Biomass Energy for Plumas District Hospital

Quincy, CA

March 2016

Prepared for:

Plumas District Hospital
1065 Bucks Lake Road
Quincy, CA 95971

Prepared by:

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Forest Service Acknowledgement

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1 Project Background

The Sierra Institute for Community and Environment, in partnership with High Sierra Community Energy Development Corporation, Inc., a subsidiary of Wisewood, Inc., successfully applied for funding from the US Department of Agriculture – Forest Service's Wood Innovations Funding Opportunity grant program in January 2015. The purpose of the grant funding was to further expand the study and development of biomass-fired energy systems in Plumas County, CA. A portion of the funds was dedicated to exploring the feasibility of utilizing biomass fuels at the Plumas District Hospital campus in Quincy, CA.

The Plumas District Hospital is a 25-bed hospital that was built in 1959 and offers cardiopulmonary services, a dental clinic, emergency services, laboratory services, patient financial assistance, patient portal, radiology services, a rural health clinic, telemedicine services, and women's services. Since the original construction, two other buildings have been added to the campus: The North Fork Medical Building and the Quincy Medical Building.

2 Energy Model

Wisewood models key data inputs such as the existing annual heating energy consumption, an estimate of the efficiency of existing heating sources, and local historical weather data to calculate the heating demand for a given building. The model is used to calculate the optimum biomass boiler size, which is defined as the boiler that offsets the maximum fossil fuel consumption for a single boiler installation.

2.1 Existing Systems

This study includes three buildings: Plumas District Hospital; the North Fork Medical Building; and the Quincy Medical Building. Each of their existing heating systems is described briefly below.

2.1.1 Plumas District Hospital

Plumas District Hospital is heated with a mix of propane- and electric-fired heating systems. In patient rooms, there are electric resistance floor and ceiling heaters with an average capacity of 2-4 kW per room. In the operating and emergency rooms, there is a 15 kW Libert air-cooled system (9-ton cooling capacity) with electric resistance preheaters. The southern wing of the hospital uses a Governair propane-fired, forced air, 225 MBH furnace that relies on electric resistance for reheating air within the ductwork. Across the rest of the hospital, various rooftop packages use both propane- and electric-fired units to heat and cool the building; these include at least one Reznor propane furnace, Carrier air conditioning units, a Bryant propane furnace, and a large swamp cooler.

2.1.2 North Fork Medical Building

The North Fork Medical Building uses six Carrier propane split furnaces that provide propane heating and electric direct expansion (DX) Air Conditioning, in combined units ("split systems"). Total heating capacity is 550 MBH.

2.1.3 Quincy Medical Building

The Quincy Medical Building's primary heating and cooling system is a "common loop" water-source heat pump system that includes 13 Climate Master brand water-source heat pumps with a combined cooling capacity of 119 MBH, and 350 MBH heating. A Bryan propane-fired hot water boiler supplies the heating energy, and an EVAPCO cooling tower rejects heat when the system is in cooling mode. A 70,000 Btu/hour propane furnace provides additional heating energy to common spaces. The facility also uses solar hot water heating.

2.2 Heat Demand

To predict the heating load for the proposed system, Plumas District Hospital provided Wisewood with billing records of the combined propane and electricity consumption for the three buildings for the period between July 2013 and August 2015. The facilities consumed and average of 13,741 gallons of propane per year and 190,664 kWh of electricity (for heating only, based on average weather data). This is equivalent to approximately 1,915 MMBtu per year in energy consumption.

2.3 Boiler Size

Wisewood's preliminary energy model calculated an ideal biomass boiler size of 450 MBH (132 kW), which would provide 96.7% of heating needs. This is the "optimized" biomass boiler size, meaning that the boiler is intentionally sized to meet less than 100% of heating demand. This biomass boiler size provides the maximum savings over the life of the system by allowing the boiler to run most efficiently for the highest number of operating hours.

A secondary 1,000 MBH propane boiler will provide the remaining 3.3% of heating needs, typically during peak periods when the biomass boiler is unable to meet 100% of heat demand, as well as at low heating loads when the biomass boiler would be cycling on/off and therefore operating at reduced efficiency. It will also provide full redundancy in case of planned or unplanned maintenance on the biomass boiler.

2.4 Fuel Consumption

Based on the preliminary energy model, a 450 MBH biomass boiler will consume approximately 143 green tons (20% moisture content) of wood fuel per year. This is equivalent to 114 bone dry tons (0% moisture content). The remaining propane consumption is calculated to be 668 gallons per year.

By using woody biomass as the primary fuel, Wisewood estimates that Plumas District Hospital will avoid consuming over 13,000 gallons of propane per year, a potential reduction of more than 95%. The system could also reduce electric consumption for heating by more than 185,000 kWh per year, a potential reduction of more than 97%.

Wisewood's complete energy model for the three buildings combined (Plumas District Hospital, North Fork and Quincy Medical Buildings) is included in Appendix A. A representative sample of site drawings and facility photos are included in Appendix B.

3 Biomass Fuel Supply Assessment

3.1 Fuel Quality

Modern, computer-controlled biomass-fired boilers are available for all levels of thermal outputs, from small-scale systems sized for individual residences to large-scale systems capable of heating entire cities. While all of these systems are able to sustain clean wood combustion by utilizing automatic controls and continuous emissions monitoring, their respective fuel quality requirements are largely dictated by the size of the system. In general, the smaller the system, the narrower the requirements for fuel quality; the larger the system, the broader the fuel types it is able to handle.

The wood fuel quality spectrum is defined by particle size, moisture content, and ash content, and has traditionally been bordered on the high end by premium wood pellets suitable for burning in small pellet boilers and stoves, and on the low end by "hog fuel," a lightly processed fuel material typically comprised of bark, tops, and limbs from forest activities and other non-marketable woody biomass. Pre-commercial woody material generated during forest management activities is chipped or ground up, resulting in a range of particle size, moisture content, and ash content. In contrast, "select" wood chips have been processed to control for particle size and moisture content, and lie on the fuel spectrum between pellets and hog fuel.

Given that the size of the boiler required to supply heat to the facility is relatively modest at 450 MBH, Wisewood recommends a boiler that would utilize select wood chip fuel with a moisture content of not more than 35% (wet basis) and with a particle size of not more than 2”. This system could also be fueled with wood pellets.

3.2 Fuel Storage

The biomass boiler system’s footprint will include primary storage for fuel, which will feed directly into the boiler. When using wood chip fuel, this storage is most often in the form of interchangeable bins, a built-in “bunker”-style container, or a silo. Fuel bins are modified shipping containers or trash hauling bins that are typically transported by roll-off or hook-lift style delivery trucks; the bins would be mounted next to the boiler and feed directly into the fuel conveyance system. Two bins are generally recommended so that one can be swapped out quickly while the other continues to feed the boiler system.

If more storage is desired on site – which can provide both greater fueling independence in case of inclement weather or other fueling disruptions, as well as decrease the total number of fuel deliveries required throughout the heating season – then a fuel bunker can be utilized and sized to store up to several week’s worth of fuel, depending on the space available and average fuel demand of the system. The bunker would have integrated fuel reclamation, such as a scraper floor, that would push the fuel toward the fuel conveyance system to continuously feed the boiler. This is the most expensive fuel storage option.

Silos are an economical choice when the fuel source is select wood chips or pellets. They can hold a significant amount of fuel in a compact footprint. The cost estimate for this feasibility study is based on a wood chip silo holding approximately 15 tons of select wood chips, or 30 tons of pellets.

3.3 Flue Gas Treatment

Most modern biomass boiler systems feature combustion technology that employs feedback from oxygen and/or temperature sensors in the flue gas stream to optimize the air-to-fuel ratio in the firebox resulting in optimum combustion characteristics, even with varying fuel quality. Due to this combustion control system, a biomass boiler of the size recommended for Plumas District Hospital is not required to have additional flue gas treatment.

4 Project Economics

4.1 Capital Costs

Wisewood estimates the cost of the biomass district energy system described in the previous sections to be $980,000. This preliminary number includes full system engineering, procurement, and construction management, as well as 10% contingency on equipment and labor costs. Summaries of total project costs are provided in Appendix C.

Beyond the boiler system itself, a significant portion of the capital cost of the project is driven by the need to interconnect the biomass boiler system with the existing mechanical systems, which are varied in type, age and accessibility for retrofitting. More detailed costs of retrofitting Plumas District Hospital will not be known until detailed engineering has been completed and bids from subcontractors have been received.

4.2 Operating Costs

Wisewood compared the existing costs of operating a fossil fuel (propane) system to heat Plumas District Hospital for one year with the proposed biomass energy system. These costs include fuel, labor, and maintenance, and show a stark contrast between the yearly operating costs of fueling with propane versus wood. Assuming a cost of $70/ton for wood chips, in Year 1 of operations the biomass system could save over $46,000 from current expenditures. Replacement reserves are also factored into the biomass annual costs to ensure adequate capital is on hand for replacement of a few small burner components that require replacement every five years or so.

A full Stabilized Year is included in Appendix D and is summarized in Table 1 below.

Table 1 Stabilized Year 1 operating cost comparison between propane/electric heating and biomass heating (rounded to the nearest $100)

Existing Heating Systems		Biomass District Energy Costs	
Propane	$25,600	**Wood Fuel**	$10,000
Electricity	$39,300	**Electricity**	$1,600
Operations & Maintenance	$5,000	**Remaining Propane**	$1,200
		Operations & Maintenance	$8,600
		Replacement Reserves	$1,000
		Administration	$1,000
Total	$69,900	**Total**	$23,400

4.3 Lifetime Costs

The operating costs shown in Table 1 above are representative of Year 1 of operations, after which costs would escalate. Wisewood used an escalator of 4% for propane fuel, which is commensurate with long term increases in the fossil fuel market. Electricity, wood fuel, and labor costs were modeled with a 2% escalator. The effects of these escalators can be seen in the 25-year lifetime economic pro forma included in Appendix E. A snapshot comparison is shown in Table 2 below, where operating costs of a propane system double over 25 years, while the already lower biomass operating costs increase by only about 60%, resulting in potential cost savings over the life of the system of over $1.7 million.

Table 2 Summary comparison of lifetime costs between propane heating and biomass district energy (rounded to the nearest $100)

	Year 1 Cost	Year 25 Cost	Cumulative Operating Cost (25 yrs)
Propane System	$69,900	$136,800	$2,483,600
Biomass System	$23,400	$38,300	$755,800
Biomass System Savings	$46,400	$98,500	$1,727,800

4.4 Simple Payback

Simple payback, which does not take into account price escalators over the life of the system, is often used to justify the economic viability of capital improvement projects when the capital outlay will result in an operational savings. When the capital expense ($980,000) is divided by the estimated Year 1 savings ($46,400), the result is a simple payback of approximately 21 years.

There are several funding opportunities available that may reduce the capital costs of the project. These include grants, low-interest loans, and tax credit programs available through various state and federal agencies.

5 Next Steps and Conclusion

5.1 Identify Project Funding

Engineering is estimated to cost approximately $115,000 for a system of this size and complexity. There are various funding options available at the State and Federal level to assist with the costs of both project design and construction funding, often for up to 50-80% of total costs (with the remaining 20-50% of costs coming from the grantee in the form of matching funds and/or in-kind time). These competitive processes are an excellent opportunity for facilities to leverage limited internal funds and take advantage of alternative energy incentive programs. Current funding sources that may have available funds for projects of this type include the USDA, the California Energy Commission, and the Sierra Nevada Conservancy.

5.2 Detailed Design and Engineering

Detailed design and engineering will include work from all the major design disciplines. Mechanical engineering will include: detailed boiler equipment specifications; detailed boiler building layout; fuel feed system selection and integration with boiler system controls; detailed design of hydronic circuits with equipment specifications; detailed design of hydronic interconnection with existing building HVAC systems; and control strategy design and equipment specifications.

In addition to power and control wiring of mechanical equipment, an electrical engineer will address controls and monitoring, as well as lighting design if a highly visible location is selected.

A more detailed cost estimate will be generated during the design and engineering phase, which will refine system needs and determine specific interconnection requirements with each building and heating system type.

5.3 Office of Statewide Health Planning and Development (OSHPD)

One complicating factor that will need to be addressed during detailed design is to understand how the implementation of the proposed system would be viewed by OSHPD. Based on previous interactions with OSPHD, so long as the proposed system is additional to a fully OSHPD-compliant heating system, there should be relatively few concerns. Therefore, Wisewood's analysis assumes that the existing heating systems will be left in place and the biomass system will be integrated such that it is supplemental to current systems. While the biomass boiler should reduce demand for fossil fuels and electricity by over 90%, it would still officially function as a supplemental heat source, as opposed to a primary heat source, which may lower the overall compliance burden. This will need to be confirmed by OSHPD.

5.4 Conclusion

Plumas District Hospital has high enough heating costs to make conversion to a biomass-fired heating system feasible. The Hospital's complex and varied heating and cooling systems pose significant, but not insurmountable, challenges for integration, which would be better understood through detailed design and engineering. Given the operational savings expected from implementation of a biomass system, this project warrants further investigation and design. The funding mechanisms discussed above for both engineering and construction may provide enough assistance to convert the entire hospital campus to biomass, which would further support the regional push toward utilization of a local, abundant natural resource to meet the heating needs of this critical institution.

Appendix A
Energy Model

Plumas District Hospital

Proposed System Analysis

WISEWOOD

Location	Quincy, CA	**Proposed System**	Biomass Boiler Installation	**Contact**	Andrew Haden
Client Contact	Tiffany Leonhardt	**Proposed System Output (MBH)**	450	**Phone**	(503) 706-6187
Date	3/29/16	**Proposed System Fuel Type**	Wood Chips	**Email**	andrew@wisewood.us

Fuel Prices		**Conversion Factors**		**Current System Consumption**	
Heating oil cost [$/gal]	$0.00	Energy of heating oil [Btu/gal]	139,000	Heating oil use [gal/yr]	0
Propane cost [$/gal]	$1.86	Energy of propane [Btu/gal]	92,000	Heating oil cost [$/yr]	$0
Electricity demand cost [$/kW]	$20.23	Energy per kWh [Btu/kWh]	3,412	Propane use [gal/yr]	13,741
Electricity cost [$/kWh]	$0.15	Moisture of biomass [% MC WB]	20%	Propane cost [$/yr]	$25,583
Biomass fuel cost [$/ton]	$70.00	Energy of bone dry wood [Btu/ton]	16,400,000	Heating electricity use [kWh/yr]	190,664
		Energy of actual biomass [Btu/ton]	12,731,840	Heating electricity cost [$/yr]	$38,855
				Total energy input [MMBtu/yr]	1,915

Current System Values					
Boiler efficiency	83%	Heating device nameplate, [MBH]	1,000	Operating hours per day	21
Max. electrical demand [kW]	100	Boiler output, low-fire [MBH]	200	Energy consumption [MMBtu/HHD]	0.29
Average electrical demand [kW]	43	Average boiler output [MBH]	209	Existing heat input [MMBtu/HHD]	0.24

Proposed Biomass Boiler Specifications		**Proposed Trim Boiler Specifications**		**Proposed System Values**	
Fuel type	Wood Chips	Fuel type	Propane	Total load carried by wood, as %	96.7%
Boiler output, high-fire [MBH]	450	Boiler output, high-fire [MBH]	1,000	Operating hours per year	7,536
Boiler output, low-fire* [MBH]	56	Boiler output, low-fire [MBH]	125	Biomass boiler output [% of peak]	75%
Max. electrical demand [kW]	1.3	Max. electrical demand [kW]	1.5		
Average electrical demand [kW]	0.6	Average electrical demand [kW]	0.19		
Boiler efficiency	85%	Boiler efficiency	85%		

Proposed Biomass Boiler Consumption and Cost		**Proposed Trim Boiler Consumption and Cost**		**Proposed Totals**	
Wood fuel consumption [tons/yr]	143	Propane consumption [gals/yr]	668	Total fuel consumption [MMBtu/yr]	1,881
Wood fuel cost [$/yr]	$10,002	Propane cost [$/yr]	$1,244	Total fuel cost [$/yr]	$11,247
Electrical consumption [kWh/yr]	4,607	Electrical consumption [kWh/yr]	1,413	Total electrical consumption [kWh/yr]	6,020
Electrical energy cost [$/yr]	$684	Electrical use charge [$/yr]	$210	Total electrical use charge [$/yr]	$894
Electrical demand charge [$/yr]	$320	Electrical demand charge [$/yr]	$364	Total electrical demand charge [$/yr]	$684

Month	Heating Degree Days [HDD]	Current gross fossil energy consumption [MMBtu]	Current net space heat energy input [MMBtu]	Projected biomass boiler gross energy consumption [MMBtu]	Projected trim boiler energy consumption [MMBtu]	Projected wood fuel use [tons]
September	267	76	64	72	2	5.7
October	612	175	146	166	6	13.0
November	799	228	190	217	7	17.0
December	1,213	347	289	329	11	25.9
January	993	284	237	270	9	21.2
February	754	215	180	205	7	16.1
March	720	206	172	195	7	15.3
April	547	156	130	148	5	11.7
May	324	92	77	88	3	6.9
June	227	65	54	62	2	4.8
July	99	28	24	27	1	2.1
August	149	43	36	40	1	3.2
Yearly Total	6,704	1,915	1,599	1,819	61	143

* Low-fire output includes the use of a 1,000-gallon thermal storage to increase effective boiler turndown

Net fossil energy savings [MMBtu/yr]	1,853

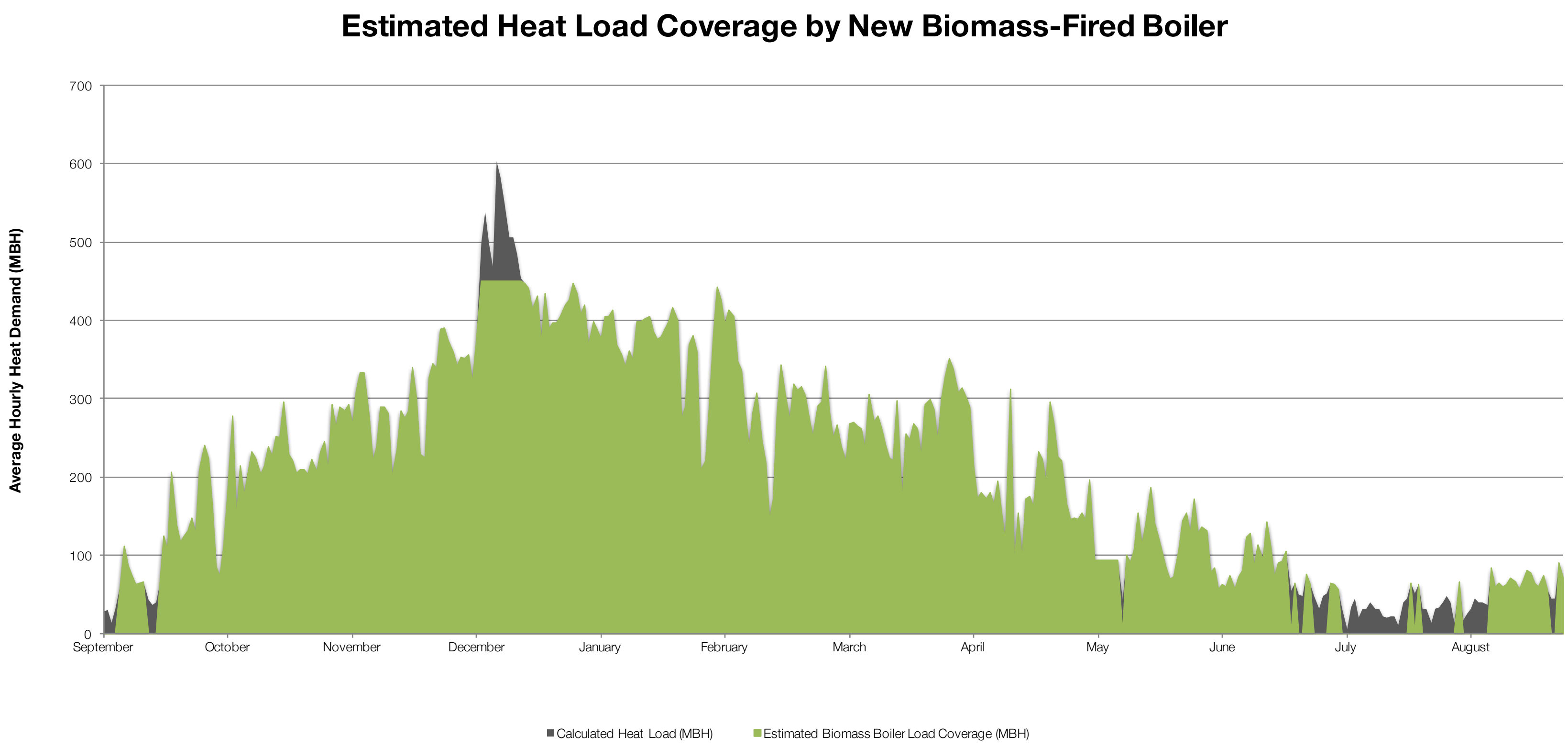
Plumas District Hospital

Proposed System Analysis

Location Quincy, CA
Client Contact Tiffany Leonhardt
Date 3/29/16

Proposed System Biomass Boiler Installation
Proposed System Output (MBH) 450
Proposed System Fuel Type Wood Chips

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



Plumas District Hospital

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Location Quincy, CA
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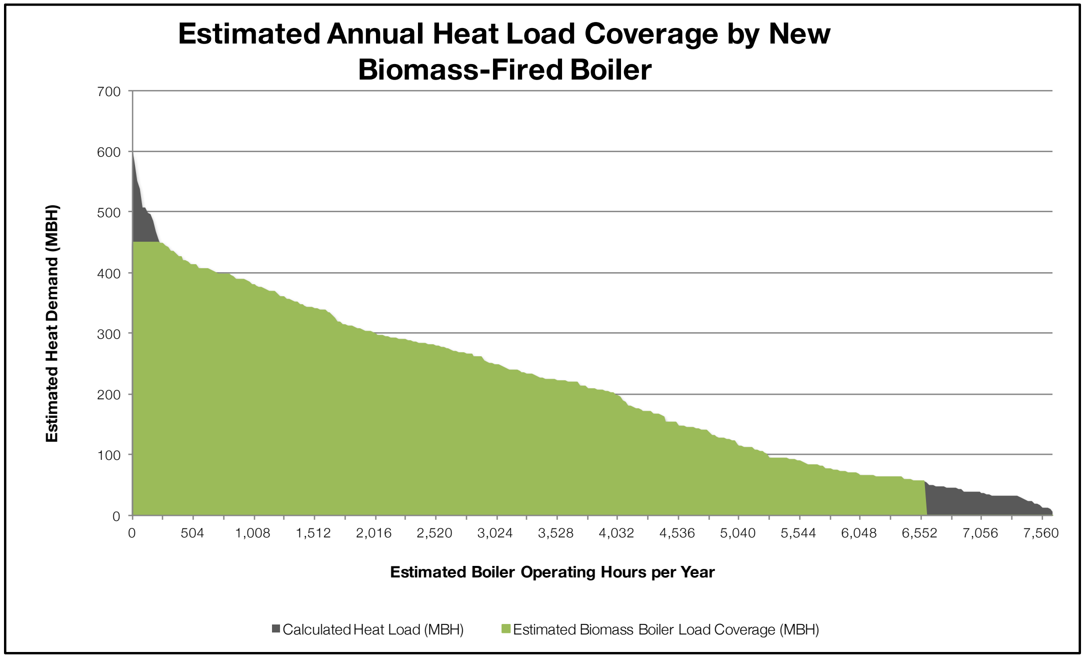

Boiler Output [MBH]	Fossil Fuel Displaced
50	22.9%
100	41.4%
150	56.8%
200	69.8%
250	80.7%
300	88.1%
350	92.9%
400	95.6%
450	96.7%
500	96.1%
550	95.4%
600	94.6%
650	94.0%
700	93.3%
750	92.7%
800	91.5%
850	91.1%
900	90.3%
950	89.8%
1,000	89.2%
1,050	88.3%
1,100	88.0%
1,150	87.0%
1,200	85.7%
1,250	84.7%

Appendix B
Site Map and Facility Photos

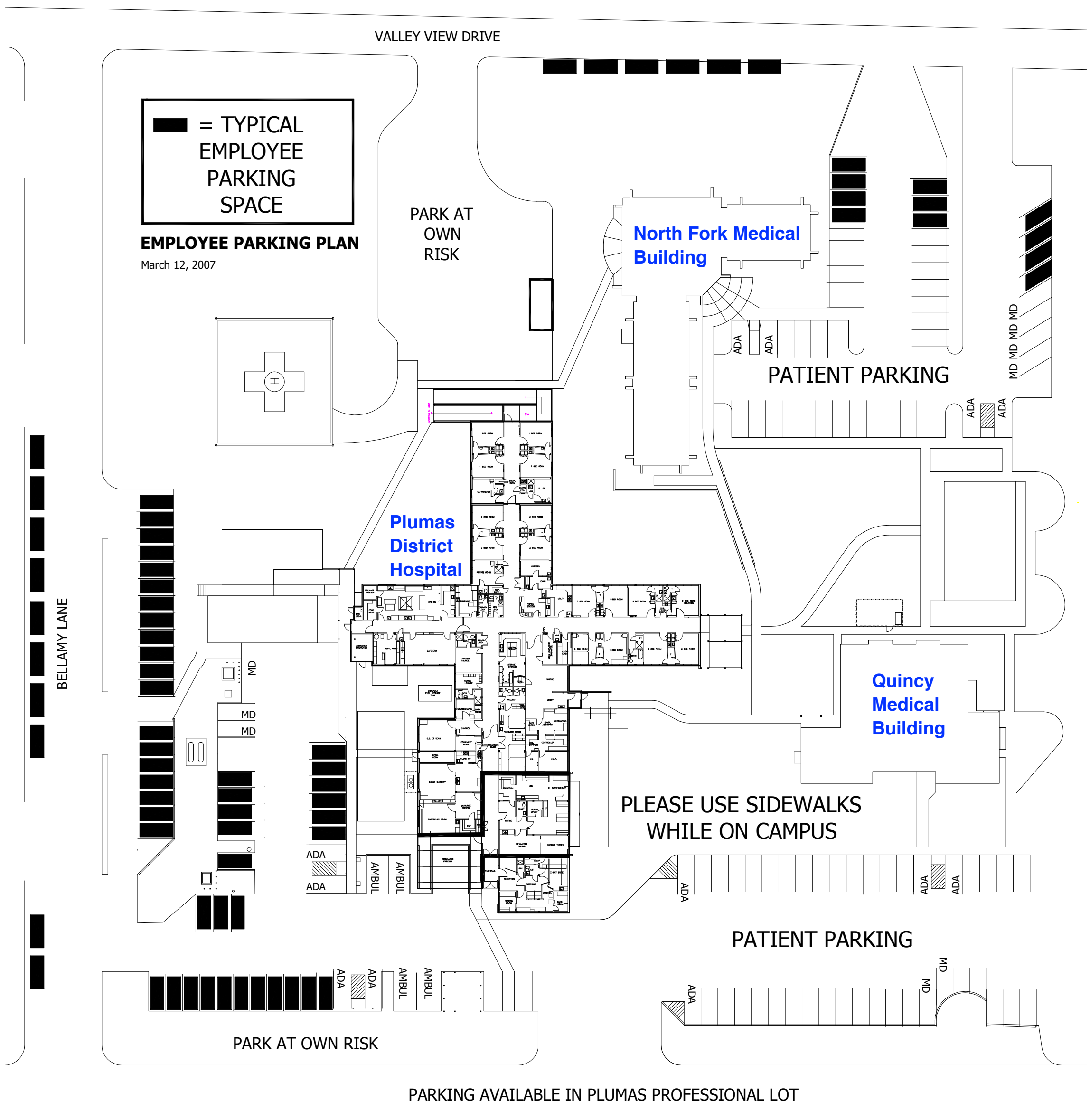
VALLEY VIEW DRIVE
= TYPICAL EMPLOYEE PARKING SPACE
EMPLOYEE PARKING PLAN
March 12, 2007
PARK AT OWN RISK
North Fork Medical Building
PATIENT PARKING
ADA
MD MD MD MD
Plumas District Hospital
BELLAMY LANE
MD
Quincy Medical Building
PLEASE USE SIDEWALKS WHILE ON CAMPUS
AMBUL
PATIENT PARKING
PARK AT OWN RISK
PARKING AVAILABLE IN PLUMAS PROFESSIONAL LOT

Photo 1 Carrier air conditioning unit on the rooftop of Plumas District Hospital.

Photo 2 Bryant propane furnace on the rooftop of Plumas District Hospital.

Photo 3 Propane furnace and air handler on the rooftop of Plumas District Hospital.

Photo 4 Rooftop ducting at Plumas District Hospital.

Photo 5 Bryan propane-fired hot water boiler in the Quincy Medical Building.

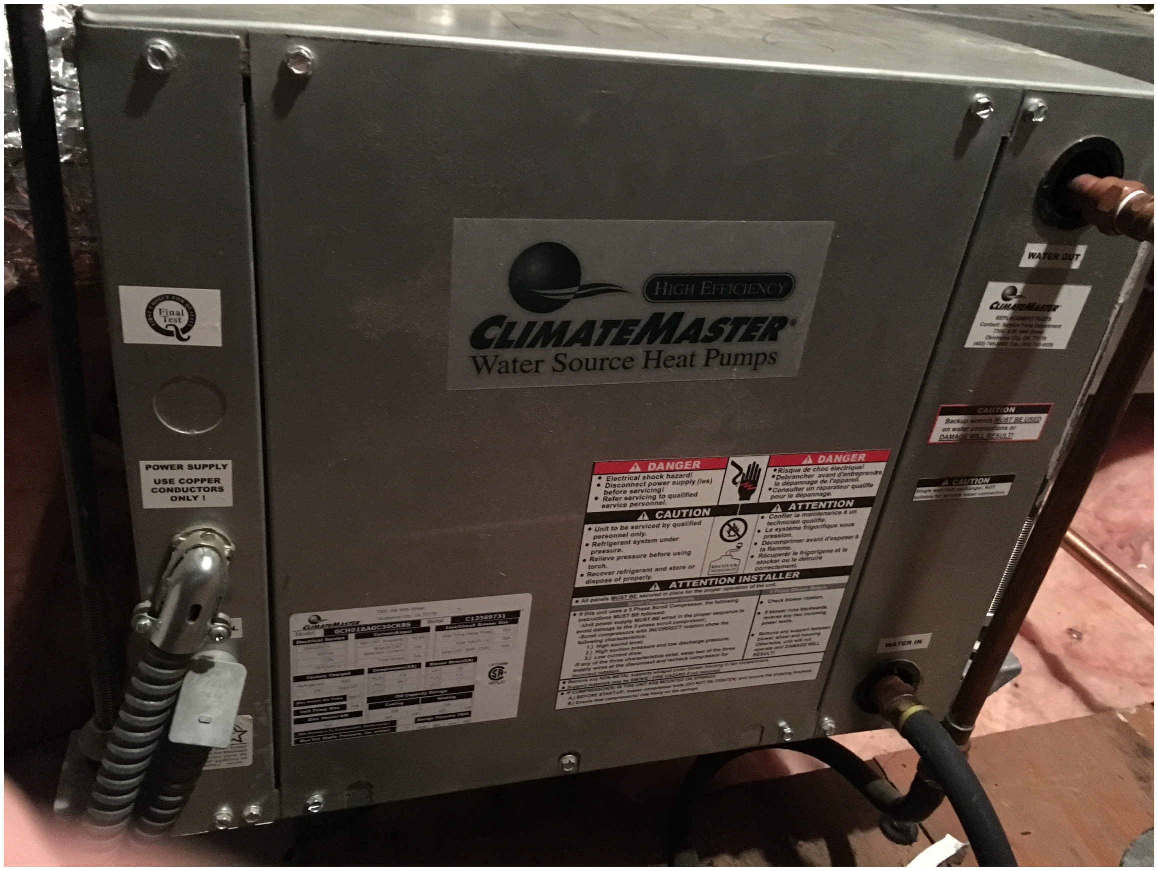

Photo 6 A Climate Master water-source heat pump in the Quincy Medical Building.

Appendix C
Summary Capital Cost Estimate

Plumas District Hospital

Proposed Boiler Cost Summary

Location	Quincy, CA	**Proposed System**	Biomass Boiler Installation	**Contact**	Andrew Haden
Client Contact	Tiffany Leonhardt	**Proposed System Output (MBH)**	450	**Phone**	(503) 706-6187
Date	3/29/16	**Proposed System Fuel Type**	Wood Chips	**Email**	andrew@wisewood.us

Item Description	Line Total	% Total Project
Construction Costs		
Civil/Structural	$ 35,000	3.5%
Mechanical Installation	$ 450,000	45.9%
Electrical	$ 73,000	7.4%
Permitting	$ 5,000	0.5%
Miscellaneous	$ 10,000	1.0%
Contingency and Unlisted Items	$ 114,000	11.7%
Subtotal Direct Costs	**$ 686,000**	**70.0%**
General Contractor Costs	$ 137,000	14.0%
Subtotal Construction Costs	**$ 824,000**	**84.0%**
Engineering, Commissioning and Management Costs		
Engineering, Procurement and Construction Mgmt.	$ 115,000	11.8%
Finance & Administration	$ 41,000	4.2%
Subtotal Development Costs	**$ 157,000**	**16.0%**
Total Project Costs	**$ 980,000**	**100%**

Labor Rates	$/Hour
Mechanical Contractor	$ 75
Electrician	$ 85
Engineering and Project Management	$ 125
Finance and Accounting	$ 200

Appendix D
Stabilized Year Operating Costs

Plumas District Hospital

Stabilized Year Operating Costs

Location	Quincy, CA	**Proposed System**	Biomass Boiler Installation	**Contact**	Andrew Haden
Client Contact	Tiffany Leonhardt	**Proposed System Output (MBH)**	450	**Phone**	(503) 706-6187
Date	3/29/16	**Proposed System Fuel Type**	Wood Chips	**Email**	andrew@wisewood.us

Item						Total
Existing Fossil Fuel Heating System Operating Cost						
Propane Fuel						
Current propane consumption		13,741	gallons per year			
Current propane cost	$	1.86	per gallon			
				Subtotal:	$	25,583
Electricity						
Current electricity for heating consumption		190,664	kWh per year			
Current electricity for heating demand		43	kW			
Current ancillary electrical use		2,330	kWh per year			
Current ancillary electrical demand		0.304	kW			
Electricity cost	$	0.15	per kWh			
Electrical demand cost	$	20.23	per kW			
				Subtotal:	$	39,274
Maintenance						
Maintenance labor	$	4,000	per year			
Maintenance parts	$	1,000	per year			
				Subtotal:	$	5,000
Existing Boiler Cost, Total					**$**	**69,858**
Proposed Biomass Energy System Operating and Maintenance Cost						
Wood Fuel						
Wood use		143	tons per year			
Wood fuel cost	$	70	per ton			
				Subtotal:	$	10,002
Electricity to Run Boiler						
Total electrical consumption		6,020	kWh			
Total electrical use charge	$	894	per year			
Total electrical demand charge	$	684	per year			
				Subtotal:	$	1,578
Remaining Propane						
Propane use (peak and low load)		668	gallons			
Propane cost	$	1.86	per gallon			
				Subtotal:	$	1,244
New Biomass System Fuel Cost, Total					$	12,825

Ash Disposal					
Ash container removal		34	intervals		
Labor for ash container removal	$	15	per interval		
Ash disposal fee	$	5	per interval		
			Subtotal:	$	680
Weekly Maintenance					
Weekly boiler checklist		40	weeks		
Labor cost	$	50	per week		
			Subtotal:	$	2,000
Monthly Maintenance					
Monthly boiler checklist		12	months		
Labor cost	$	200	per month		
			Subtotal:	$	2,400
Remote Monitoring					
Remote monitoring		12	months per year		
Static IP and Internet connection	$	60	per month		
			Subtotal:	$	720
Wood Fuel Handling & Delivery					
Handling and transportation		143	tons per year		
Tons per delivery container		6.8	tons per load		
Fuel deliveries needed		21	loads per year		
Cost to load container	$	45	per load		
Delivery segments (one way trip)		2	per delivery		
Total delivery segments		42	segments		
Transportation cost	$	45	per segment		
			Subtotal:	$	2,837
Replacement Reserves					
Annual repairs/reserves budget	$	1,000	per year		
			Subtotal:	$	1,000
Administration					
Insurance		0.10%	of Project Cost		
			Subtotal:	$	980
New Biomass System Operations and Maintenance Costs, Total				$	10,617
New Biomass System Cost, Total				**$**	**23,442**
Operating Costs Savings with Biomass				**$**	**46,416**

*The Stabilized Year budget shown above does not account for any possible cost of personnel to manage fuel procurement.

Appendix E
25-Year Economic Pro Forma

Plumas District Hospital

25-Year Operating Pro Forma

Location Quincy, CA
Client Contact Tiffany Leonhardt
Date 3/29/16

Proposed System Biomass Boiler Installation
Proposed System Output (MBH) 450
Proposed System Fuel Type Wood Chips

***Fossil Fuel Escalator** 4.0%
****Wood/Electricity/Labor Escalator** 2.0%

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

	Year 1	2	3	4	5	6	7	8	9	10	15	20	25
Existing Heating System Operating Costs													
Existing Fuel Cost													
Existing Fossil Fuel Cost*	$ 25,583	$ 26,607	$ 27,671	$ 28,778	$ 29,929	$ 31,126	$ 32,371	$ 33,666	$ 35,013	$ 36,413	$ 44,302	$ 53,900	$ 65,578
Existing Electricity Cost**	$ 39,274	$ 40,060	$ 40,861	$ 41,678	$ 42,512	$ 43,362	$ 44,229	$ 45,114	$ 46,016	$ 46,937	$ 51,822	$ 57,215	$ 63,171
Operations and Maintenance													
Operations & Maintenance Cost**	$ 5,000	$ 5,100	$ 5,202	$ 5,306	$ 5,412	$ 5,520	$ 5,631	$ 5,743	$ 5,858	$ 5,975	$ 6,597	$ 7,284	$ 8,042
Total Existing Heating Costs	**$ 69,858**	**$ 71,767**	**$ 73,734**	**$ 75,762**	**$ 77,853**	**$ 80,009**	**$ 82,231**	**$ 84,523**	**$ 86,887**	**$ 89,325**	**$ 102,721**	**$ 118,400**	**$ 136,791**
Proposed Heating System Operating Costs													
Proposed Fuel Cost													
Trim Fuel (Peak and Low Load)*	$ 1,244	$ 1,294	$ 1,346	$ 1,400	$ 1,456	$ 1,514	$ 1,575	$ 1,638	$ 1,703	$ 1,771	$ 2,155	$ 2,622	$ 3,190
Wood Fuel**	$ 10,002	$ 10,203	$ 10,407	$ 10,615	$ 10,827	$ 11,044	$ 11,264	$ 11,490	$ 11,720	$ 11,954	$ 13,198	$ 14,572	$ 16,088
Electricity (Boiler Controls)**	$ 1,578	$ 1,610	$ 1,642	$ 1,675	$ 1,708	$ 1,742	$ 1,777	$ 1,813	$ 1,849	$ 1,886	$ 2,082	$ 2,299	$ 2,538
Subtotal Fuel Costs	$ 12,825	$ 13,106	$ 13,394	$ 13,689	$ 13,991	$ 14,300	$ 14,616	$ 14,940	$ 15,272	$ 15,611	$ 17,435	$ 19,492	$ 21,816
Operations and Maintenance													
Parts and Labor**	$ 8,637	$ 8,810	$ 8,986	$ 9,165	$ 9,349	$ 9,536	$ 9,726	$ 9,921	$ 10,119	$ 10,322	$ 11,396	$ 12,582	$ 13,892
Refractory Replacement	$ 1,000	$ 1,000	$ 1,000	$ 1,000	$ 1,000	$ 1,000	$ 1,000	$ 1,000	$ 1,000	$ 1,000	$ 1,000	$ 1,000	$ 1,000
Accounting**	$ 980	$ 1,000	$ 1,020	$ 1,040	$ 1,061	$ 1,082	$ 1,104	$ 1,126	$ 1,149	$ 1,172	$ 1,293	$ 1,428	$ 1,577
Subtotal O&M Costs	$ 10,617	$ 10,809	$ 11,006	$ 11,206	$ 11,410	$ 11,618	$ 11,830	$ 12,047	$ 12,268	$ 12,493	$ 13,690	$ 15,010	$ 16,469
Total Proposed Heating Costs	**$ 23,442**	**$ 23,916**	**$ 24,400**	**$ 24,895**	**$ 25,401**	**$ 25,918**	**$ 26,447**	**$ 26,987**	**$ 27,540**	**$ 28,104**	**$ 31,125**	**$ 34,503**	**$ 38,285**
Biomass Energy Savings	$ 46,416	$ 47,851	$ 49,334	$ 50,867	$ 52,452	$ 54,091	$ 55,785	$ 57,536	$ 59,348	$ 61,221	$ 71,596	$ 83,897	$ 98,506
Cumulative Cash Savings	$ 46,416	$ 94,266	$ 143,601	$ 194,468	$ 246,920	$ 301,011	$ 356,795	$ 414,332	$ 473,679	$ 534,900	$ 871,429	$ 1,265,471	$ 1,727,773