Feasibility of Biomass Energy for Gyppo Ale Mill

Humboldt County, CA

July 2014

Prepared for:

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1 Introduction

The Gyppo Ale Mill contracted with Wisewood to analyze the potential cost savings associated with utilizing woody biomass to generate thermal energy in its planned brewing operations in Humboldt County, California. The brewery is not connected to the natural gas grid, and is therefore seeking ways to provide process heat needs from energy sources other than expensive propane and electricity.

The goals of the study were as follows:

1) to understand whether biomass could be utilized effectively as an energy source at the brewery;
2) to understand the amount of biomass needed for the brewing process; and
3) to properly size a biomass boiler system for the brewery.

2 The Brewing Process

The first step in creating a conceptual design for the Gyppo Ale Mill was to understand the amount of energy needed in the brew process and to understand the periodicity of this energy use. Paul Arney of the Ale Apothecary in Bend, OR, (http://www.thealeapothecary.com/) created an overview of the water and energy needs of a small 15-barrel (bbl) brewery that Wisewood used to generate an energy consumption model for the brewing process to model the anticipated energy needs of the brewery during the course of three stages of the brewery's potential growth (see Appendix C). The brewery energy consumption varies according to the brew schedule, provided by Paul Arney:

Table 1. Target typical brewery operations by week

YEAR ONE	(1) 15 bbl brew, (1) 15 bbl fermentation, (1) Kettle/heat ex Clean-In-Place (CIP), (1) 15 bbl FV CIP, (1) 15 bbl SV CIP, (1) beer transfer
YEAR TWO	(3) 15 bbl brews, (1) 15 bbl fermentation, (1) 30 bbl fermentation, (2) Kettle/heat ex CIP, (1) 15 bbl FV CIP, (1) 30 bbl FV CIP, (2) 15 bbl SV CIP, (2) beer transfers, kegging operations
FULL THROTTLE	(12) 15 bbl brews, (2) 15 bbl fermentations, (5) 30 bbl fermentations, (5) Kettle/heat ex CIP, (2) 15 bbl FV CIP, (5) 30 bbl FV CIP, (7) beer transfers, kegging and bottling operations

Terms used:

- FV = Fermentation Vessel
- SV = Serving Vessel
- BBL = Barrel = 31 Gallons
- CIP = Clean-In-Place

2.1 Restaurant Space and Hot Water Heating

The restaurant area is compact and structurally open to the brewery portion of the building, and is thus anticipated to generally require cooling energy, given the mild climate of Humboldt County. If substantial supplemental heat were required, it would be simple to add one or more hydronic unit heaters that can be fueled from the boiler system, or to choose Rooftop Packaged Unit heaters that can make use of hydronic heating coils, as opposed to propane-fired furnaces or heat pumps. Similarly, the hot water use for the restaurant kitchen and bathrooms will be small in comparison to the overall use of energy in the brewing process, and should be able to be supplied by a small, indirect-fired hot water tank heated by boiler water and located at the point of use.

2.2 Steam and Hot Water Use for Brewing

In the brewing process, there is a need for both hot water and steam. Wisewood explored the possibility of implementing a biomass boiler to produce steam for the entire brew process versus implementing a biomass boiler system to supply only hot water, but quickly determined that the short duration of the steam demand during a brewing cycle was insufficient to justify the added cost and complexity of installing a biomass-fired steam boiler for the brewery.

Because a steam boiler of the size needed for the brewery could be 2-3 times the cost of a hot water-only boiler and would only offset a small additional portion of the overall energy needs, Wisewood focused on a hot water boiler only and assumed that all steam production will be left to a small, standalone steam boiler dedicated to this purpose, or by selecting propane-fired kettles. Furthermore, Wisewood determined that there was a sufficient amount of hot water demand for the remaining brewing processes to warrant pursuing a wood-fired hot water generation system for the brewery. The energy model presented in Section 2.4 illustrates this.

2.3 Energy Consumption for Brewing

Wisewood used the brew schedule provided to model the estimated energy consumption of the system. There is an interesting dynamic in the efficiency of the brewing process that is described well below (substituting “energy” for “natural gas” will make the statement more applicable to Gyppo Ale Mill):

> *“One of the complicating factors of estimating natural gas usage in the brewing process is that it can vary from cycle to cycle. When wort is cooled after boiling, it exchanges heat with incoming city water. The cooled wort continues to a FV at approximately 72 degF, and the newly heated water proceeds to the HLT at approximately 150 degF. If another batch of beer is brewed soon thereafter, a large quantity of pre-heated hot water is available. If several days pass, this hot water will have cooled, and will have to be reheated by the boiler. Therefore, the*

> *amount of gas actually used in each batch varies, depending on the amount of hot water made available from the previous brew."*[1]

In order to capture this dynamic, Wisewood created three energy consumption models based on the estimated amount of energy needed to complete the provided weekly brew schedule. These weekly schedules were extrapolated to an annual schedule for analyzing cumulative energy demand and financial paybacks.

Table 2 outlines the hot water and energy needs and frequency of brewing processes that were modeled on a weekly basis for each of the yearly scenarios. The "knock-out" is a process by which hot water can be recaptured from the brew kettle and used for subsequent processes. This can save energy if the brew processes follow in close enough succession that the heat energy recovered in the hot liquor tank does not dissipate before the next brewing cycle commences.

Table 2. Hot Water and Energy Needs and Frequency of Brewing Processes

Process Name	Hot Water Needed (gal)	Temp (°F)	Energy Demand (Btu)	Estimated Drawdown Time (min)	Frequency
Mash	560	175	583,800	60	Every Brew
Sparge	840	170	840,672	30	Every Brew
Kettle CIP	105	150	87,570	30	Every Brew
FV-15 CIP	105	150	87,570	30	Every Brew
FV-30 CIP	105	150	87,570	30	Every Brew
SV-15 CIP	105	150	87,570	30	Every Other Brew
Prop Tank CIP	60	150	50,040	30	Monthly
Storage Tank CIP	60	150	50,040	30	Monthly
Mash CIP	105	150	87,570	30	Monthly
Knock-Out (recovered HW)	560	170	560,448	60[2]	Every Brew, Full Throttle

2.4 Wood Energy Consumption for Brewing

Due to the batch nature of the brew process and the relatively small heat demand of the brewery (in comparison to institutional or industrial boiler systems), Wisewood initially modeled the use of cordwood in a modern, high efficiency cordwood boiler (50 kW output) as the basis of the wood consumption estimates. A small electric

[1] Bennett, J. et al. 2010. The Green Brewery Project. MS Thesis, University of Michigan. http://deepblue.lib.umich.edu/bitstream/handle/2027.42/83664/The_Green_Brewery_Project.pdf?sequence=1

[2] Knock-out represents hot water recovery from the brewing process, but is available only when brewing proceeds consecutively, at least daily.

boiler is also included in the model (12 kW output). Based on the brew schedule provided, Wisewood modeled the estimated consumption of wood and electricity annually. Wisewood modeled a 1,600-gallon hot water tank that would be charged by the wood boiler during brew cycles and would receive the recovered thermal energy from the knock-out.

At the request of Gyppo Ale, Wisewood also modeled a modern pellet boiler, which would enable bulk delivery of fuel and allow for unmanned operation, minimizing on-site labor. The major difference between the two systems is that a slightly larger 60 kW pellet boiler was modeled, which due to its increased output and automatic firing capability could reduce the amount of thermal energy storage required by 25%. We also add a wood pellet storage silo capable of holding approximately 25 tons of wood pellets.

In Tables 3, 4 and 5 below, the "wood boiler firings" figures are only relevant to cordwood, as the pellet boiler would fire automatically as required by system controls. The use of the pellet boiler coupled with less heat storage slightly modifies the energy model. The pellet boiler model outputs are shown in Appendix B.

2.4.1 Year 1 Weekly Energy Use

Year 1 represents the start-up period for the brewery and as such, only a single brew per week was modeled. Because the brewery is not running at full output, the ability to recapture the heat from the knock-out is limited. Also, because there are long periods between brews, there is a significant amount of electrical energy need to keep the tank in a ready state. This could be lessened by only keeping one small hot water tank hot at all times. Table 3 lists the weekly, monthly, and annual energy use expected in Year 1.

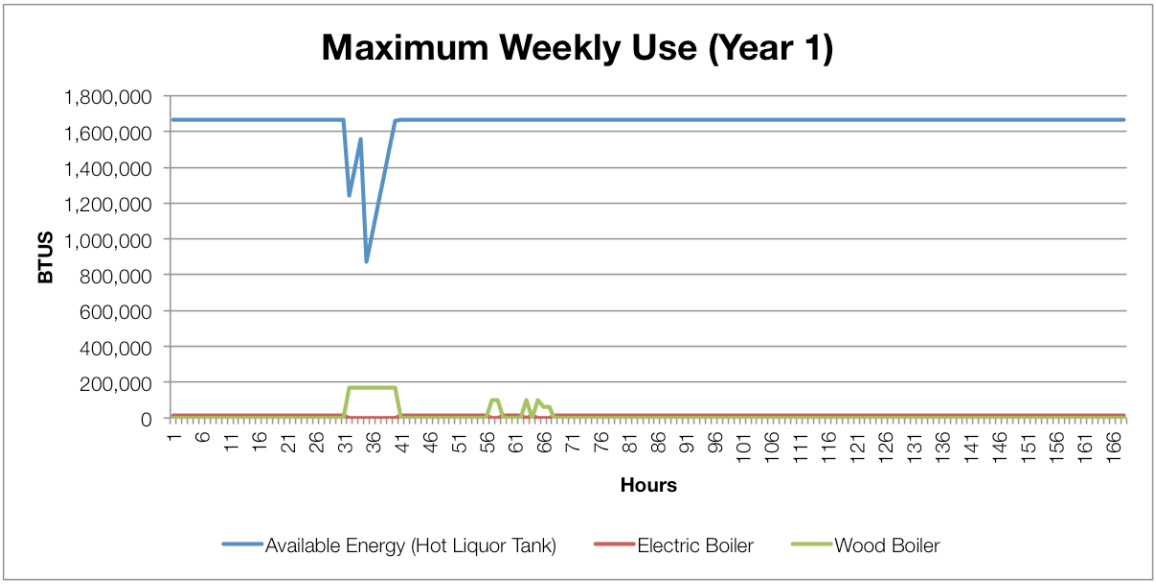
Figure 1 below shows how the cordwood boiler is fired to cover for the unloading of the hot water tanks (which hold approximately 1,600,000 Btu when at 175°F) during the brewing process. The electric boiler is on at a low level (~4 kW) to maintain tank temperature.

Table 3. Estimated Energy Use, Year 1 - (1) 15 BBL Brew per Week – Cordwood

Year 1	Weekly	Monthly	Annually
Energy use, Btu	4,108,356.0	17,255,095.2	207,061,142.4
Energy use, kWhr	1,204.1	5,057.2	60,686.1
Wood energy use, Btu	2,066,724.0	8,680,240.8	104,162,889.6
Electrical energy use, Btu	2,041,632.0	8,574,854.4	102,898,252.8
Wood consumption, lbs	303.9	1,276.5	15,318.1
Wood consumption, tons	0.2	0.6	7.7

Wood boiler firings	2.1	8.6	103.5
Offset Electricity, kWh	605.7	2,544.0	30,528.4
Remaining Electricity, kWh	598.4	2,513.1	30,157.8

Figure 1. Estimated Energy Use, Year 1 - (1) 15 BBL Brew per Week – Cordwood



2.4.2 Year 2 Weekly Energy Use

Year 2 represents a growth period for the brewery and as such, three brewing cycles per week are modeled. The increase in the brewing frequency also increases the total proportion of wood energy that can be productively used, offsetting an equivalent amount of electrical energy.

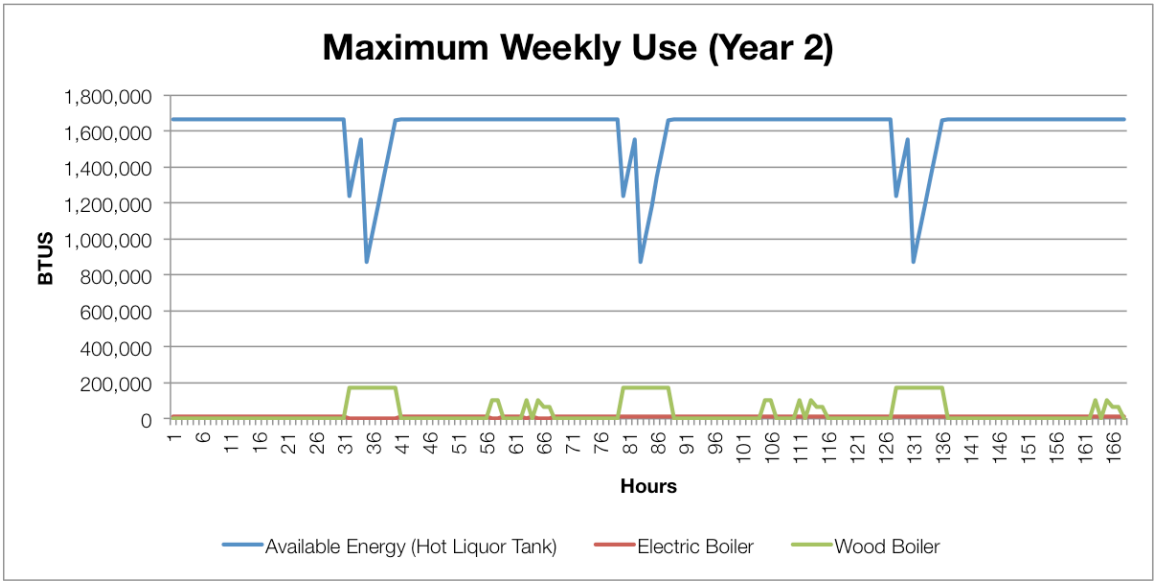
Table 4 lists the weekly, monthly, and annual energy use expected in Year 2. Figure 2 shows how the cordwood boiler is fired during the brewing process.

Table 4. Estimated Energy Use, Year 2 - (3) 15 BBL Brew per Week – Cordwood

Year 2	**Weekly**	**Monthly**	**Annually**
Energy use, Btu	7,666,344.0	32,198,644.8	386,383,737.6
Energy use, kWhr	2,246.9	9,436.9	113,242.6
Wood energy use, Btu	5,998,344.0	25,193,044.8	302,316,537.6
Electrical energy use, Btu	1,668,000.0	7,005,600.0	84,067,200.0
Wood consumption, lbs	882.1	3,704.9	44,458.3
Wood consumption, tons	0.4	1.9	22.2

Wood boiler firings	6.0	25.0	300.4
Offset Electricity, kWh	1,758.0	7,383.7	88,603.9
Remaining Electricity, kWh	488.9	2,053.2	24,638.7

Figure 2. Estimated Energy Use, Year 1 - (3) 15 BBL Brew per Week - Cordwood



2.4.3 Year 3 Weekly Energy Use, or Full Throttle

Year 3 represents the brewery at full throttle, brewing 12 times per week. In this scenario the brewing process could then make use of the energy recovered during knock-out. Even with the knock-out, the full capacity of the wood boiler (170 MBH or 50 kW) would be required to keep up with the hot water demands of the brewing process.

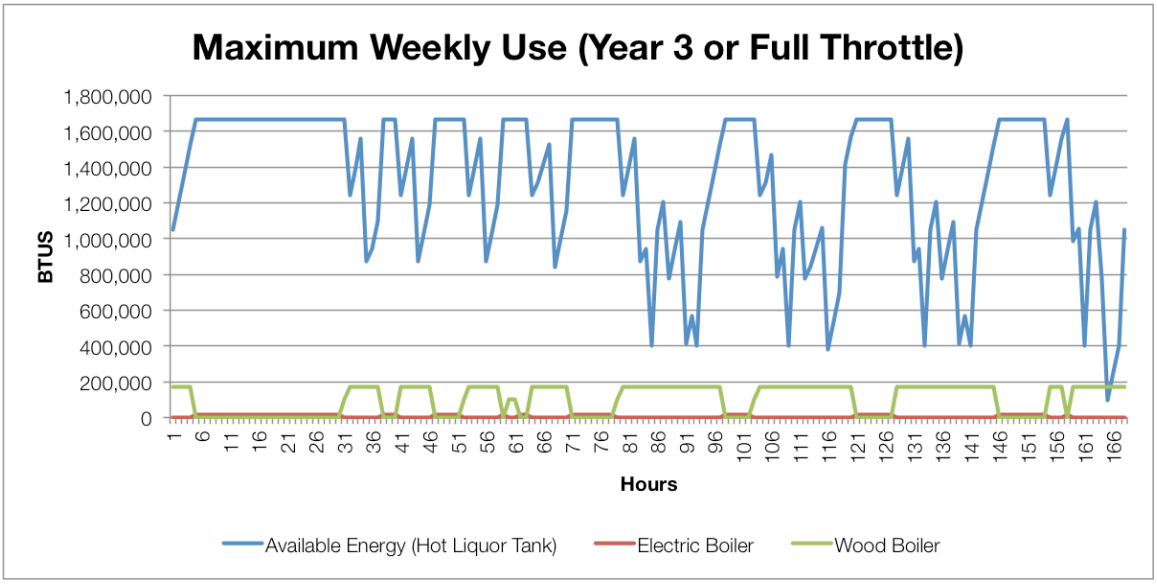
Table 5 lists the weekly, monthly, and annual energy use expected in Year 3. Figure 3 shows how the cordwood boiler is fired during the brewing process.

Table 5. Estimated Energy Use, Year 3 - (12) 15 BBL Brew per Week – Cordwood

Year 3	Weekly	Monthly	Annually
Energy use, Btu	17,716,032.0	74,407,334.4	892,888,012.8
Energy use, kWhr	5,192.3	21,807.5	261,690.5
Wood energy use, Btu	16,821,984.0	70,652,332.8	847,827,993.6
Electrical energy use, Btu	894,048.0	3,755,001.6	45,060,019.2
Wood consumption, lbs	2,473.8	10,390.0	124,680.6

Wood consumption, tons	1.2	5.2	62.3
Wood boiler firings	16.7	70.2	842.4
Offset Electricity, kWh	4,930.2	20,707.0	248,484.2
Remaining Electricity, kWh	262.0	1,100.5	13,206.3

Figure 3. Estimated Energy Use, Year 3 - (12) 15 BBL Brew per Week – Cordwood



3 Wood-Fired Boiler Systems

3.1 Cordwood Boiler

Using the requirements of the Year 3 scenario as a guide for system sizing, Gyppo Ale Mill could utilize a 50 kW (170 MBH) cordwood boiler to provide all necessary energy for the hot water needs of the facility for brewing: mashing, sparging, and clean-in-place (CIP) for all brewing scenarios up to “full throttle”, meaning brewing twelve (12) 15-barrel batches per year.

Wisewood selected cordwood fuel for the basis of conceptual design because there is no local pellet mill near Humboldt County, and the purpose of the statewide wood energy team is to foster local wood energy use. Modern, high-efficiency cordwood boilers exist could satisfy the demand of the facility and do so with low emissions. Backup and standby heating with electricity could be provided by a small electric boiler rated at 12-20 KW.

Figure 4. A typical modern, high-efficiency cordwood boiler installation
(Source: www.woodboilers.com)

3.2 Pellet Boiler

Using the requirements of the Year 3 scenario as a guide for system sizing, Gyppo Ale Mill would could utilize a 60 kW (200 MBH) wood pellet boiler to provide all necessary energy for the hot water needs of the facility for brewing: mashing, sparging, and clean-in-place (CIP) for all brewing scenarios up to “full throttle”, meaning brewing twelve (12) 15-barrel batches per year. A modern wood pellet boiler can respond to heat demand automatically and can run unattended for months on end before needing to be cleaned.

3.3 Cost Estimates

The cordwood boiler cost estimate includes all of the labor, materials and management needed to implement the conceptual design, as well as the cordwood boiler, four (4) 400-gallon hot water tanks and all necessary pumps, heat exchangers, etc., to create hot water for the brewing process. Plumbing, sewer and power connections are assumed to be included in the overall cost of the new

facility. The total cost of the system is estimated at $89,000. One simple cost saving measure could be to add hot water tanks in 400-gallon increments as the brewery grows, starting with two tanks and installing additional tanks as needed.

The wood pellet boiler cost estimate includes all of the items included in the cordwood estimate, but instead includes a pellet boiler (approximately double the cost of the cordwood unit) and adds a 25-ton silo (including all necessary structural concrete, etc.). The total cost of the installation is estimated at $141,000.

Both cost estimates include 15% construction contingency and 5% unlisted parts allowance, which combined account for 12.8% of the total project cost.

3.4 Financial Calculations

Detailed financial calculations are provided in Appendix A, and indicate the following simple paybacks when brewing is modeled to operate at the maximum weekly use into the future:

- Year 1 model: 31.3 years
- Year 2 model: 11.1 years
- Year 3 model: 3.9 years

The energy prices used to calculate the payback are as follows:

- Cordwood $200/cord ($7.66/MMBtu)
- Electricity $0.12/kWhr ($35.17/MMBtu)
- Propane $2.60 per gallon ($28.42/MMBtu)

This indicates that only after the brewery is operating at a capacity that is greater than three brews per week does the investment in a cordwood boiler start to make economic sense. If the brewery reaches its full output, the annual savings can be as high as $22,000, which would allow the capital cost to be paid off in less than four years (the simple payback of 3.9 years listed above at a Year 3 level of operations).

4 Recommendations

Given that the financial performance of an investment in a biomass energy system is highly variable depending on the brewing schedule, the decision to choose wood energy is likely to be based significantly on the rate at which the Gyppo Ale Mill team plans on ramping up beer production. If the brewery stays at a level of output equivalent to 1-3 brews per week, it is likely not worth the investment. If the brewery increases output to a frequency greater than this, the investment could pay off quite well.

Appendix A: Financial Calculations for Cordwood

Gyppo Ale Mill

Project Costs - Summary

System	Wood-Fired Process Hot Water	**Orig. Date**	05-May-14	**Contact**	Andrew Haden
Boiler Output	170 MBH	**Rev. Date**	11-Jul-14	**Phone**	(503) 706-6187
Fuel Type	Cordwood	**Version**	1.0.0	**Email**	andrew@wisewood.us

Item Description	Est. Hours	Install Equipment	Install Materials	Install Labor	Line Total	% Total Project
CONSTRUCTION COSTS						
Civil/Structural	16	$ -	$ -	$ 1,000	$ 1,000	1.3%
Mechanical	176	$ -	$ 35,000	$ 13,000	$ 48,000	54.1%
Electrical	24	$ -	$ 2,000	$ 2,000	$ 4,000	4.5%
Permitting	0	$ -	$ -	$ -	$ 1,000	0.6%
Miscellaneous	0	$ -	$ -	$ -	$ 3,000	3.4%
Subtotal Direct Costs	216	$ -	$ 37,000	$ 16,000	$ 57,000	63.9%
Contingency and Unlisted Items - Direct Costs					$ 11,000	12.8%
General Contractor Costs					$ 7,000	7.7%
Subtotal Construction Costs					$ 75,000	84.4%
DEVELOPMENT COSTS						
Engineering, Procurement and Construction Management Services					$ 14,000	15.6%
Subtotal Development Costs					$ 14,000	15.6%
TOTAL PROJECT COST					**$ 89,000**	**100.0%**

Return on Investment Calculations

Proforma Project Financial Statement

(1) 15 BBL Brew per Week

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

Project Gyppo Ale Mill
Location Humboldt County., CA
Contact Julie Peacock
Date 7/11/14

System Wood-Fired Process Hot Water
Boiler Output (MBH) 170
Fuel Type Cordwood
Workbook Version 1.0.0

DEBT SERVICE		
Total Installation Cost		$ 89,000
Grants	0%	$ -
Financed Amount		$ 89,000
Debt Leverage		0.0%
Project Equity		100.0%
Loan Amount		$ -
Amount of Equity		$ 89,000
Annual Rate		5.0%
Term (Years)		15.00

FUEL COSTS	Fossil Fuel	Wood	Electricity
Unit	(mmBtu)	(mmBtu)	(kWhr)
Cost per unit	$28.42	$7.66	$0.12
Escala. Rate	3.0%	1.5%	2.0%

FUEL LABOR	Labor		Electricity
Fueling intervals	103.5	Max. electrical draw (kW)	0.2
lbs/interval	148.0	Average draw (kW)	0.2
Labor (hrs/per)	0.25	Annual use (kWhr)	382
$/hr	$20	Annual el. cost, wood boiler	$46
hrs/yr	25.88	Oil boiler, blower, kW	0.5
Total/yr	$129.38	Oil boiler, elec. kWh	$0

30 YR ACCUMULATED CASH FLOW	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 15	Year 20	Year 25	Year 30
EXISTING HEATING SYSTEM OPERATING COSTS														
Projected Electricity Use, BAU	$ 7,282	$ 7,501	$ 7,726	$ 7,958	$ 8,196	$ 8,442	$ 8,695	$ 8,956	$ 9,225	$ 9,502	$ 11,015	$ 12,770	$ 14,803	$ 17,161
Maintenance Cost, BAU	$ 150	$ 153	$ 156	$ 159	$ 162	$ 166	$ 169	$ 172	$ 176	$ 179	$ 198	$ 219	$ 241	$ 266
TOTAL	**$ 7,432**	**$ 7,654**	**$ 7,882**	**$ 8,117**	**$ 8,359**	**$ 8,608**	**$ 8,864**	**$ 9,129**	**$ 9,401**	**$ 9,681**	**$ 10,573**	**$ 12,988**	**$ 15,045**	**$ 17,428**
PROPOSED HEATING SYSTEM OPERATING COSTS														
Electricity Use, Backup	$ 3,619	$ 3,727	$ 3,839	$ 3,955	$ 4,073	$ 4,195	$ 4,321	$ 4,451	$ 4,584	$ 4,722	$ 5,474	$ 6,346	$ 7,357	$ 8,528
Wood Fuel	$ 798	$ 810	$ 822	$ 834	$ 847	$ 859	$ 872	$ 885	$ 899	$ 912	$ 983	$ 1,059	$ 1,140	$ 1,229
Fueling Labor	$ 129	$ 132	$ 135	$ 137	$ 140	$ 143	$ 146	$ 149	$ 152	$ 155	$ 171	$ 188	$ 208	$ 230
Wood Boiler Electrical Cost	$ 46	$ 47	$ 48	$ 49	$ 50	$ 51	$ 52	$ 53	$ 54	$ 55	$ 61	$ 67	$ 74	$ 81
TOTAL	**$ 4,592**	**$ 4,716**	**$ 4,844**	**$ 4,975**	**$ 5,110**	**$ 5,248**	**$ 5,391**	**$ 5,538**	**$ 5,688**	**$ 5,844**	**$ 6,688**	**$ 7,660**	**$ 8,779**	**$ 10,068**
PROJECT RELATED DEBT														
Beginning Principal Balance	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Principal Repayments	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Interest Payments	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Ending Principal Balance	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
TOTAL DEBT PAYMENT	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**
ANNUAL OPERATING COST SAVINGS (LOSS)	**$ 2,840**	**$ 2,938**	**$ 3,038**	**$ 3,142**	**$ 3,249**	**$ 3,360**	**$ 3,473**	**$ 3,591**	**$ 3,712**	**$ 3,838**	**$ 4,525**	**$ 5,328**	**$ 6,266**	**$ 7,360**
Cash Investment (equity)	$ (89,000)	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -				
Income (cost savings)	$ 2,840	$ 2,938	$ 3,038	$ 3,142	$ 3,249	$ 3,360	$ 3,473	$ 3,591	$ 3,712	$ 3,838	$ 4,525	$ 5,328	$ 6,266	$ 7,360
Net Cash Flow	$ (86,160)	$ 2,938	$ 3,038	$ 3,142	$ 3,249	$ 3,360	$ 3,473	$ 3,591	$ 3,712	$ 3,838	$ 4,525	$ 5,328	$ 6,266	$ 7,360
ACCUMULATED CASH FLOW	**$ (86,160)**	**$ (83,222)**	**$ (80,184)**	**$ (77,042)**	**$ (73,793)**	**$ (70,433)**	**$ (66,959)**	**$ (63,368)**	**$ (59,656)**	**$ (55,819)**	**$ (34,611)**	**$ (9,625)**	**$ 19,771**	**$ 54,314**

IRR on Equity	5 YR IRR	10 YR IRR	15 YR IRR	20 YR IRR	25 YR IRR	30 YR IRR
	-48.4%	-16.5%	-5.9%	-1.1%	1.5%	3.1%

Simple Payback, years 31.3

Return on Investment Calculations

Proforma Project Financial Statement

(3) 15 BBL Brews per Week

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

Project Gyppo Ale Mill
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lbs/interval	148.0	Average draw (kW)	0.2
Labor (hrs/per)	0.25	Annual use (kWhr)	382
$/hr	$20	Annual el. cost, wood boiler	$46
hrs/yr	75.10	Oil boiler, blower, kW	0.5
Total/yr	$375.49	Oil boiler, elec. kWh	$0

30 YR ACCUMULATED CASH FLOW	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 15	Year 20	Year 25	Year 30
EXISTING HEATING SYSTEM OPERATING COSTS														
Projected Electricity Use, BAU	$ 13,589	$ 13,997	$ 14,417	$ 14,849	$ 15,295	$ 15,754	$ 16,226	$ 16,713	$ 17,214	$ 17,731	$ 20,555	$ 23,829	$ 27,624	$ 32,024
Maintenance Cost, BAU	$ 150	$ 153	$ 156	$ 159	$ 162	$ 166	$ 169	$ 172	$ 176	$ 179	$ 198	$ 219	$ 241	$ 266
TOTAL	**$ 13,739**	**$ 14,150**	**$ 14,573**	**$ 15,008**	**$ 15,457**	**$ 15,919**	**$ 16,395**	**$ 16,885**	**$ 17,390**	**$ 17,910**	**$ 19,565**	**$ 24,047**	**$ 27,865**	**$ 32,290**
PROPOSED HEATING SYSTEM OPERATING COSTS														
Electricity Use, Backup	$ 2,957	$ 3,045	$ 3,137	$ 3,231	$ 3,328	$ 3,428	$ 3,530	$ 3,636	$ 3,745	$ 3,858	$ 4,472	$ 5,184	$ 6,010	$ 6,968
Wood Fuel	$ 2,316	$ 2,350	$ 2,386	$ 2,421	$ 2,458	$ 2,494	$ 2,532	$ 2,570	$ 2,608	$ 2,648	$ 2,852	$ 3,073	$ 3,310	$ 3,566
Fueling Labor	$ 375	$ 383	$ 391	$ 398	$ 406	$ 415	$ 423	$ 431	$ 440	$ 449	$ 495	$ 547	$ 604	$ 667
Wood Boiler Electrical Cost	$ 46	$ 47	$ 48	$ 49	$ 50	$ 51	$ 52	$ 53	$ 54	$ 55	$ 61	$ 67	$ 74	$ 81
TOTAL	**$ 5,694**	**$ 5,825**	**$ 5,961**	**$ 6,099**	**$ 6,241**	**$ 6,387**	**$ 6,537**	**$ 6,690**	**$ 6,848**	**$ 7,009**	**$ 7,880**	**$ 8,871**	**$ 9,998**	**$ 11,282**
PROJECT RELATED DEBT														
Beginning Principal Balance	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Principal Repayments	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Interest Payments	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Ending Principal Balance	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
TOTAL DEBT PAYMENT	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**
ANNUAL OPERATING COST SAVINGS (LOSS)	**$ 8,046**	**$ 8,324**	**$ 8,612**	**$ 8,909**	**$ 9,216**	**$ 9,532**	**$ 9,858**	**$ 10,195**	**$ 10,542**	**$ 10,901**	**$ 12,872**	**$ 15,176**	**$ 17,867**	**$ 21,008**
Cash Investment (equity)	$ (89,000)	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -				
Income (cost savings)	$ 8,046	$ 8,324	$ 8,612	$ 8,909	$ 9,216	$ 9,532	$ 9,858	$ 10,195	$ 10,542	$ 10,901	$ 12,872	$ 15,176	$ 17,867	$ 21,008
Net Cash Flow	$ (80,954)	$ 8,324	$ 8,612	$ 8,909	$ 9,216	$ 9,532	$ 9,858	$ 10,195	$ 10,542	$ 10,901	$ 12,872	$ 15,176	$ 17,867	$ 21,008
ACCUMULATED CASH FLOW	**$ (80,954)**	**$ (72,630)**	**$ (64,018)**	**$ (55,109)**	**$ (45,893)**	**$ (36,361)**	**$ (26,503)**	**$ (16,308)**	**$ (5,766)**	**$ 5,135**	**$ 65,431**	**$ 136,561**	**$ 220,348**	**$ 318,913**

IRR on Equity	5 YR IRR	10 YR IRR	15 YR IRR	20 YR IRR	25 YR IRR	30 YR IRR
	-26.4%	1.2%	8.3%	11.0%	12.3%	12.9%

Simple Payback, years 11.1

Return on Investment Calculations

Proforma Project Financial Statement

(12) 15 BBL Brews per Week (Full Throttle)

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

Project Gyppo Ale Mill
Location Humboldt County., CA
Contact Julie Peacock
Date 7/11/14

System Wood-Fired Process Hot Water
Boiler Output (MBH) 170
Fuel Type Cordwood
Workbook Version 1.0.0

DEBT SERVICE			
Total Installation Cost		$	89,000
Grants	0%	$	-
Financed Amount		$	89,000
Debt Leverage			0.0%
Project Equity			100.0%
Loan Amount		$	-
Amount of Equity		$	89,000
Annual Rate			5.0%
Term (Years)			15.00

FUEL COSTS	Fossil Fuel	Wood	Electricity
Unit	(mmBtu)	(mmBtu)	(kWhr)
Cost per unit	$28.42	$7.66	$0.12
Escala. Rate	3.0%	1.5%	2.0%

FUEL LABOR	Labor		Electricity
Fueling intervals	842.4	Max. electrical draw (kW)	0.2
lbs/interval	148.0	Average draw (kW)	0.2
Labor (hrs/per)	0.25	Annual use (kWhr)	382
$/hr	$20	Annual el. cost, wood boiler	$46
hrs/yr	210.61	Oil boiler, blower, kW	0.5
Total/yr	$1,053.05	Oil boiler, elec. kWh	$0

30 YR ACCUMULATED CASH FLOW	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 15	Year 20	Year 25	Year 30
EXISTING HEATING SYSTEM OPERATING COSTS														
Projected Electricity Use, BAU	$ 31,403	$ 32,345	$ 33,315	$ 34,315	$ 35,344	$ 36,405	$ 37,497	$ 38,622	$ 39,780	$ 40,974	$ 47,500	$ 55,065	$ 63,836	$ 74,003
Maintenance Cost, BAU	$ 600	$ 612	$ 624	$ 637	$ 649	$ 662	$ 676	$ 689	$ 703	$ 717	$ 792	$ 874	$ 965	$ 1,066
TOTAL	**$ 32,003**	**$ 32,957**	**$ 33,940**	**$ 34,951**	**$ 35,994**	**$ 37,067**	**$ 38,172**	**$ 39,311**	**$ 40,483**	**$ 41,691**	**$ 45,534**	**$ 55,939**	**$ 64,801**	**$ 75,068**
PROPOSED HEATING SYSTEM OPERATING COSTS														
Electricity Use, Backup	$ 1,585	$ 1,632	$ 1,681	$ 1,732	$ 1,784	$ 1,837	$ 1,892	$ 1,949	$ 2,008	$ 2,068	$ 2,397	$ 2,779	$ 3,221	$ 3,735
Wood Fuel	$ 6,494	$ 6,591	$ 6,690	$ 6,790	$ 6,892	$ 6,996	$ 7,101	$ 7,207	$ 7,315	$ 7,425	$ 7,999	$ 8,617	$ 9,283	$ 10,000
Fueling Labor	$ 1,053	$ 1,074	$ 1,096	$ 1,118	$ 1,140	$ 1,163	$ 1,186	$ 1,210	$ 1,234	$ 1,258	$ 1,389	$ 1,534	$ 1,694	$ 1,870
Wood Boiler Electrical Cost	$ 46	$ 47	$ 48	$ 49	$ 50	$ 51	$ 52	$ 53	$ 54	$ 55	$ 61	$ 67	$ 74	$ 81
TOTAL	**$ 9,177**	**$ 9,344**	**$ 9,515**	**$ 9,688**	**$ 9,865**	**$ 10,046**	**$ 10,230**	**$ 10,418**	**$ 10,610**	**$ 10,806**	**$ 11,846**	**$ 12,997**	**$ 14,272**	**$ 15,686**
PROJECT RELATED DEBT														
Beginning Principal Balance	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Principal Repayments	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Interest Payments	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Ending Principal Balance	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
TOTAL DEBT PAYMENT	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**
ANNUAL OPERATING COST SAVINGS (LOSS)	**$ 22,825**	**$ 23,613**	**$ 24,425**	**$ 25,263**	**$ 26,128**	**$ 27,021**	**$ 27,942**	**$ 28,892**	**$ 29,873**	**$ 30,885**	**$ 36,445**	**$ 42,942**	**$ 50,529**	**$ 59,382**
Cash Investment (equity)	$ (89,000)	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -				
Income (cost savings)	$ 22,825	$ 23,613	$ 24,425	$ 25,263	$ 26,128	$ 27,021	$ 27,942	$ 28,892	$ 29,873	$ 30,885	$ 36,445	$ 42,942	$ 50,529	$ 59,382
Net Cash Flow	$ (66,175)	$ 23,613	$ 24,425	$ 25,263	$ 26,128	$ 27,021	$ 27,942	$ 28,892	$ 29,873	$ 30,885	$ 36,445	$ 42,942	$ 50,529	$ 59,382
ACCUMULATED CASH FLOW	**$ (66,175)**	**$ (42,562)**	**$ (18,137)**	**$ 7,126**	**$ 33,254**	**$ 60,275**	**$ 88,217**	**$ 117,109**	**$ 146,982**	**$ 177,867**	**$ 348,626**	**$ 549,941**	**$ 786,942**	**$ 1,065,600**

IRR on Equity	5 YR IRR	10 YR IRR	15 YR IRR	20 YR IRR	25 YR IRR	30 YR IRR
	18.2%	36.1%	38.5%	38.9%	39.0%	39.1%

Simple Payback, years 3.9

Appendix B: Energy Model and Financial Calculations for Wood Pellets

Gyppo Ale Mill

Project Costs - Summary

System	Wood-Fired Process Hot Water	**Orig. Date**	05-May-14	**Contact**	Andrew Haden
Boiler Output	200 MBH	**Rev. Date**	09-Jul-14	**Phone**	(503) 706-6187
Fuel Type	Wood pellets	**Version**	1.0.0	**Email**	andrew@wisewood.us

Item Description	Est. Hours	Install Equipment	Install Materials	Install Labor	Line Total	% Total Project
CONSTRUCTION COSTS						
Civil/Structural	16	$ -	$ -	$ -	$ 8,000	5.5%
Mechanical	224	$ -	$ 55,000	$ 17,000	$ 72,000	52.9%
Electrical	24	$ -	$ 2,000	$ 2,000	$ 4,000	3.0%
Permitting	0	$ -	$ -	$ -	$ 1,000	0.4%
Miscellaneous	0	$ -	$ -	$ -	$ 3,000	2.2%
Subtotal Direct Costs	264	$ -	$ 57,000	$ 19,000	$ 87,000	63.9%
Contingency and Unlisted Items - Direct Costs					$ 17,000	12.8%
General Contractor Costs					$ 10,000	7.7%
Subtotal Construction Costs					$ 115,000	84.4%
DEVELOPMENT COSTS						
Engineering, Procurement and Construction Management Services					$ 21,000	15.6%
Subtotal Development Costs					$ 21,000	15.6%
TOTAL PROJECT COST					**$ 136,000**	**100.0%**

Return on Investment Calculations

Proforma Project Financial Statement

(1) 15 BBL Brew per Week

Project Gyppo Ale Mill
Location Humboldt County., CA
Contact Julie Peacock
Date 7/9/14

System Wood-Fired Process Hot Water
Boiler Output (MBH) 200 MBH
Fuel Type Wood pellets
Workbook Version 1.0.0

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

DEBT SERVICE		
Total Installation Cost		$ 136,000
Grants	0%	$ -
Financed Amount		$ 136,000
Debt Leverage		0.0%
Project Equity		100.0%
Loan Amount		$ -
Amount of Equity		$ 136,000
Annual Rate		5.0%
Term (Years)		15.00

FUEL COSTS	Fossil Fuel	Wood	Electricity
Unit	(mmBtu)	(mmBtu)	(kWhr)
Cost per unit	$28.42	$20.73	$0.12
Escala. Rate	3.0%	1.5%	2.0%

FUEL LABOR	Labor		Electricity
Fueling intervals	79.7	Max. electrical draw (kW)	0.2
lbs/interval	148.0	Average draw (kW)	0.2
Labor (hrs/per)	0.25	Annual use (kWhr)	382
$/hr	$20	Annual el. cost, wood boiler	$46
hrs/yr	19.93	Oil boiler, blower, kW	0.5
Total/yr	$99.65	Oil boiler, elec. kWh	$0

30 YR ACCUMULATED CASH FLOW	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 15	Year 20	Year 25	Year 30
EXISTING HEATING SYSTEM OPERATING COSTS														
Projected Electricity Use, BAU	$ 5,184	$ 5,339	$ 5,500	$ 5,665	$ 5,835	$ 6,010	$ 6,190	$ 6,376	$ 6,567	$ 6,764	$ 7,841	$ 9,090	$ 10,538	$ 12,216
Maintenance Cost, BAU	$ 150	$ 153	$ 156	$ 159	$ 162	$ 166	$ 169	$ 172	$ 176	$ 179	$ 198	$ 219	$ 241	$ 266
TOTAL	**$ 5,334**	**$ 5,492**	**$ 5,656**	**$ 5,824**	**$ 5,997**	**$ 6,175**	**$ 6,359**	**$ 6,548**	**$ 6,743**	**$ 6,943**	**$ 7,581**	**$ 9,309**	**$ 10,779**	**$ 12,483**
PROPOSED HEATING SYSTEM OPERATING COSTS														
Electricity Use, Backup	$ 1,833	$ 1,888	$ 1,945	$ 2,003	$ 2,063	$ 2,125	$ 2,189	$ 2,255	$ 2,322	$ 2,392	$ 2,773	$ 3,214	$ 3,726	$ 4,320
Wood Fuel	$ 1,975	$ 2,004	$ 2,034	$ 2,065	$ 2,096	$ 2,127	$ 2,159	$ 2,192	$ 2,225	$ 2,258	$ 2,432	$ 2,620	$ 2,823	$ 3,041
Fueling Labor	$ 100	$ 102	$ 104	$ 106	$ 108	$ 110	$ 112	$ 114	$ 117	$ 119	$ 131	$ 145	$ 160	$ 177
Wood Boiler Electrical Cost	$ 46	$ 47	$ 48	$ 49	$ 50	$ 51	$ 52	$ 53	$ 54	$ 55	$ 61	$ 67	$ 74	$ 81
TOTAL	**$ 3,953**	**$ 4,041**	**$ 4,131**	**$ 4,223**	**$ 4,317**	**$ 4,413**	**$ 4,512**	**$ 4,613**	**$ 4,717**	**$ 4,824**	**$ 5,397**	**$ 6,047**	**$ 6,783**	**$ 7,619**
PROJECT RELATED DEBT														
Beginning Principal Balance	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Principal Repayments	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Interest Payments	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Ending Principal Balance	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
TOTAL DEBT PAYMENT	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**
ANNUAL OPERATING COST SAVINGS (LOSS)	**$ 1,381**	**$ 1,452**	**$ 1,525**	**$ 1,601**	**$ 1,680**	**$ 1,762**	**$ 1,847**	**$ 1,935**	**$ 2,025**	**$ 2,120**	**$ 2,642**	**$ 3,262**	**$ 3,996**	**$ 4,863**
Cash Investment (equity)	$ (136,000)	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -				
Income (cost savings)	$ 1,381	$ 1,452	$ 1,525	$ 1,601	$ 1,680	$ 1,762	$ 1,847	$ 1,935	$ 2,025	$ 2,120	$ 2,642	$ 3,262	$ 3,996	$ 4,863
Net Cash Flow	$ (134,619)	$ 1,452	$ 1,525	$ 1,601	$ 1,680	$ 1,762	$ 1,847	$ 1,935	$ 2,025	$ 2,120	$ 2,642	$ 3,262	$ 3,996	$ 4,863
ACCUMULATED CASH FLOW	**$ (134,619)**	**$ (133,168)**	**$ (131,643)**	**$ (130,041)**	**$ (128,361)**	**$ (126,599)**	**$ (124,752)**	**$ (122,818)**	**$ (120,792)**	**$ (118,673)**	**$ (106,544)**	**$ (91,517)**	**$ (73,055)**	**$ (50,531)**

IRR on Equity	5 YR IRR	10 YR IRR	15 YR IRR	20 YR IRR	25 YR IRR	30 YR IRR
	-62.8%	-28.7%	-15.3%	-8.7%	-4.9%	-2.5%

Simple Payback, years 98.5

Return on Investment Calculations

Proforma Project Financial Statement

(3) 15 BBL Brews per Week

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

Project Gyppo Ale Mill
Location Humboldt County., CA
Contact Julie Peacock
Date 7/9/14

System Wood-Fired Process Hot Water
Boiler Output (MBH) 200 MBH
Fuel Type Wood pellets
Workbook Version 1.0.0

DEBT SERVICE		
Total Installation Cost		$ 136,000
Grants	0%	$ -
Financed Amount		$ 136,000
Debt Leverage		0.0%
Project Equity		100.0%
Loan Amount		$ -
Amount of Equity		$ 136,000
Annual Rate		5.0%
Term (Years)		15.00

FUEL COSTS	Fossil Fuel	Wood	Electricity
Unit	(mmBtu)	(mmBtu)	(kWhr)
Cost per unit	$28.42	$20.73	$0.12
Escala. Rate	3.0%	1.5%	2.0%

FUEL LABOR	Labor		Electricity
Fueling intervals	231.2	Max. electrical draw (kW)	0.2
lbs/interval	148.0	Average draw (kW)	0.2
Labor (hrs/per)	0.25	Annual use (kWhr)	382
$/hr	$20	Annual el. cost, wood boiler	$46
hrs/yr	57.80	Oil boiler, blower, kW	0.5
Total/yr	$289.02	Oil boiler, elec. kWh	$0

30 YR ACCUMULATED CASH FLOW	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 15	Year 20	Year 25	Year 30
EXISTING HEATING SYSTEM OPERATING COSTS														
Projected Electricity Use, BAU	$ 11,268	$ 11,606	$ 11,954	$ 12,313	$ 12,682	$ 13,062	$ 13,454	$ 13,858	$ 14,274	$ 14,702	$ 17,043	$ 19,758	$ 22,905	$ 26,553
Maintenance Cost, BAU	$ 150	$ 153	$ 156	$ 159	$ 162	$ 166	$ 169	$ 172	$ 176	$ 179	$ 198	$ 219	$ 241	$ 266
TOTAL	**$ 11,418**	**$ 11,759**	**$ 12,110**	**$ 12,472**	**$ 12,844**	**$ 13,228**	**$ 13,623**	**$ 14,030**	**$ 14,449**	**$ 14,881**	**$ 16,255**	**$ 19,977**	**$ 23,146**	**$ 26,820**
PROPOSED HEATING SYSTEM OPERATING COSTS														
Electricity Use, Backup	$ 1,549	$ 1,596	$ 1,644	$ 1,693	$ 1,744	$ 1,796	$ 1,850	$ 1,905	$ 1,963	$ 2,021	$ 2,343	$ 2,717	$ 3,149	$ 3,651
Wood Fuel	$ 5,727	$ 5,813	$ 5,900	$ 5,989	$ 6,079	$ 6,170	$ 6,263	$ 6,356	$ 6,452	$ 6,549	$ 7,055	$ 7,600	$ 8,187	$ 8,820
Fueling Labor	$ 289	$ 295	$ 301	$ 307	$ 313	$ 319	$ 325	$ 332	$ 339	$ 345	$ 381	$ 421	$ 465	$ 513
Wood Boiler Electrical Cost	$ 46	$ 47	$ 48	$ 49	$ 50	$ 51	$ 52	$ 53	$ 54	$ 55	$ 61	$ 67	$ 74	$ 81
TOTAL	**$ 7,612**	**$ 7,751**	**$ 7,893**	**$ 8,037**	**$ 8,185**	**$ 8,336**	**$ 8,490**	**$ 8,647**	**$ 8,807**	**$ 8,970**	**$ 9,840**	**$ 10,805**	**$ 11,875**	**$ 13,066**
PROJECT RELATED DEBT														
Beginning Principal Balance	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Principal Repayments	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Interest Payments	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Ending Principal Balance	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
TOTAL DEBT PAYMENT	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**
ANNUAL OPERATING COST SAVINGS (LOSS)	**$ 3,806**	**$ 4,008**	**$ 4,217**	**$ 4,434**	**$ 4,659**	**$ 4,892**	**$ 5,134**	**$ 5,384**	**$ 5,643**	**$ 5,911**	**$ 7,401**	**$ 9,172**	**$ 11,271**	**$ 13,754**
Cash Investment (equity)	$ (136,000)	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -				
Income (cost savings)	$ 3,806	$ 4,008	$ 4,217	$ 4,434	$ 4,659	$ 4,892	$ 5,134	$ 5,384	$ 5,643	$ 5,911	$ 7,401	$ 9,172	$ 11,271	$ 13,754
Net Cash Flow	$ (132,194)	$ 4,008	$ 4,217	$ 4,434	$ 4,659	$ 4,892	$ 5,134	$ 5,384	$ 5,643	$ 5,911	$ 7,401	$ 9,172	$ 11,271	$ 13,754
ACCUMULATED CASH FLOW	**$ (132,194)**	**$ (128,186)**	**$ (123,968)**	**$ (119,534)**	**$ (114,875)**	**$ (109,983)**	**$ (104,849)**	**$ (99,465)**	**$ (93,823)**	**$ (87,912)**	**$ (53,990)**	**$ (11,792)**	**$ 40,222**	**$ 103,859**

IRR on Equity	5 YR IRR	10 YR IRR	15 YR IRR	20 YR IRR	25 YR IRR	30 YR IRR
	-49.7%	-16.9%	-5.8%	-0.8%	1.9%	3.5%

Simple Payback, years 35.7

Return on Investment Calculations

Proforma Project Financial Statement

(12) 15 BBL Brews per Week (Full Throttle)

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

Project Gyppo Ale Mill
Location Humboldt County., CA
Contact Julie Peacock
Date 7/9/14

System Wood-Fired Process Hot Water
Boiler Output (MBH) 200 MBH
Fuel Type Wood pellets
Workbook Version 1.0.0

DEBT SERVICE			
Total Installation Cost		$	136,000
Grants	0%	$	-
Financed Amount		$	136,000
Debt Leverage			0.0%
Project Equity			100.0%
Loan Amount		$	-
Amount of Equity		$	136,000
Annual Rate			5.0%
Term (Years)			15.00

FUEL COSTS	Fossil Fuel	Wood	Electricity
Unit	(mmBtu)	(mmBtu)	(kWhr)
Cost per unit	$28.42	$20.73	$0.12
Escala. Rate	3.0%	1.5%	2.0%

FUEL LABOR	Labor		Electricity
Fueling intervals	678.1	Max. electrical draw (kW)	0.2
lbs/interval	148.0	Average draw (kW)	0.2
Labor (hrs/per)	0.25	Annual use (kWhr)	382
$/hr	$20	Annual el. cost, wood boiler	$46
hrs/yr	169.52	Oil boiler, blower, kW	0.5
Total/yr	$847.60	Oil boiler, elec. kWh	$0

30 YR ACCUMULATED CASH FLOW	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 15	Year 20	Year 25	Year 30
EXISTING HEATING SYSTEM OPERATING COSTS														
Projected Electricity Use, BAU	$ 29,482	$ 30,367	$ 31,278	$ 32,216	$ 33,183	$ 34,178	$ 35,204	$ 36,260	$ 37,348	$ 38,468	$ 44,595	$ 51,698	$ 59,932	$ 69,477
Maintenance Cost, BAU	$ 600	$ 612	$ 624	$ 637	$ 649	$ 662	$ 676	$ 689	$ 703	$ 717	$ 792	$ 874	$ 965	$ 1,066
TOTAL	**$ 30,082**	**$ 30,979**	**$ 31,902**	**$ 32,853**	**$ 33,832**	**$ 34,841**	**$ 35,879**	**$ 36,949**	**$ 38,051**	**$ 39,185**	**$ 42,796**	**$ 52,572**	**$ 60,897**	**$ 70,543**
PROPOSED HEATING SYSTEM OPERATING COSTS														
Electricity Use, Backup	$ 982	$ 1,011	$ 1,041	$ 1,073	$ 1,105	$ 1,138	$ 1,172	$ 1,207	$ 1,243	$ 1,281	$ 1,485	$ 1,721	$ 1,995	$ 2,313
Wood Fuel	$ 16,796	$ 17,048	$ 17,304	$ 17,564	$ 17,827	$ 18,095	$ 18,366	$ 18,641	$ 18,921	$ 19,205	$ 20,689	$ 22,288	$ 24,011	$ 25,866
Fueling Labor	$ 848	$ 865	$ 882	$ 899	$ 917	$ 936	$ 955	$ 974	$ 993	$ 1,013	$ 1,118	$ 1,235	$ 1,363	$ 1,505
Wood Boiler Electrical Cost	$ 46	$ 47	$ 48	$ 49	$ 50	$ 51	$ 52	$ 53	$ 54	$ 55	$ 61	$ 67	$ 74	$ 81
TOTAL	**$ 18,672**	**$ 18,971**	**$ 19,275**	**$ 19,584**	**$ 19,899**	**$ 20,219**	**$ 20,544**	**$ 20,875**	**$ 21,211**	**$ 21,553**	**$ 23,353**	**$ 25,311**	**$ 27,443**	**$ 29,766**
PROJECT RELATED DEBT														
Beginning Principal Balance	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Principal Repayments	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Interest Payments	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Ending Principal Balance	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
TOTAL DEBT PAYMENT	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**
ANNUAL OPERATING COST SAVINGS (LOSS)	**$ 11,411**	**$ 12,008**	**$ 12,627**	**$ 13,269**	**$ 13,933**	**$ 14,622**	**$ 15,335**	**$ 16,074**	**$ 16,839**	**$ 17,632**	**$ 22,034**	**$ 27,261**	**$ 33,454**	**$ 40,777**
Cash Investment (equity)	$ (136,000)	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -				
Income (cost savings)	$ 11,411	$ 12,008	$ 12,627	$ 13,269	$ 13,933	$ 14,622	$ 15,335	$ 16,074	$ 16,839	$ 17,632	$ 22,034	$ 27,261	$ 33,454	$ 40,777
Net Cash Flow	$ (124,589)	$ 12,008	$ 12,627	$ 13,269	$ 13,933	$ 14,622	$ 15,335	$ 16,074	$ 16,839	$ 17,632	$ 22,034	$ 27,261	$ 33,454	$ 40,777
ACCUMULATED CASH FLOW	**$ (124,589)**	**$ (112,581)**	**$ (99,954)**	**$ (86,685)**	**$ (72,752)**	**$ (58,130)**	**$ (42,795)**	**$ (26,721)**	**$ (9,882)**	**$ 7,750**	**$ 108,810**	**$ 234,303**	**$ 388,769**	**$ 577,519**

IRR on Equity	5 YR IRR	10 YR IRR	15 YR IRR	20 YR IRR	25 YR IRR	30 YR IRR
	-27.2%	1.1%	8.6%	11.5%	12.8%	13.4%

Simple Payback, years 11.9

Table 1. Estimated Energy Use, Year 1 - (1) 15 BBL Brew per Week – Wood Pellets

Year 1	Weekly	Monthly	Annually
Energy use, Btu	3,461,648.0	14,538,921.6	174,467,059.2
Energy use, kWhr	1,014.6	4,261.1	51,133.4
Wood energy use, Btu	1,910,408.0	8,023,713.6	96,284,563.2
Electrical energy use, Btu	1,551,240.0	6,515,208.0	78,182,496.0
Wood, lbs	236.6	993.6	11,923.8
Wood pellets, tons	0.1	0.5	6.0
Offset Electricity, kWh	559.9	2,351.6	28,219.4
Remaining Electricity, kWh	454.6	1,909.5	22,914.0

Figure 1. Estimated Energy Use, Year 1 - (1) 15 BBL Brew per Week – Wood Pellets

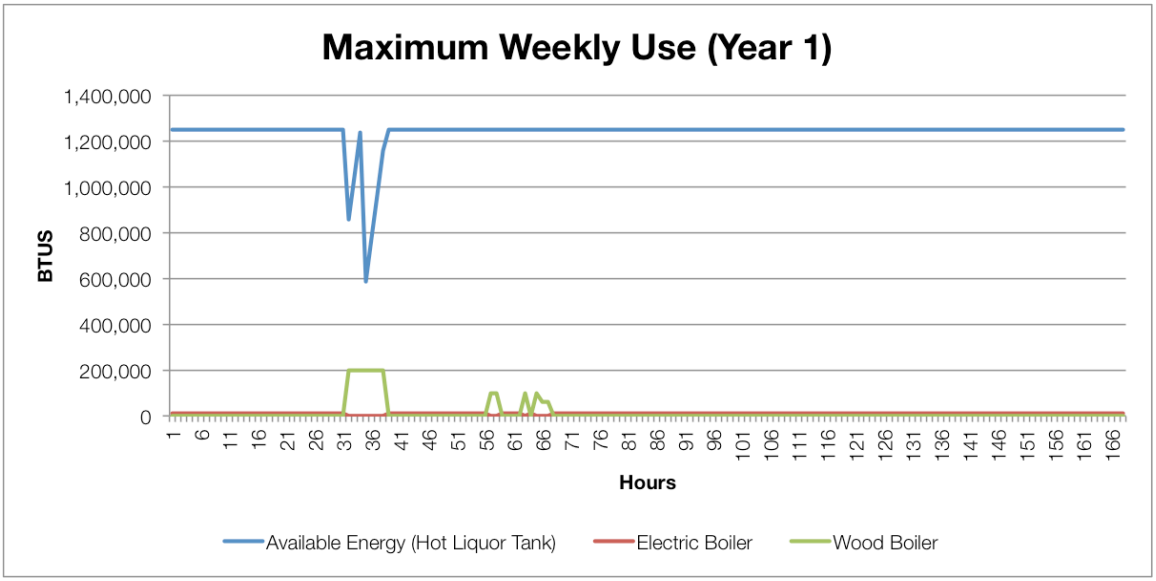


Table 2. Estimated Energy Use, Year 2 - (3) 15 BBL Brews per Week – Wood Pellets

Year 2	Weekly	Monthly	Annually
Energy use, Btu	6,847,116.0	28,757,887.2	345,094,646.4
Energy use, kWhr	2,006.8	8,428.5	101,141.5
Wood energy use, Btu	5,536,068.0	23,251,485.6	279,017,827.2
Electrical energy use, Btu	1,311,048.0	5,506,401.6	66,076,819.2
Wood, lbs	685.6	2,879.4	34,553.3
Wood pellets, tons	0.3	1.4	17.3
Offset Electricity, kWh	1,622.5	6,814.6	81,775.4
Remaining Electricity, kWh	384.2	1,613.8	19,366.0

Figure 2. Estimated Energy Use, Year 2- (3) 15 BBL Brew per Week – Wood Pellets

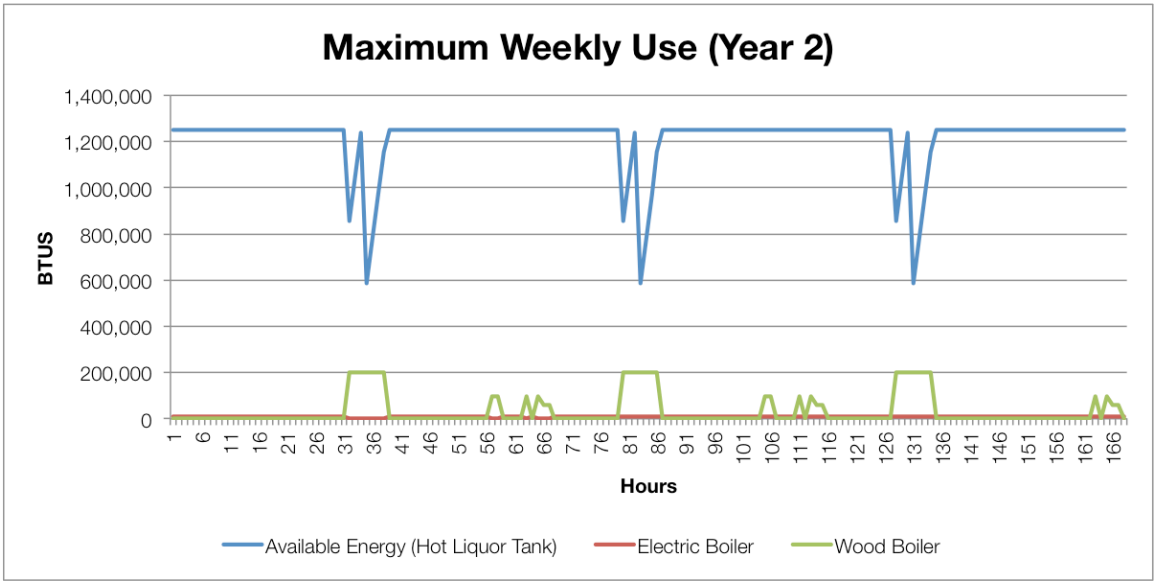
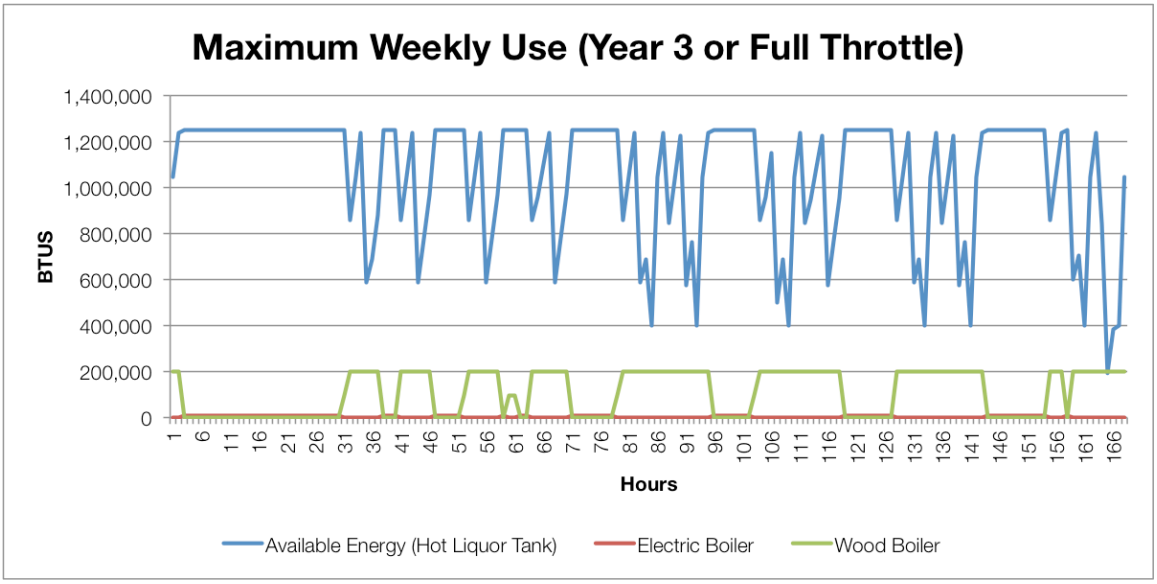


Table 3. Estimated Energy Use, Year 3 - (12) 15 BBL Brew per Week (Full Throttle) – Wood Pellets

Year 3	Weekly	Monthly	Annually
Energy use, Btu	18,736,068.0	78,691,485.6	944,297,827.2
Energy use, kWhr	5,491.2	23,063.2	276,757.9
Wood energy use, Btu	17,985,468.0	75,538,965.6	906,467,587.2
Electrical energy use, Btu	750,600.0	3,152,520.0	37,830,240.0
Wood, lbs	2,227.3	9,354.7	112,256.0
Wood pellets, tons	1.1	4.7	56.1
Offset Electricity, kWh	5,271.2	22,139.2	265,670.5
Remaining Electricity, kWh	220.0	924.0	11,087.4

Figure 3. Estimated Energy Use, Year 3 - (12) 15 BBL Brew per Week – Wood Pellets



Appendix C: Water and Energy Use Estimates

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WATER & ENERGY NEEDS FOR BREWING PROCESSES

BREWHOUSE FLOW				
NUMBERS BASED ON EACH 15 BBL BREW (465 GALLONS)				
GRIND	MASH	SPARGING	BOIL	KNOCK-OUT
220V Electrical draw to crush malt: 30 min-1 hr	**350 gallons to 560 gallons of 175 degree water, brew dependant**	**525 gallons to 840 gallons of 170 degree water, brew dependant**	**300,000 BTU's for 1.5 hours of boiling 500 gallons of wort**	BEST GUESS: Each 15 bbl batch will **generate** *approximately* 520 gallons of 170 degree water from process cooling which will be added back to our hot liquor tank

FERMENTATION			BREWHOUSE CIP	
15 or 30 bbl, brew & tank dependant				
FERMENTATION	CONDITIONING	CRASH-COOL	MASH TUN	KETTLE/HEAT EX
The first 3 days of fermentation will require the glycol system to compete with the heat generated from active fermentation of 15 bbls (465 gallons) wort.	Post-primary, the beer will need to be held at 65 degrees. Glycol and beer temp competing with ambient air temperature, but not heat generation from active fermentation.	Prior to serving, the beer will be chilled overnight, taking the beer from 60 degrees down to 35+/-.	1x per month cleaning cycle. 2 bbls caustic cleaning + 2 bbls acid cleaning + 3 rinses = **7 bbls of 140-150 degree water**	Per Brew: **7 bbls of 140-150 degree water** for cleaning and rinsing cycles. Can be combined with mash tun cycles when possible.

CELLAR TANK CIP			SOUR WORT TANKS	
15 bbl FV	30 bbl FV	15 bbl SV	PROP TANK	STORAGE TANK
7 bbls 140-150 degree water for cleaning cycles every use	**7 bbls 140-150 degree water for cleaning cycles** every use.	**3-7 bbls 140-150 degree water for cleaning every other use**	**1-2X per month, 4 bbls of 140-150 degree water for cleaning cycle**	**1x per month 4 bbls 140-150 degree water for cleaning cycles**

CELLAR PROCESSES (per batch process)			HOT LIQUOR TANK
BEER TRANSFER	FILTRATION	BOTTLING/KEGGING	DAILY/WEEKLY OPERATIONS
2-3 bbls 140 degree water for sanitation and rinsing of beer pump & lines	**FUTURE**, similar to beer transfer numbers	**FUTURE**, unknown. Some keg systems have independent water heating sources. Bottling will need cold water for bottle rinses and hot water for cleaning, but volumes depend on the system implemented.	Daily usage will require constant addition of incoming city cold water (& incoming recovered hot water from boil knock-out) to system in order to maintain water volume necessary for brewery process.

TARGET TYPICAL BREWERY OPERATIONS BY WEEK	
YEAR ONE	(1) 15 bbl brew, (1) 15 bbl fermentation, (1) Kettle/heat ex CIP, (1) 15 bbl FV CIP, (1) 15 bbl SV CIP, (1) Beer
YEAR TWO	(3) 15 bbl brews, (1) 15 bbl fermentation, (1) 30 bbl fermentation, (2) Kettle/heat ex CIP, (1) 15 bbl FV CIP, (1)
FULL THROTTLE	(12) 15 bbl brews, (2) 15 bbl fermentations, (5) 30 bbl fermentations, (5) Kettle/heat ex CIP, (2) 15 bbl FV CIP,

STARTUP OPERATIONS	
WEEK 1	(2) 15 bbl brews, (1) 30 bbl fermentation, (2) Kettle/heat ex CIP, (1) 30 bbl FV CIP, (1) Sour Wort prop tank
WEEK 2	(2) 15 bbl brews, (1) 30 bbl fermentation, (2) Kettle/heat ex CIP, (2) 30 bbl FV CIP, (1) Beer transfer
WEEK 3	(2) 15 bbl brews, (1) 30 bbl fermentation, (2) Kettle/heat ex CIP, (1) 30 bbl FV CIP, (1) Sour Wort prop tank
WEEK 4	(1) 15 bbl brew, (1) 15 bbl fermentation, (1) Kettle/heat ex CIP, (1) 15 bbl FV CIP, (3) 15 bbl SV CIP, (3) Beer
WEEK 5	(1) 15 bbl brew, (1) 15 bbl fermentation, (1) Kettle/heat ex CIP, (1) 30 bbl FV CIP
WEEK 6	(1) 15 bbl brew, (1) 15 bbl fermentation, (1) Kettle/heat ex CIP, (1) 30 bbl FV CIP
WEEK 7	(1) 15 bbl brew, (1) 15 bbl fermentation, (1) Kettle/heat ex CIP, (1) 30 bbl FV CIP
WEEK 8	(1) 15 bbl brew, (1) 15 bbl fermentation, (1) Kettle/heat ex CIP, (1) 30 bbl FV CIP