission rates that indicate a control efficiency of 73 percent for PM_{10} when the uncontrolled emission rate is 0.71 lb/MMBtu. The resulting multicyclone controlled emission rate is 0.19 lb/MMBtu. When the uncontrolled emission rate is as low as 0.1 to 0.2 lb/MM Btu the overall control efficiency will be lower. Some combustion units could meet an emission level of 0.1 lb/MM Btu with a multicyclone.

Fabric Filters or Baghouses

With the correct design and choice of fabric, particulate control efficiencies of over 99 percent can be achieved even for very small particles (one micrometer or less) by fabric filters or baghouses. The lowest emission rate for large wood-fired boilers controlled by fabric filters reported is 0.01 lb/MMBtu. Operating experience with baghouses on larger wood-fired boilers indicates that there is a fire risk, due to caking of the filters with unburned wood dust. It is possible to control or manage this risk by installation of a mechanical collector upstream of the fabric filter to remove large burning particles of fly ash (i.e. "sparklers”). A cyclone-baghouse combination reduces the fire risk.

Electrostatic Precipitators (ESP)

ESPs are widely used for the control of particulates from a variety of combustion sources including wood combustion. An ESP is a particle control device that employs electric fields to collect particles from the gas stream on to collector plates from where they can be removed. There are a number of different designs that achieve very high overall control efficiencies.

Control efficiencies typically average over 98 percent with control efficiencies almost as high for particle sizes of one micrometer or less. Overall ESPs are almost as good as the best fabric filters. Two designs were considered for smaller boilers: a dry electrostatic precipitator and a wet electrostatic precipitator. The systems are basically similar except that wet electrostatic precipitators use water to flush the captured particles from the collectors. The advantage of dry systems is that they may have a lower capital cost and reduced waste disposal problems. Wet systems may be less expensive to operate and are probably slightly more efficient at capturing very small particles that may include toxic metals.

Stack Height

Wood system chimneys at this size range emit virtually no visible smoke (the white plume of vapor on cold days is condensed water). Nevertheless, all but the very best wood burning systems, whether in buildings or power plants, have significantly higher PM emissions than do corresponding gas and oil systems. For this reason, it is necessary to use a stack with a height that will effectively disperse any remaining emissions into the air and reduce ground-level concentrations of PM (and other pollutants) to ensure acceptable levels are maintained.

The recommended control devices for air emissions system are a multicyclone, provided as a part of manufacturer equipment. Due to the fact that the EPA is currently in the process of revising the Emissions Standards for Area Source Industrial, Commercial, and Institutional Boilers an ESP emission control device might be required to further reduce the particulate emissions. The EPA will publish the new and revised rules in December 2010.

Air Quality Permitting

In accordance with the Idaho Administrative Procedure Act (IDAPA) 58.01.01.221.02.d., a permit to construct (PTC) is not required for a source that satisfies the criteria set forth in Section 220 (allowable capacity and emission limits) and that is fuel burning equipment for indirect heating with a capacity of less than one million (1,000,000) Btu per hour input. However, the Idaho State Implementation Plan (SIP) classifies the Sandpoint region as a "Non Attainment Area (NAA)" for PM_{10} emissions. The Idaho SIP supersedes the IDAPA exemption because the SIP states that no permitting exemptions can be granted to facilities applying to construct or modify within the Sandpoint NAA.

A new woody biomass facility will need to comply with Idaho's SIP. In addition the plant will need to satisfy the new EPA limits for $PM_{2.5}$, NO_X, SO_X, and CO. In addition the selected biomass boiler will need to satisfy the Maximum Achievable Control Technology (MACT). The Sandpoint district will need to submit a construction permit application for an air quality Permit to Construct (PTC) for the proposed biomass energy plant. The permit should be secured before the project scope is finalized. The permit will clearly identify certain scoping issues such as allowable emission limits, required stack height and required air pollution control equipment. Having the permit will also allow the Sandpoint district energy plant to include the permit conditions (and request emission rate guarantees) in their scope of work in the bid packages sent to potential boiler suppliers. The permitting process can take approximately four months from the time that the Idaho Department of Environmental Quality (DEQ) receives a complete permit application until the time that the permit is issued. DEQ has developed a streamlined permit application process and recommends that any new woody biomass project schedule a pre-application meeting by calling the DEQ's Air Quality Permitting Hotline at 1-877-5PERMIT.

ECONOMIC ANALYSIS

BERC has developed a life-cycle cost (LCC) analysis tool that examines the costs of purchasing and operating a biomass heating system side-by-side with the costs associated with continuing to heat with fossil fuels, natural gas & electricity. This tool allows decision makers to compare fuel cost savings with expenditures over a 30-year period. BERC ran two LCCs, one using pellets and one using woodchips, to identify the best possible system configuration. Each LCC compares the biomass boiler system directly to the fossil fuel system.

Important inputs and calculations from the LCC are discussed below. The full LCC analyses are included in the Appendices.

Analysis Assumptions

- Included in the capital cost analysis is the quote received for updating the existing electrical and natural gas-fired systems.
- Total natural gas and electricity consumption for space heating was converted to decatherms for an aggregated total of 2,054 decatherms of natural gas use annually
- Total portion of electric heating usage was 124,121 kWh annually, or the equivalent of 424 decatherms of natural gas
- Each decatherm of natural gas delivered to the boiler contains 800,000 Btu
- Each kWh of electricity used for heating provides 3,412.14 Btu
- Regional woody biomass fuels average 14 MMBtu per dry ton
- The average seasonal efficiency for the natural gas systems is 80 percent
- The average seasonal efficiency for the electric heating is 100 percent
- The average seasonal efficiency for wood pellet heating is 80 percent
- The average seasonal efficiency for woodchip heating is 70 percent
- The 12-month average commercial natural gas rate is \$8.82 per decatherm
- The 12-month average commercial electric rate is \$0.1012 per kWh
- The 12-month average wood pellet fuel cost is \$160 per ton
- The 12-month average woodchip fuel cost is \$25 per ton
- Capital costs estimate from TRI STATE HVAC&R is \$62,000
- The general inflation rate is 3.25 percent
- The price escalator for woodchips with general inflation is 3.75 percent
- The price escalator for wood pellets with general inflation is 5.00 percent
- The price escalator for fossil fuels with general inflation is 6.25 percent

- The discount rate, used to bring 30-year projected costs back to 2010 dollars for comparison, was 4.5 percent
- System costs are based on estimates from several vendors, with a contingency of 10 percent
- All costs are estimates based on BERC's experience with similar projects; these cost estimates are intended as the basis for preliminary feasibility analysis and are expected to be within +/- 20 percent and subject to change
- The analysis does not include the cost of any other work that might need to be completed before the installation of a biomass heating system
- The analysis assumes that after installation, the biomass boiler will supply 85-90 percent of the total heating needs, with the remaining 10-15 percent to be supplied by fossil fuel systems
- BERC has made the assumption that either existing heating systems will remain as a fully redundant backup alongside the biomass system, or provisions will be in place for electrical heating systems.
- Building costs are estimated at $80 per square foot for a pre-fabricated, steel building
- Underground piping and trenching is estimated at $100 per linear foot
- The estimated salvage value of the biomass system is estimated to be 30 percent of the capital cost before mark up after 30 years, without inflation

Option 1 – Status Quo

In this option the city of Sandpoint will continue to heat the three facilities with 1,630 decatherms of natural gas and 124,121 kWh of electricity from the grid, as it presently does. The most recent data from the local utility, Avista Utilities, indicates that natural gas is being delivered at $8.82 per decatherm, and electricity at $0.1012 per kWh (including demand charges and fees). Total current heating cost expenditures for all three buildings are estimated at $26,921.

Option 2 – Woodchip Heating

In this option, the woodchip heating plant would need to purchase 246 green tons of woodchips (at approximately 42 percent moisture content) per year to cover 85 percent of the thermal load; the remaining 15 percent would be provided with the existing natural gas and electric systems.

Capital Cost

The capital cost is the total dollars spent on purchasing and installing the biomass heating system, including the building that houses it, as well as the heat distribution piping and building interconnection cost. Capital costs are averages based on estimates from several vendors for recently bid systems of this size. The capital costs for the woodchip heating system has included a high efficiency multi-cyclone that, by the manufacturer's literature, will meet the new proposed EPA emission standards of 0.03 lbs/MMBtu for Particulate Matter (PM). Once the new provisions have been changed, a review of the equipment should be done and if necessary, an Electrostatic

Precipitator (ESP) would be the next level of equipment to be installed. The average cost for this piece of equipment for a project this size is in the range of $50,000 to $65,000. For this analysis, BERC has not included this cost.

Capital Cost: Woodchip Heating System

Wood system	$65,000
Stack	$15,000
System Controls	$2,500
Electrical Connections	$2,500
Interconnection	$30,000
HVAC conversion	$62,000
Piping	$72,000
Building (1000 SF * $80/SF)	$80,000
Total capital	**$329,000**
GC markup 15%	$49,350
Design 10%	$32,900
Grand Total	**$411,250**

Life Cycle Cost Analysis

While examining the feasibility of biomass energy systems it is also important to think in terms of life cycle costs. Typically biomass heating systems will result in savings over time that can offset their initial capital costs. A life cycle cost (LCC) tool was used to analyze the cost effectiveness of purchasing, operating, and maintaining a biomass heating system over its 30-year period. Numerous inputs, including woodchip price, fossil fuel price, and system cost are weighed against the annual cost of operating and maintaining the existing natural gas and electric heating systems.

Two calculations are of particular interest when assessing the outcome of the LCC analysis: first-year fuel cost savings, and the 30-year net present value (NPV) of savings.

First-year fuel cost savings can be shown as a percentage or dollar amount. With the installation of a woodchip heating system, fuel cost savings in this analysis would amount to $17,941 or 63 percent of current fuel costs, in the first year.

NPV can be defined as the difference, in current year dollars, between the value of the cash inflows and the value of the cash outflows associated with operating a wood system project. A positive 30-year NPV of savings indicates that, from society's economic perspective, the project is worth doing. A negative 30-year NPV of savings indicates a project that is not worth doing.

30 year NPV: Woodchip Heating System

Total 30-Year Cost, fossil fuel system	1,055,576
Total 30-Year Cost, wood system	561,883
Difference (30-year NPV of savings)	**$493,693**

The full LCC analysis is included as Appendix B.

Option 3 – Wood Pellet Heating

In Option 3, the wood pellet heating plant would require 140 tons of wood pellets per year (providing 90 percent of the total heating load with the remaining 10 percent provided by fossil fuel systems).

Capital Cost

As in option 2 the capital cost is the total dollars spent on purchasing and installing the biomass heating system, including the building that houses it, as well as the heat distribution piping and building interconnection cost. The capital cost for a wood pellet system is generally smaller than for a woodchip heating system. The main difference is in the lower cost of the fuel handling equipment and the required building space to house the required equipment. Capital costs are averages based on estimates from several vendors for recently bid systems of this size. The capital costs for the wood pellet heating system has included a high efficiency multi-cyclone that, by the manufacturer's literature, will meet the new proposed EPA emission standards of 0.03 lbs/MBtu for Particulate Matter (PM). Once the new provisions have been changed, a review of the equipment should be done and if necessary, an Electrostatic Precipitator (ESP) would be the next level of equipment to be installed. The average cost for this piece of equipment for a project of this size is the range of $50,000 to $65,000. For this study, BERC has not included this cost.

Capital Cost: Wood Pellet System

Wood System	$55,000
Stack	$15,000
System Controls	$2,500
Electrical Connections	$2,500
Interconnection	$30,000
HVAC conversion	$62,000
Piping	$72,000
Storage Silo & Fuel Delivery	$25,000
Building (600SF *$80/SF)	$48,000
Total capital	**$312,000**
GC markup 15%	$46,800
Design 10%	$31,200
Grand Total	**$390,000**

Life Cycle Cost Analysis

The life cycle cost analysis for option 3, wood pellet heating, was performed using the same methodology as option 2, woodchip heating.

First-year fuel cost savings are shown as a percentage and dollar amount. With the installation of a wood pellet heating system, fuel cost savings would amount to $2,398 or 8 percent of current fuel costs, in the first year.

30-year NPV: Wood Pellet Heating System

Total 30-Year Cost, fossil fuel system	1,055,576
Total 30-Year Cost, wood system	1,003,641
Difference (30-year NPV of savings)	**$51,935**

The full LCC analysis is included as Appendix C.

CONCLUSIONS AND RECOMMENDATIONS

This feasibility analysis indicates the following:

- The economics analysis are showing positive results for converting the three city owned buildings to a biomass fired heating system, though option 2, woodchip heating, provides the best project economics. Over the 30-year span of the project, by operating a woodchip boiler instead of the existing natural gas and electric heating systems Sandpoint will save over $493,000 while supporting a local, secure energy source.
- A biomass CHP system in the size range examined is not a commercially available technology solution in the United States at this time.
- The fuel supply infrastructure for woodchips and wood pellets is relatively well-established, making both biomass fuels an available and an affordable alternative to natural gas and electricity.
- There are no barriers to siting a biomass boiler at the site. Sandpoint industrial area presents a good site for a relatively easy and low-cost conversion to a biomass system. The proposed site for the biomass heating plant is in an ideal location for the possibility of expansion to other buildings in the area by the addition of more, or larger, boilers and has an ideal location for chip storage. BERC is recommending a wood chip heating system due to the constraints of pellets and their costs. Once a system size rises about 2 to 3 million Btu/hr, the cost of pellets no longer becomes as cost effective as they are more expensive and volatile in price.

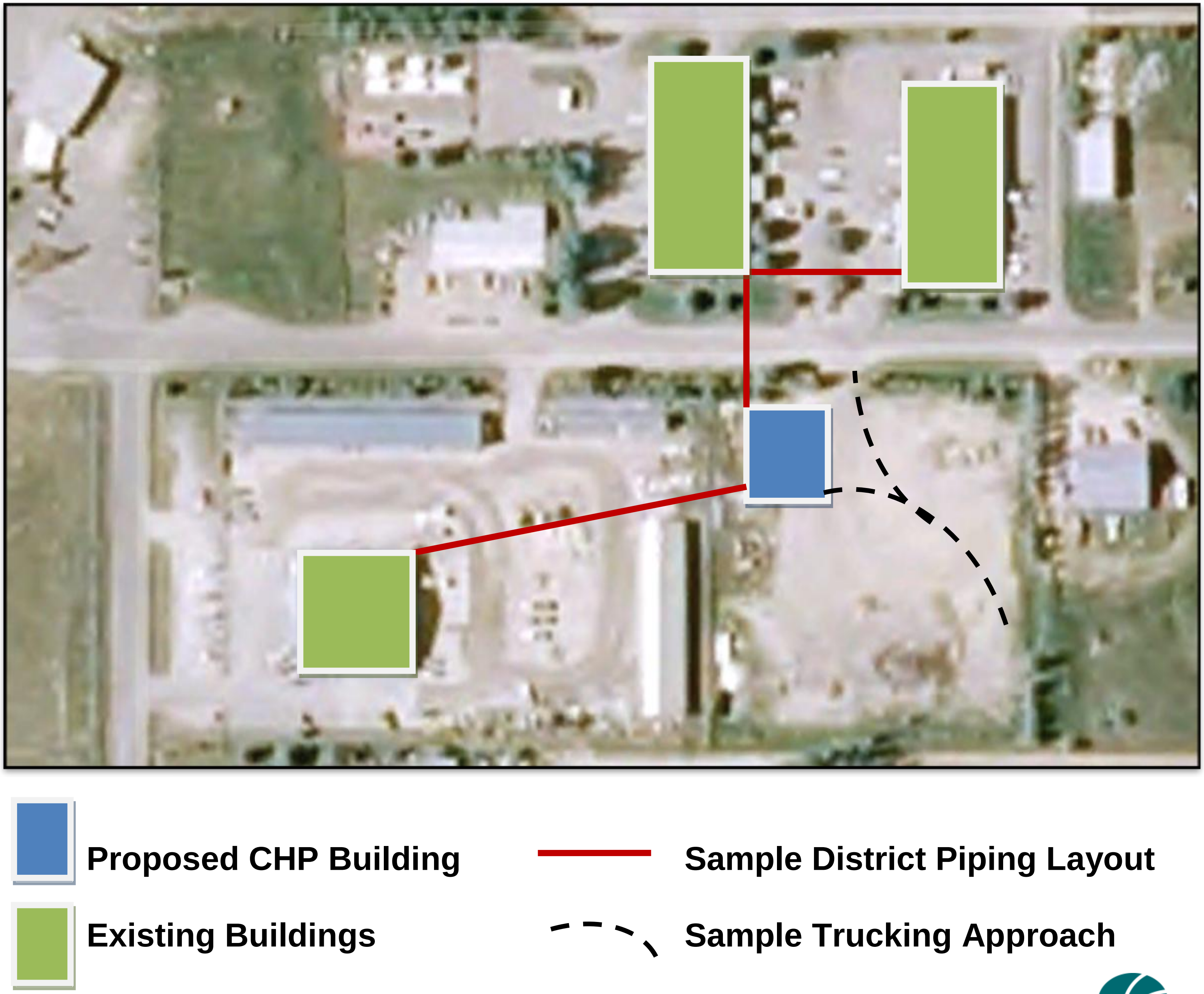
The Sandpoint decision makers should consider the findings and recommendations in this report and make a decision whether or not to pursue the option of heating the existing city owned facilities with a biomass system. The following is a list of suggested next steps:

- Present the findings and recommendations from this report to decision makers and stakeholders.
- Managers, executives, and maintenance staff should visit existing biomass heated facilities. Seeing the technology and talking with system operators is extremely valuable in addressing doubts and concerns.

- One of the coming opportunities that Sandpoint decision makers should consider is the utilization of packaged biomass systems. BERC has considered a building suited for an industrial setting – i.e. pre-fabricated steel building for the purpose of capital cost estimation. Companies that can provide a "Plug and Play" system with will include the boiler, stack, cyclone, piping connections, etc., are becoming competitive and available. A system of this size may require a slab, electrical on connections to the district piping, but would cost in the range of $50,000 and up – depending on accessories that might be desired.
- Develop solid relationships with potential or chosen biomass fuel suppliers in the early stages of this project. Working closely and cooperatively will ensure the success of both the proposed project and of the biomass heating market in Idaho overall.
- Decide the strategy for implementing the project. The biomass boiler vendor can be appointed as General Contractor to undertake all the civil, mechanical, and electrical work for the project. Another option is to appoint a General Contractor to undertake the civil work for the boiler as well as the mechanical and electrical work for the project with a biomass boiler vendor as a subcontractor to the General Contractor. Both methods are viable and worth consideration. Currently, the best approach is difficult to determine because it will depend upon the outcome of the bidding process and vendor selection. This decision should be made once the Request for Proposals submissions have been received.
- Should Sandpoint's decision makers decide to pursue the installation of the biomass energy system, BERC will assist the city administrators with developing a request for proposals (RFP) document focused on performance specifications. BERC will then assist the city in the evaluation and selection of vendor bids for the implementation phase of the project.

Appendix A – Site Layout Map

City of Sandpoint, Idaho



BERC
Biomass Energy Resource Center

Appendix B – Woodchip LCC

Biomass Energy Resource Center

LIFE CYCLE COST ANALYSIS

(compared to operating existing fossil fuel system)

Organization Conducting Analysis	BERC	**Facility Name**	Sand Point Idaho (3 City Buildings)	**Biomass Boiler Size:**	0.831 MMBtu/Hr

Assumptions

Total Project Cost	**$411,250**
Financing, annual bond rate	**4.50%**
Finance term (years)	**20**

Current fuel	**Natural Gas**
Current fuel units	**decatherms**
Current fuel price per unit	**$8.82**
Annual units, current fuel	**1,630**
Current fuel	**Electric**
Current fuel units	**kWh**
Current fuel price per unit	**$0.10**
Annual units, current fuel (kWh)	**124,121**
Decatherm equivalent	**$29.62**
Annual units, (decatherm equiv.)	**424**

Wood price, yr 1 (per ton)	**$25**
Wood fraction (ann. heat load)	**85%**

General annual inflation rate	**3.25%**
Discount rate	**4.50%**
Fossil Fuel inflation (w/ genl inflation)	**6.25%**
Wood inflation (w/ genl inflation)	**3.75%**

Ann. Wood O&M cost, yr 1	**$4,276.24**
Major repairs (annualized)	**$273**
Estimated Boiler Life	**40**
Estimated Building Life	**60**

Capital Cost

Wood system	$65,000
Stack	$15,000
System Controls	$2,500
Electrical Connections	$2,500
Interconnection	$30,000
HVAC conversion	$62,000
Piping	$72,000
Building (1000 SF * $80/SF)	$80,000
Total capital	**$329,000**
GC markup 15%	$49,350
Design 10%	$32,900
Grand Total	**$411,250**

Calculated values

Financed amount		**$161,250**
Value of grant		**$250,000**
Annual wood use, if 100% wood (tons)		**289**
Wood/current fuel system:		
Annual wood use	tons	**246**
Annual current fuel use	decatherms	**308**
First year fuel cost savings (%)		**63%**
First year fuel cost savings ($)		**$17,941**

30 Year NPV

Total 30-Year Cost, fossil fuel system	1,055,576
Total 30-Year Cost, wood system	561,883
Difference (30-year NPV of savings)	**$493,693**

LIFE CYCLE COST ANALYSIS

	Inflation	**Natural Gas**	**Electric**		**Woodchip/Fossil Fuel System**				Non-capital	Total	Total
Yr.	Calculator	Total Annual Cost	Total Annual Cost	Capital and Financing Costs	Wood Cost	Backup Fuel Cost	Incremental Annualized O&M	Annualized Major Repairs	Annual Wood System Costs	Wood System Annual Costs	Annualized Savings
0	1.000	$14,377	$12,545	$161,250	$0	$0	$0	$0	$0	161,250	($161,250)
1	1.033	$15,275	$13,329	$0	$6,372	$4,291	$4,415	$282	$15,360	15,360	$13,244
2	1.066	$16,230	$14,162	$0	$6,611	$4,483	$4,559	$291	$15,944	15,944	$14,448
3	1.101	$17,244	$15,047	$0	$6,859	$4,763	$4,707	$300	$16,630	16,630	$15,661
4	1.136	$18,322	$15,987	$0	$7,116	$5,061	$4,860	$310	$17,347	17,347	$16,962
5	1.173	$19,467	$16,986	$0	$7,383	$5,377	$5,018	$320	$18,099	18,099	$18,355
6	1.212	$20,684	$18,048	$0	$7,660	$5,714	$5,181	$331	$18,885	18,885	$19,847
7	1.251	$21,977	$19,176	$0	$7,947	$6,071	$5,349	$342	$19,708	19,708	$21,444
8	1.292	$23,350	$20,375	$0	$8,245	$6,450	$5,523	$353	$20,571	20,571	$23,154
9	1.334	$24,809	$21,648	$0	$8,554	$6,853	$5,703	$364	$21,474	21,474	$24,983
10	1.377	$26,360	$23,001	$0	$8,875	$7,281	$5,888	$376	$22,420	22,420	$26,941
11	1.422	$28,008	$24,439	$0	$9,208	$7,737	$6,079	$388	$23,412	23,412	$29,034
12	1.468	$29,758	$25,966	$0	$9,553	$8,220	$6,277	$401	$24,451	24,451	$31,273
13	1.516	$31,618	$27,589	$0	$9,911	$8,734	$6,481	$414	$25,540	25,540	$33,667
14	1.565	$33,594	$29,313	$0	$10,283	$9,280	$6,691	$427	$26,682	26,682	$36,226
15	1.616	$35,694	$31,145	$0	$10,669	$9,860	$6,909	$441	$27,879	27,879	$38,960
16	1.668	$37,924	$33,092	$0	$11,069	$10,476	$7,134	$455	$29,134	29,134	$41,883
17	1.722	$40,295	$35,160	$0	$11,484	$11,131	$7,365	$470	$30,450	30,450	$45,005
18	1.778	$42,813	$37,358	$0	$11,915	$11,826	$7,605	$485	$31,831	31,831	$48,340
19	1.836	$45,489	$39,692	$0	$12,361	$12,565	$7,852	$501	$33,280	33,280	$51,901
20	1.896	$48,332	$42,173	$0	$12,825	$13,351	$8,107	$518	$34,800	34,800	$55,705
21	1.957	$51,353	$44,809	$0	$13,306	$14,185	$8,371	$534	$36,396	36,396	$59,766
22	2.021	$54,562	$47,610	$0	$13,805	$15,072	$8,643	$552	$38,071	38,071	$64,101
23	2.087	$57,972	$50,585	$0	$14,323	$16,014	$8,923	$570	$39,829	39,829	$68,728
24	2.155	$61,596	$53,747	$0	$14,860	$17,015	$9,213	$588	$41,676	41,676	$73,666
25	2.225	$65,445	$57,106	$0	$15,417	$18,078	$9,513	$607	$43,615	43,615	$78,936
26	2.297	$69,536	$60,675	$0	$15,995	$19,208	$9,822	$627	$45,652	45,652	$84,559
27	2.372	$73,882	$64,467	$0	$16,595	$20,408	$10,141	$647	$47,792	47,792	$90,557
28	2.449	$78,499	$68,496	$0	$17,217	$21,684	$10,471	$668	$50,040	50,040	$96,955
29	2.528	$83,406	$72,777	$0	$17,863	$23,039	$10,811	$690	$52,403	52,403	$103,780
30	2.610	$88,618	$77,326	($127,813)	$18,533	$24,479	$11,163	$713	$54,887	(72,925)	$238,870
Totals		$1,262,112	$1,101,283		$342,813	$348,706	$218,773	$13,967	$924,259	$796,447	$1,566,948
30 YR NPV:		**$563,704**	**$491,872**	**$127,124.06**	**$165,109**	**$155,781**	**$107,036**	**$6,833**	**$434,759**	**$561,883**	**$493,693**

Appendix C – Wood Pellet LCC

Biomass Energy Resource Center

LIFE CYCLE COST ANALYSIS

(compared to operating existing fossil fuel system)

Organization Conducting Analysis	BERC	**Facility Name**	Sand Point Idaho (3 City Buildings)	**Biomass Boiler Size:**	0.831 MMBtu/Hr

Assumptions

Total Project Cost	**$390,000**
Financing, annual bond rate	**4.50%**
Finance term (years)	**20**

Current fuel	**Natural Gas**
Current fuel units	**decatherms**
Current fuel price per unit	**$8.82**
Annual units, current fuel	**1,630**
Current fuel	**Electric**
Current fuel units	**kWh**
Current fuel price per unit	**$0.10**
Annual units, current fuel (kWh)	**124,121**
Decatherm equivalent	**$29.62**
Annual units, (decatherm equiv.)	**424**

Wood price, yr 1 (per ton)	**$160**
Wood fraction (ann. heat load)	**90%**

General annual inflation rate	**3.25%**
Discount rate	**4.50%**
Fossil Fuel inflation (w/ genl inflation)	**6.25%**
Wood inflation (w/ genl inflation)	**5.00%**

Ann. Wood O&M cost, yr 1	**$2,361.49**
Major repairs (annualized)	**$231**
Estimated Boiler Life	**40**
Estimated Building Life	**60**

Capital Cost

Wood System	$55,000
Stack	$15,000
System Controls	$2,500
Electrical Connections	$2,500
Interconnection	$30,000
HVAC conversion	$62,000
Piping	$72,000
Storage Silo & Fuel Delivery	$25,000
Building (600SF *$80/SF)	$48,000
Total capital	**$312,000**
GC markup 15%	$46,800
Design 10%	$31,200
Grand Total	**$390,000**

Calculated values

Financed amount		**$140,000**
Value of grant		**$250,000**
Annual wood use, if 100% wood (tons)		**154**
Wood/current fuel system:		
Annual wood use (90%)	tons	**139**
Annual current fuel use	decatherms	**205**
First year fuel cost savings (%)		**8%**
First year fuel cost savings ($)		**$2,398**

30 Year NPV

Total 30-Year Cost, fossil fuel system	1,055,576
Total 30-Year Cost, wood system	1,011,433
Difference (30-year NPV of savings)	**$44,143**

LIFE CYCLE COST ANALYSIS

		Natural Gas	**Electric**		**Woodchip/Fossil Fuel System**						
Yr.	Inflation Calculator	Total Annual Cost	Total Annual Cost	Capital and Financing Costs	Wood Cost	Backup Fuel Cost	Incremental Annualized O&M	Annualized Major Repairs	Non-capital Annual Wood System Costs	Total Wood System Annual Costs	Total Annualized Savings
0	1.000	$14,377	$12,545	$140,000	$0	$0	$0	$0	$0	140,000	($140,000)
1	1.033	$15,275	$13,329	$0	$23,345	$2,860	$2,438	$239	$28,882	28,882	($279)
2	1.066	$16,230	$14,162	$0	$24,513	$3,461	$2,517	$246	$30,737	30,737	($346)
3	1.101	$17,244	$15,047	$0	$25,738	$3,677	$2,599	$254	$32,269	32,269	$22
4	1.136	$18,322	$15,987	$0	$27,025	$3,907	$2,684	$263	$33,878	33,878	$431
5	1.173	$19,467	$16,986	$0	$28,376	$4,151	$2,771	$271	$35,570	35,570	$884
6	1.212	$20,684	$18,048	$0	$29,795	$4,411	$2,861	$280	$37,347	37,347	$1,385
7	1.251	$21,977	$19,176	$0	$31,285	$4,686	$2,954	$289	$39,214	39,214	$1,938
8	1.292	$23,350	$20,375	$0	$32,849	$4,979	$3,050	$298	$41,177	41,177	$2,548
9	1.334	$24,809	$21,648	$0	$34,492	$5,290	$3,149	$308	$43,239	43,239	$3,218
10	1.377	$26,360	$23,001	$0	$36,216	$5,621	$3,252	$318	$45,407	45,407	$3,954
11	1.422	$28,008	$24,439	$0	$38,027	$5,972	$3,357	$328	$47,685	47,685	$4,761
12	1.468	$29,758	$25,966	$0	$39,928	$6,346	$3,466	$339	$50,079	50,079	$5,645
13	1.516	$31,618	$27,589	$0	$41,925	$6,742	$3,579	$350	$52,596	52,596	$6,611
14	1.565	$33,594	$29,313	$0	$44,021	$7,164	$3,695	$361	$55,241	55,241	$7,666
15	1.616	$35,694	$31,145	$0	$46,222	$7,611	$3,815	$373	$58,022	58,022	$8,817
16	1.668	$37,924	$33,092	$0	$48,533	$8,087	$3,939	$385	$60,945	60,945	$10,071
17	1.722	$40,295	$35,160	$0	$50,960	$8,592	$4,067	$398	$64,017	64,017	$11,437
18	1.778	$42,813	$37,358	$0	$53,508	$9,129	$4,200	$411	$67,248	67,248	$12,923
19	1.836	$45,489	$39,692	$0	$56,183	$9,700	$4,336	$424	$70,643	70,643	$14,538
20	1.896	$48,332	$42,173	$0	$58,992	$10,306	$4,477	$438	$74,214	74,214	$16,292
21	1.957	$51,353	$44,809	$0	$61,942	$10,950	$4,623	$452	$77,967	77,967	$18,195
22	2.021	$54,562	$47,610	$0	$65,039	$11,635	$4,773	$467	$81,913	81,913	$20,258
23	2.087	$57,972	$50,585	$0	$68,291	$12,362	$4,928	$482	$86,063	86,063	$22,495
24	2.155	$61,596	$53,747	$0	$71,706	$13,135	$5,088	$498	$90,426	90,426	$24,917
25	2.225	$65,445	$57,106	$0	$75,291	$13,956	$5,253	$514	$95,014	95,014	$27,538
26	2.297	$69,536	$60,675	$0	$79,055	$14,828	$5,424	$531	$99,838	99,838	$30,373
27	2.372	$73,882	$64,467	$0	$83,008	$15,755	$5,600	$548	$104,911	104,911	$33,438
28	2.449	$78,499	$68,496	$0	$87,159	$16,739	$5,782	$566	$110,246	110,246	$36,750
29	2.528	$83,406	$72,777	$0	$91,516	$17,785	$5,970	$584	$115,856	115,856	$40,327
30	2.610	$88,618	$77,326	($120,313)	$96,092	$18,897	$6,164	$603	$121,757	1,444	$164,500
Totals		$1,262,112	$1,101,283		$1,551,032	$268,736	$120,814	$11,818	$1,952,400	$1,832,088	$531,307
30 YR NPV:		**$563,704**	**$491,872**	**$107,876.56**	**$718,841**	**$119,824**	**$59,109**	**$5,782**	**$903,557**	**$1,011,433**	**$44,143**