PRELIMINARY ANALYSIS OF POTENTIAL SMALL-SCALE FOREST BIOMASS ENERGY FACILITY IN PIERCY, CALIFORNIA

Prepared for:

The Watershed Research and Training Center
Hayfork, CA
On behalf of the California Statewide Wood Energy Team

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I. INTRODUCTION

Lost Coast Forestlands LLC (LCF) owns forestland in the Mattole and South Fork Eel River watersheds of southern Humboldt County and northern Mendocino County. LCF's mission is to restore and conserve working forestlands in the Redwood Region. LCF was formed to address and reverse the region's trend of diminishing timberland productivity, fragmentation of ownerships, conversion to non-timber uses, and subsequent degradation of forest resources, including key salmonid streams. LCF has acquired, and rejoined under a single ownership approximately 6,800 acres of previously subdivided forestland. In partnering with a local land trust, LCF has permanently protected over 3,200 of those acres through working forest conservation easements.

Forest Management Challenge: tanoak dominance

As a result of past logging practices, significant portions of LCF lands now feature excessive volumes of tanoak trees. The dominance of tanoak is partly due to the history of conifer removal during timber harvest with little effort devoted to reforestation. In the absence of active conifer reforestation, the sprouting tanoaks easily dominated many stands that were formerly dominated by conifers, such as redwood and Douglas fir. While tanoak and other local hardwoods have important ecological and cultural values, they have little economic value at the current time. There have been various attempts to develop a market for tanoak over the past 80 years, yet none have succeeded on a commercial scale. In the absence of any significant market for tanoak, removal of tanoak remains strictly a cost center for landowners who seek to transition stands back to conifer dominance.

Potential Solution: bioenergy facility

Seeking alternatives for treatment of over-abundant tanoak and small diameter conifer trees, LCF contracted Phoenix Biomass Energy to complete a preliminary analysis of the potential development of a 2MW bioenergy facility in Southern Humboldt County, California. Producing bioenergy through a program established by CA Senate Bill 1122 (SB1122), such a facility would utilize woody biomass feedstock—primarily tanoak—from LCF lands and other landowners in the region. As part of SB1122 legislation, California's largest investor owned utilities have been mandated to collectively procure 50 megawatts of renewable energy from small-scale bioenergy projects—each producing three megawatts or less—using byproducts of sustainable forest management.

Goals of Analysis

In undertaking an initial analysis of a bioenergy facility, LCF had the following goals:

- Determine site suitability for potential facility in the Piercy, CA area
- Broadly compare existing bioenergy production technologies
- Analyze woody biomass feedstock supply
- Financial analysis of a 2MW bioenergy facility investment

This report summarizes the analysis of the first three of these four goals.

II. SITE SELECTION

In November 2015, Phoenix received a Rule 21 Pre-Application Report from Pacific Gas & Electric (PG&E) for the potential siting of a 2MW biomass facility on a 5-acre site in Piercy, CA. See Appendix I for the result of that report.

Per the PG&E report, the closest breaker shows a 9700kW peak load. This suggests that total interconnection costs may be substantially lower if the bioenergy facility was reduced to a 1.385MW (equal to 9700kW x 15% - 70kW), as this could potentially eliminate the need for upgrades at the breaker level, which might otherwise result in significant cost. As a tradeoff, while decreasing project size from 2MW to 1.4MW (net) might reduce capital expenditures for project development, it would also significantly reduce scale of energy produced and thus the amount of net operating income.

> **Conclusion:** LCF should consider modeling the financial return of a 2MW project with higher interconnection costs (as a result of breaker upgrades) and higher revenue potential against a 1.4MW project with lower interconnection costs and lower net operating income potential.

III. TECHNOLOGY

This report briefly summarizes a few key comparisons of gasification and direct "solid fuel" combustion bioenergy technologies that were provided both in existing reports and through interviews with biomass project developers and consultants. More in-depth bioenergy technology comparisons, including technical descriptions of the technologies, are publicly available (e.g., see 2014 "Biomass Feasibility Assessment" prepared by TSS Consultants).

Figure 1 | Gasification: tradeoffs

Advantages	Challenges
Higher efficiency (20-30%)	Less "mature": few <3MW commercial projects—designed primarily for electricity production—that have proven reliability
Uses limited or no water	Produces lower quality waste heat or steam (e.g., cannot be used in district heating)
Produces a biochar byproduct for a potential additional revenue stream	Requires more uniform fuel (chip size, moisture content)
Lower labor cost (no specialty certifications required)	Potentially expensive gas cleaning that may be less economical for a <3MW facility

Figure 2 | Direct ("solid fuel") combustion: tradeoffs

Advantages	Challenges
More "mature," proven technologies	Lower efficiency (10-15%) at <3MW scale
Produces higher quality waste heat (e.g., for kiln drying, district heating/combined heat and power)	Uses significantly more water
Accepts broader fuel variability (chip size and content, moisture content)	More particulate matter requires potentially costly treatment
	No biochar byproduct
	Higher labor costs (specialty certifications required)

<u>Conclusion</u>: As SB1122 bioenergy facilities begin to be developed in 2016, LCF should revisit analysis of the latest technologies being deployed and the tradeoffs that they may continue to present, as well as potential mitigations for the challenges outlined above.

IV. FEEDSTOCK SUPPLY

Feedstock Volume

Biomass consultants and project developers generally appear to agree that **8,000 to 9,000 of bone dry tons (BDT) of biomass per net megawatt per year** would be required and a log truck is capable of hauling approximately **13 BDT per truckload**. A 2MW facility would therefore consume 16,000 to 18,000 BDT—or 1,200 to 1,400 truckloads—of woody biomass per year.

While it was focused instead on conifer species from the Sierras for a potential bioenergy facility in Nevada County, rather than tanoak species in the North Coast, one biomass availability study assumed **12.5 BDT per acre** of biomass would be available, indicating that "Interviews with forest managers and fiber procurement foresters confirmed that between 10 and 15 BDT per acre of biomass is considered recoverable during fuels treatment and plantation thinning activities… assum[ing] an average recovery factor of 12.5 BDT per acre." (TSS Consultants 2014)

With 10 to 15 BDT per acre of tanoak potentially available, and 16,000 to 18,000 BDT consumed per year, a 2MW facility could require treatment of between 1,000 to 1,800 acres.

> **Conclusion:** Should LCF further pursue the potential development of a bioenergy facility, it would be necessary to engage other regional landowners to complete a broader supply analysis beyond its own timberland holdings.

Feedstock Cost

Costs to log, grind/chip, and haul woody biomass material are not available for LCF's specific timberland and facility, species composition, and silvicultural regime. For estimates of feedstock costs, however, four existing studies are compared below (see Figure 3).

Figure 3 | Comparison of feedstock processing cost studies

$/BDT cost	TSS/Sierra Institute (2012)	Vitorelo et al. (2011)	Harrill & Han (2012)	Harrill & Han (2010)
Log	$14.00 (feller buncher)	$20.72 (feller buncher)	$3.37 (feller buncher)	- (slash already piled)
Skid	$14.00 (600ft skid)	$15.37 (skid up to 650ft)	$3.34 (shovel and load)	$6.30 (load slash into bins)
Haul to central landing	-	-	$4.64 (1-1.5 miles)	$10.46
Chip or grind	$13.00 (chip)	$12.97 (grind)	$12.10 (chip)	$16.22 (grind)
Load (e.g., to chip van)	-	$3.35	$0.92	-
Subtotal, Log/Chip (does not include haul to bioenergy site)	**$41.00**	**$52.41**	**$24.37**	**$32.98**
Silviculture	Thin	Thin	Clearcut	Clearcut
Study location	Northern Sierra Nevada	Klamath National Forest	GRDCo land; Humboldt County	GDRCo land; Humboldt County

Per Figure 3, feedstock processing costs increase significantly—as much as 2x—in thinning operations, as compared to clearcut operations that already have piled slash. Indeed, another study for GRDCo land in Humboldt County (Bisson et al. 2014) similarly calculated a "stump to truck" cost of $26.59 to process piled slash from clearcut harvests.

Figure 4 | Estimate of feedstock haul cost

Trucking cost ($/hr)	$100
Vol. per truckload (BDT/truck)	13
Haul time, roundtrip (hours)	2
Subtotal, Haul ($/BDT/two hr haul)	**$15.38**

Per Figure 4, assuming $100 per hour trucking costs and an ability to haul 13 BDT of woody biomass per truckload, it would cost $7.69 per hour per BDT. At a two-hour round-trip haul, haul costs increase to $15.38/BDT.

Figure 5 | Total feedstock cost

$/BDT cost	TSS/Sierra Institute (2012)	Vitorelo & Han (2011)	Harrill & Han (2012)	Harrill & Han (2008)
Log/Chip (Figure 3)	$41.00	$52.41	$24.37	$32.98
Haul, 2hr RT (Figure 4)	+ $15.38	+ $15.38	+ $15.38	+ $15.38
Total (Figure 3+4)	**$56.38**	**$67.79**	**$39.75**	**$48.36**

Per Figure 5, thinning harvests and hauling for up to one hour each way (two-hour round-trip) from the harvest unit to a bioenergy facility could conceivably cost $56 to $68 per BDT.

Conclusion: Should LCF further pursue the potential development of a bioenergy facility, it would likely be necessary to complete a pilot that harvests and delivers tanoak material to the potential facility site to confirm feedstock delivery cost estimates. Any financial analysis should incorporate feedstock cost assumptions based on that pilot and modeling of haul costs from other landowners in the region. It may be necessary to assume that landowners, including LCF, would have to partially subsidize the removal of tanoak (i.e., that tanoak would not "pay its way out of the woods" entirely if a bioenergy facility could not pay greater than $50 per BDT)—such a subsidy could be compared to the cost of alternative treatments of tanoak.

Pre-Application Report for Generator Interconnection

Project Name: LCF Piercy (2 MW Biomass)
Address: 80301 CA-271
Substation: GARBERVILLE
Feeder: 192221101
GPS: 39.9656917, -123.7969472

A. Total Capacity (MW) of substation bank and circuit likely to serve proposed site.
See Table 1

B. Allocated Capacity (MW) of substation/area bus or bank and circuit likely to serve proposed site.
See Table 1

C. Queued Capacity (MW) of substation/area bus or bank and circuit likely to serve proposed site.
See Table 1

D. Available Capacity (MW) of substation/area bus or bank and circuit most likely to serve proposed site.
See Table 1

E. Substation nominal distribution voltage or transmission nominal voltage if applicable.
12 kV

F. Nominal distribution circuit Primary voltage at the proposed site.
12 kV

G. Approximate circuit distance between the proposed site and the substation.
73628 ft

H. Relevant Line Section(s) peak load estimate, and minimum load data, when available.
See Table 2

I. Number of protective devices and voltage regulating devices between the proposed site and the substation/area.
4 Protective Devices
0 Regulating Devices
0 Auto Transformer Devices

J. Whether or not three-phase power is available at the site.
3-phase

K. Limiting conductor rating from proposed Point of Interconnection to distribution substation.
147 Amps
See Table 3 for more details.

Table 1

Device	A (MW)	B (MW)	C (MW)	D (MW)
Bank	16.4	0.22	0	16.18
Breaker	8.12	0.07	0	8.05

Table 2

Type	Peak (KW)	Min (KW)
Recloser	798.88	0
Recloser	1247	576
Recloser	1709	873
Breaker	3079	1610
Bank	9700	5860

Table 3

Equipment ID	Rating	Length (ft)
397_AAC_C	582	27139
267_AAC_C	452	32262
4/0_ACSR_C	395	827
1/0_AL_XLP-CONC-CIC_22KV_3P	147	7758
4/0_AAC_C	391	2189
1/0_AL_PEC_22KV_3P	147	3465
336_AAC_C	524	2567
4/0_AL_XLP-CONC-PVC_22KV_3P	220	813
715_AAC_C	838	487

L. Based on proposed Point of Interconnection, existing or known constraints such as, but not limited to, electrical dependencies at that location, short circuit interrupting capacity issues, power quality or stability issues on the circuit, capacity constraints, or secondary.

VI. REFERENCES

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