California Biomass Utilization Facility

Economic Viability Assessment

Completed for:

The State of California
Department of Housing and Community Development

THE BECK GROUP

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CALIFORNIA BIOMASS UTILIZATION FACILITY (BUF)

ECONOMIC VIABILITY ASSESSMENT

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TABLE OF CONTENTS

PAGE

CHAPTER 1 – EXECUTIVE SUMMARY

1.1 INTRODUCTION

The US Department of Housing and Urban Development (HUD) administers the National Disaster Resilience Competition (NDRC). The NDRC provides grants totaling up to $1 billion to communities to rebuild in a more resilient way following disasters. The State of California Department of Housing and Community Development won an NDRC grant to help restore forest and watershed health, support local economic development, and increase disaster resilience in areas affected by the 2013 Rim Fire. One objective of the California NDRC grant is planning for the development of a Biomass Utilization Facility (BUF) in Tuolumne County to enhance forest resilience in the region affected by the Rim Fire. The Beck Group, a forest products planning and consulting firm, was retained to assist in the BUF planning effort. BUF planning activities included two major tasks: 1) a biomass feedstock supply study and 2) a feasibility analysis for selected biomass utilizing businesses.

1.2 BIOMASS FEEDSTOCK SUPPLY STUDY

The first step in the BUF planning effort was completing a supply study.[1] The key findings were that within a 40-mile straight line radius of East Sonora, California there is an estimated total of nearly 650,000 bone dry tons (BDT) of biomass is potentially available each year. However, after accounting for consumption by existing users, and for biomass that cannot be practically or cost effectively collected, the net available annual quantity is only about 43,000 BDT. Key findings specific to forest derived biomass (a key focus of the BUF effort) were an annual potentially available supply of 280,000 BDT, a practically available annual quantity of about 171,000 BDT, and a net available quantity of about 33,000 BDT. The estimated delivered cost for forest derived biomass ranges between $25/BDT and $82/BDT depending on biomass type and transportation distance.

Two issues complicate the feedstock supply assessment. First, there is a considerable amount of standing dead timber in the supply area. Normally, standing dead trees are not included in a supply assessment because they decay and as a result have decreasing utility over time. In this case, however, standing dead volume was included in the analysis for two reasons. First, the study area contains many more standing dead trees than one might normally expect. Second, many of the standing dead trees are quite large in diameter, which should allow them to remain useful longer than what might normally be expected. The standing dead volume estimate was adjusted for decay that has already occurred and for the decreasing rate at which trees have been dying due to drought and insect attack. The second complicating factor is that net available biomass quantity could be substantially higher depending on the operating posture of one large existing user in the supply area. This issue is addressed in greater detail in item 3 of Section 1.4 of the executive summary.

The supply study results were used extensively in the technology screening and feasibility assessments described in this report.

[1] https://sierranevada.ca.gov/wp-content/uploads/sites/236/2019/01/NDRCBUFFeedstockSpplyRprt110118.pdf

1.4 BIOMASS UTILIZATION FACILITY FEASIBILITY ANALYSIS

This report identifies and assesses several biomass utilizing businesses that could be developed as a BUF in Tuolumne County. The specific business types assessed in this report are those judged by BECK to have the greatest chance of being viable. BECK used a screening process to narrow a large list of biomass utilization technologies down to a select few judged to be most viable for feasibility assessment. The screening process is described in Chapter 3.

A fundamental assumption in the feasibility analysis is that several distinct but complementary businesses would be developed and co-located on a single site. The benefits of this approach are that resources and costs can be shared among the businesses and the available biomass can be directed to its highest value use. To the consulting team's knowledge, this is the first time such an approach has been modeled in a publicly available report. The businesses selected for feasibility analysis included:

- *Small-scale Biomass Power* – 5 MW biomass power plant that operates under California's BioMAT program selling 3 MW of power to a utility.
- *Small-scale Sawmill* – Small-scale, simple design sawmill utilizing large-diameter standing dead, cull, or off-species logs to produce concrete forming and pallet grade lumber.
- *Post and Pole Manufacturing* – Post and pole manufacturing operation producing posts and poles from small diameter trees and selling output to nearby wood preservation treaters who in turn supply nearby agricultural post and pole markets.
- *Firewood Bundling* – Firewood manufacturing operation producing bundled firewood from small diameter trees that are distributed and sold via retail outlets in California.
- *Biomass Fuel Grinding* – Gathering biomass, using mobile equipment to reduce it to a size suitable for combustion at a power plant, and selling it to a power plant. This business was treated as a standalone business and therefore is not included in **Table 1.1**. It is discussed in greater detail in Section 1.4 of the executive summary and in Chapter 4 of the report.

Table 1.1 summarizes key findings from the feasibility analysis. As the results show, each business is profitable on both an EBIT (earnings before interest and taxes) and EBITDA (earnings before interest, taxes, depreciation, and amortization) or cash flow basis. Combined, the businesses would utilize nearly 50,000 BDT of biomass annually, generate $3.6 million in annual cash flow, and have a combined capital cost of just over $45 million. Note the business's combined annual raw material requirement exceeds the estimated minimum of logs available per the supply study. This issue is discussed in greater detail in Point 3 of Section 1.5. The facility would provide 46 direct jobs and an additional 100 to 150 estimated indirect and induced jobs. Also, on a combined basis, the estimated breakeven delivered raw material cost is $78 per bone dry ton of logs.

Table 1.1 – California BUF Feasibility Assessment Summary

Business Type	Annual Raw Material Needed (BDT)	Number of Direct Jobs	Capital Expense ($ 000)	Annual EBITDA ($ 000)	Annual EBIT ($ 000)	Simple Payback Pre-Tax (Years)	Annual Return Pre-Tax (%)	EBIT/BDT ($/BDT)	Raw Material Del. Price ($/BDT)	Breakeven Delivered Raw Material Price ($/BDT)
Sawmill	25,000	13	9,670	1,126	158	8.6	11.6	6	65	71
Pole	14,056	2	1,150	239	124	4.8	20.8	9	80	89
Firewood	3,800	6	389	76	38	5.1	19.5	10	65	75
Power Plant	27,189 (total) 6,523 (external)	10	33,800	2,177	762	15.5	6.4	28	34	62
Shared Labor		15								
Total	**49,379**	**46**	**45,009**	**3,618**	**1,082**	**12.5**	**8.0**	**22**	**56**	**78**

1.5 DISCUSSION

The feasibility analysis raises several discussion points:

1. Co-location – The modeled businesses benefit from sharing labor, management, raw material, and capital. Perhaps most importantly, the sawmill, pole plant, and firewood operation will generate byproducts (bark, sawdust, etc.). Those byproducts form a key low-cost supply of fuel for the biomass plant. This is because the cost of gathering and transporting that material is borne by the co-located businesses and not by the power plant. Another example of a co-location benefit is that a total of 6 operators of various types of rolling stock would work at the site moving raw materials to processing centers and finished products into inventory or onto trucks for shipment. This approach allows those workers and machines to be more fully utilized by simultaneously serving multiple operations. Additionally, key managerial functions such as safety, human resources, accounting, sales, raw material procurement, repair and maintenance have all been modeled as shared among the businesses and include a total of 9 direct jobs. Similarly, some operating and capital costs can be shared across the businesses. For example, truck scales as a capital cost, or land and office leases and office equipment as shared operating expenses. This approach clearly provides a cost savings for small-scale businesses. See **Table 4.1** and **Table 4.2** in Chapter 4 for additional detail about the assumptions underlying cost sharing.

   A difficulty arising from the co-located approach, however, is that if the businesses are independently owned and operated, the sharing of resources and expenses could quickly become very cumbersome. For ease of modeling, the consulting team treated all the businesses as separate profit centers, but all operating under the umbrella of a single owner. Any entrepreneurs seeking to develop independently owned but co-located BUF businesses will need to find a way to address this issue.

2. Siting – No general arrangement layout drawings were developed at this early stage in the feasibility assessment of the BUF businesses. Therefore, it is difficult to say with certainty how much space the co-located businesses will require. However, the Camage Avenue industrial site used as the focus of the supply study is approximately 5 acres in size and is likely too small

for all the businesses, which would likely require a combined total of about 7.5 to 10 acres. Another potential site is the current Tuolumne County Wood Sort Yard located near Chinese Camp. That site is considerably larger but has the disadvantage of being about 15 miles more distant from most of the biomass resource, which translates into about an extra $5 per bone dry ton in raw material transportation cost. Regardless of the ultimate siting location, the following is a list of the key basic infrastructure needs beyond adequate space include the list below. Please note that the cost for each is site and situation specific so cost estimates are not included.

a. *Electrical Service and Substation* – The site will require a nearby substation capable of interconnecting up to 5 MW of power from the power plant with the electrical grid. Additionally, the co-located businesses will require a combined peak load total of approximately 1.5 MW of electrical power.

b. *Water* – The site will require water for the biomass plant and a connection for the discharge of a small amount of waste water. The biomass plant is expected to require 60 gallons of water per minute for cooling. The cost for securing adequate water supply is contingent on the existing availability and quality of water at the selected site.

c. *Access* – If all businesses are operating at full capacity, the site will receive about 4,000 truckloads of raw material annually (about 14 inbound trucks/day). Additionally, there would be about 1,900 truckloads of outbound finished product annually (about 6 to 7 outbound trucks/day). Thus, the industrial site would have to be located on a road system capable of handling this increased amount of truck traffic and with road improvements (traffic lights, turn lanes, signage, etc.) to ensure safe and smooth flow of traffic.

3. <u>Raw Material</u> – The feedstock supply study found that on an annual basis there is a minimum of about 43,000 BDT of biomass supply that is currently unutilized in the Tuolumne County region. Key assumptions about biomass supply in the study were conservative. These include limiting dead tree volume to only trees greater than 20” in diameter and using a relatively low factor to relate logging slash volume to sawtimber harvest volume. The businesses modeled in the study would use a total of about 50,000 BDT annually. Thus, the businesses would utilize slightly more than is apparently available. However, as described in the supply study, there is one large biomass consumer in the region that may reduce its consumption of forest derived biomass pending changes to California’s BioRAM program. If so, additional feedstock would become available to the BUF businesses. Another possibility is that not all of the co-located businesses may be developed simultaneously. To the extent only some of the businesses were developed, there would be less pressure on raw material. However, if this scenario played out there would also be a downside in that some of the cost savings arising from co-location would not be realized.

4. <u>Timing</u> – The ability of the businesses to be planned, financed, permitted, and developed on a very short timeline was a key consideration in the screening process. It is the consulting team’s opinion that all the businesses modeled could be operating by the end of 2021 or sooner if launched quickly.

5. Biomass Fuel Grinding – The biomass fuel grinding business was treated as a standalone operation. This is because it would be a mobile operation gathering and processing biomass fuel at a variety of sites and would sell the biomass fuel to the highest value market, not just the BUF businesses. The business would provide 3.5 direct jobs, has a capital cost of $1.665 million and generates an operating profit of about $325,000 per year, which translates into about a 5.1 year simple payback period.

   Key assumptions associated with the analysis are that the fuel would be ground as a service to a power plant, or that the fuel processed would be available to the business at no cost. In the latter scenario, landowners elect to provide the business the fuel at no cost in exchange for avoiding fuel disposal cost arising from slash burning or other means of disposal. Additionally, it is assumed that logging slash is already accumulated at log landings, which means the grinding business does not incur a cost gathering the biomass before processing it into fuel. Finally, a 30 percent margin was applied to the "all-in" cost of processing fuel (i.e., grinding). This allowed the business to breakeven on an EBIT basis. Under current market conditions that cost structure can still yield fuel delivered at market prices (about $50 to $55 per BDT), so long as transportation distances are not excessive. However, should the market price of fuel drop or transportation distances exceed the fuel supply area (40 mile radius), the economics of the business would quickly deteriorate. See Chapter 4, Section 4.7 for additional details.

6. Financial Modeling – Except for the biomass power plant, all of the businesses were modeled on a 100 percent equity basis. In other words, the developer would not finance the development of the businesses. While this situation rarely occurs, it is useful for comparing the financial performance of different businesses without having to account for how each business may be financed. Any developer pursuing development of these businesses would likely be able to obtain financing, which would likely increase the rate of return on the developer's equity on the businesses.

   The exception to the 100 percent equity approach to financial modeling is the biomass plant. This is because biomass plants are a much larger capital investment, which makes it more likely to require financing. The availability of a long-term power contract at known rates is the security that is required to allow biomass plants to be financed. Additionally, the biomass plant's financial performance was modeled on an after-tax basis since such businesses enjoy tax benefits often unavailable to other industries. See Appendices 1 to 4 for additional details about the financial modeling of the biomass plant.

7. HUD & Other Assistance – CDBG-NDR funding paid for phase one feasibility studies of BUF development, this report and the supply study. CDBG-NDR funding is also available for project planning and development in the BUF implementation stage (phase two) of the HUD grant. In addition to CDBG-NDR implementation funding, Appendix 6 contains a chart with a list of funding sources for developers wishing to design and operate a BUF business or campus.

1.6 CONCLUSIONS AND RECOMMENDATIONS

Based on the results of the supply study and the feasibility analysis for selected BUF businesses, the consulting team concludes that developing a BUF in Tuolumne County using the concept of co-located businesses is viable. The businesses considered all utilize well proven technologies, can utilize the species found in the region, can be developed and operating quickly, and can do so within California's permitting and regulatory environment.

However, there are several risk factors that need to be carefully considered by BUF developers. First, the supply study found a limited supply of currently unutilized and lower cost biomass raw material. This raw material supply risk may be mitigated in the future pending upcoming policy changes to California's BioRAM program. Also related to supply, a significant portion of the biomass in the region is under public ownership and management. This creates uncertainty in surety of raw material supply from the view point of most commercial lenders.

Second, while each business modeled was found to generate positive cash flows, none of the businesses provided superior returns. This is not surprising given the objective of utilizing lower value forms of biomass. Therefore, entrepreneurs should seek to lower their risk by taking advantage of business development assistance options (e.g., low interest loans, loan guarantees, grants, tax credits, etc.) available from the NDRC program and from other sources.

Third, while the co-location approach provides clear and needed advantages to the BUF businesses, it pushes development efforts toward a single ownership structure. Any developers pursuing a standalone business, but who are willing to consider co-locating will have to navigate structuring of business ownership and/or sharing of resources and costs. Such efforts may slow the development process and limit ability to utilize NDRC assistance, which has a fixed NDR expenditure deadline of June 30, 2022.

CHAPTER 2 – INTRODUCTION

2.1 HISTORY OF WILDFIRE IN TUOLUMNE COUNTY

Wildfire has a long history in Tuolumne County. For example, in 1987 the Stanislaus Complex Fire burned more than 145,000 acres in the Tuolumne and Merced River watersheds. More recently, the Rim Fire burned over 257,000 acres in 2013. Prior to fires that occurred elsewhere in California in the summer of 2018, the Rim Fire was the largest in the State's history.

A build-up of fuel from decades of excluding fire, many standing dead trees from drought and insects, increased tree density, reduced forest management activity, and climate change leading to hotter and drier summers are all cited as wildfire causes. Regardless of the cause or causes, there is increasing public recognition of the need for increasing the pace and scale of efforts aimed at restoring forest health and protecting infrastructure. These typically include forest management treatments such as forest thinning to reduce tree density. Thinning typically allows for removal of smaller diameter trees, retention of the most vigorous trees, and eliminates "ladder fuels", which if present, allow a low-intensity, fast-moving ground fire to climb into tree tops and become an uncontrollable inferno.

A difficulty with wildfire hazard reduction and forest health thinning treatments is that they are costly. On a per acre basis, the cost varies depending on the number and size of the trees harvested and the terrain, but it is frequently in excess of $1,000 per acre. California has about 33 million acres of forest land. Thus, if only 1 % of the acres were treated annually at a cost of $1,000 per acre, the annual total cost would be $330 million. Fortunately, these costs can be mitigated if there are nearby businesses that can utilize the trees harvested during the forest health vegetation management treatments.

2.2 NATIONAL DISASTER RESILIENCE COMPETITION PROGRAM

Given the devastating results of the Rim Fire and the recognized need for increased forest vegetation management, public leaders in Tuolumne County are seeking to address forest health issues. One opportunity identified for meeting those objectives is the National Disaster Resilience Competition (NDRC). It is a national program administered by the US Department of Housing and Urban Development (HUD) that provides grants totaling up to $1 billion to communities to rebuild in a more resilient way following major disaster. The funds are awarded competitively and are designed to promote risk assessment, planning, and the implementation of innovative resilience projects to better prepare communities for future extreme natural events.

2.3 CALIFORNIA BIOMASS UTILIZATION FACILITY PLANNING ASSISTANCE

The State of California received an NDRC grant to help restore forest and watershed health, support local economic development, and increase disaster resilience in the rural areas affected by the 2013 Rim Fire. The monies received will be used as part of the Community and Watershed Resilience Program (CWRP), which is designed to develop three project activities to provide long-term community resilience. One of the project activities of the California NDRC grant is planning for the development of a Biomass Utilization Facility (BUF) in Tuolumne County. Development of a BUF facility is aimed at enhancing forest resilience in the region affected by the Rim Fire. The Beck Group, a forest products planning and consulting firm, was retained to assist in the BUF planning effort. The two major tasks completed in the BUF planning effort were:

1. Supply Study - A biomass feedstock supply study focused on the Tuolumne County region. The supply study was completed by CT Bioenergy Consulting (CTB) of Twain Harte, California, a sub-contractor to BECK.
2. Feasibility Assessment - BECK identified several biomass utilizing businesses and assessed their feasibility in the Tuolumne County region. The results of that assessment are contained in this report.

2.3.1 Feedstock Supply Study Results

The key findings from the feedstock supply study are summarized in **Table 2.1**. As the results show, when all forms of biomass are included (i.e., forest derived, mill byproducts, ag/orchard, and urban) there are an estimated 641,000 BDT of biomass feedstock potentially available each year in an area defined by a 40 mile radius around the Camage Avenue Industrial Park in East Sonora, California. After accounting for material that is not cost-effectively or practically available and for material already being utilized by existing users, the net quantity of annually available biomass is estimated to be about 43,000 BDT.

A focus of the California BUF effort is increased utilization of forest biomass. Therefore, delivered cost estimates were developed specific to forest derived biomass. The results showed that delivered costs ranged from a low of about \$25 per BDT to a high of about \$82 per BDT. Driving factors in the delivered price are the type of material (e.g., logging slash, roundwood from thinning, standing dead trees, etc.) and the distance it must be transported. Importantly, since much of the biomass in the region is already believed to be utilized, existing users are almost certainly consuming material from the lowest cost forest derived sources. Thus, a new biomass consuming business will likely have to pay delivered prices toward the higher end of the delivered cost range.

This report identifies and assesses several businesses that could be developed as a BUF in Tuolumne County. The supply study findings were used extensively in the screening of prospective businesses and in the feasibility analysis of selected businesses.

Table 2.1 - Annual Biomass Feedstock Availability and Demand Within the FSA (BDT/Year)

Biomass Feedstock Type	Quantity Potentially Available	Quantity Practically Available	Quantity Already Being Utilized					Net Quantify Available
	BDT	BDT	Use Type: Biomass Fuel (BDT Logs and Chips)	Use Type: Mulch & Compost (BDT Logs and Chips)	Use Type: Animal Bedding (BDT Logs only)	Use Type: Particle-Board (BDT Logs only)	Use Type: Other (BDT from all Sources)	BDT
Forest Derived Feedstocks	279,659	170,592	105,000	9,000	16,800	4,500	2,000	**33,292**
Non-Forest Derived Mill Residues	124,740	124,740	30,294	5,346	0	30,640	53,460	**5,000**
Non-Forest Derived: Orchard Removals	167,854	167,854	153,000	0	0	0	12,500	**2,354**
Non-Forest Derived: Urban/Industrial & Tree Service	69,522	45,163	15,000	20,000	0	0	8,000	**2,163**
Total	**641,775**	**508,349**	**303,294**	**34,346**	**16,800**	**35,140**	**75,960**	**42,809**

2.3.2 BUF Feasibility Assessment

The remainder of this report describes the process BECK used to identify the biomass utilization technologies judged to be most viable in Tuolumne County and the feasibility assessment completed for the selected businesses. A cornerstone concept in BECK's analysis is that several distinct, but complementary businesses operating together enhance and strengthen the viability of each business. This is a simple concept, but modeling it as separate businesses, under separate owners is challenging and likely different than how BUF businesses will be developed. Therefore, to simplify the analysis, BECK modeled the financial performance of these businesses under a single owner scenario, where each business is treated as a separate profit center, but each business shares some site-wide expenses.

Entrepreneurs interested in establishing a biomass business in Tuolumne County may come forward with standalone businesses, or a suite of complementary businesses, but which are structured differently than what is modeled in this report. Regardless of the ownership structure of any business developed in Tuolumne County, entities interested in pursuing these businesses can utilize up to $20 million in funds from the NDRC grant to assist in planning, developing, and financing these or other biomass utilization businesses. Those funds are available as low-cost loans, grants (to public agencies) for infrastructure improvement, commercial rehabilitation or construction of a facility by a public or non-profit entity, and job training.

CHAPTER 3 – BUF BIOMASS UTILIZATION TECHNOLOGY SCREENING

Described in this chapter is the screening process BECK utilized to determine which biomass utilization technologies had the greatest viability within the Tuolumne County context.

3.1 LISTING OF BIOMASS UTILIZATION TECHNOLOGIES

For at least the last 20 years there has been widespread recognition of the need to identify and develop technologies for better utilizing small diameter trees increasingly common to western U.S. forests.[2] Building on the initial small diameter utilization work of U.S. Forest Service and more recent developments in small diameter tree utilization, BECK identified 34 technologies suited for utilizing small diameter trees (see **Table 3.1**). In general, the technologies listed below utilize either small diameter roundwood (i.e., material sourced directly from the forest in roundwood form) or wood particles (i.e., smaller pieces of wood such as sawdust, bark, chips, etc.) derived from small diameter trees.

For any readers not familiar with some of the technologies listed below, please see an earlier, similar study[3] completed by BECK where the technologies are described in greater detail. Also note a second phase[4] of the same study that includes a feasibility assessment of several of the technologies for utilizing small diameter trees.

Table 3.1 – Listing of BUF Biomass Utilization Technologies Considered for Detailed Analysis

Activated Carbon	Decorative Bark	Large Scale Sawmill	Torrefied Wood Pellets
Air Filtration Media	Decorative Chips	Logs - For Export	Veneer - LVL
Anaerobic Digestion	Erosion Control	Mobile Sawmill	Veneer - Plywood
Animal Bedding	Excelsior	Oriented Strand Board	Biomass Fuel Grinding
Biochar	Extractives	Post and Pole	Whole Log Chipping (Pulp & Paper)
Cellulosic Ethanol	Firewood	Pyrolysis Oils	Wood Pellets
Charcoal	Fuel Bricks/Logs	Small Biomass Power	Wood Plastic Composite
CLT (Mass Timber)	Hardboard	Small Gasification/IC Engine	
Compost/Mulch	Large Scale Biomass Power	Small Scale Sawmill	

[2] Small Diameter Utilization Issues and Opportunities. 1999. Rusty Dramm. https://www.fpl.fs.fed.us/documnts/pdf1999/dramm99a.pdf Exploring the Uses for Small Diameter Trees. 2002. S.L. Levan-Green & J. Livingston. https://www.fpl.fs.fed.us/documnts/pdf2001/levan01a.pdf

[3] https://www.nationalforests.org/assets/pdfs/California-Assessment-Wood-Biomass-Innovation-Interim-Report-June-2015.pdf

[4] https://www.nationalforests.org/assets/pdfs/Phase-II-Report-MASTER-1-4-16.pdf

3.2 SCREENING CRITERIA

To focus the Tuolumne County BUF feasibility assessment on technologies that are most viable, BECK completed a screening process by which the full list of 34 technologies was narrowed to a select few judged to be most viable in Tuolumne County.

The first step in the screening process was developing a set of screening criteria to be applied to each technology. A total of 15 criteria were developed by the consulting team (see **Table 3.2** on the following page). Each criterion was sorted into one of several sub groups and each was given a score. Scoring was completed by a team of BECK staff based on the team's experience, knowledge, and judgment. The total score of all criteria was 100 points. The higher a given technology's score (on a scale of 0 to 100) the greater its viability.

Regarding the grouping of criteria into sub groups, while financial viability criteria are obviously important in screening, several additional criteria were developed specific to Tuolumne County. The result is that four sub categories were identified with each described as follows:

- *Timing* – quick business development and operation. This sub group accounts for 26 of the 100 possible points.
- *Tuolumne County Context* – the ability to utilize local species, utilize live and/or standing dead trees, and appropriately scaled. This sub group accounts for 18 of the possible 100 points.
- *Financial Viability* – market related criteria, costs, proven technology, etc. Combined, the financial viability criteria sub group accounts for 28 of the 100 possible points.
- *Fatal Flaw* – this sub category included criteria, which if possessed by a given technology, eliminated that technology from further consideration. This sub category accounts for 28 of the 100 possible points.

  The Fatal Flaw sub category was developed because during the screening process, the BECK team noted that some technologies score well on nearly all the criteria, but the given technology may have an inherent flaw that destroys the technology's viability in the Tuolumne County context. One example is directly competing with an existing business for raw material. Another example of this phenomenon is wood pellet manufacturing. Global demand from wood pellets continues to grow because they are used as a fuel for heating and as a feedstock in electrical power production. Thus, markets are strong. Additionally, the technology is well proven, a plant could be scaled to the amount of material available in Tuolumne County and a plant could likely be developed on a fairly fast timeline. However, most existing Western North America pellet plants utilize mill byproducts (sawdust and shavings) as raw material. Mill byproducts are generally available for \$35 to \$50 per bone dry ton. Additionally, the material is already appropriately sized for manufacture into pellets. In contrast a pellet plant in Tuolumne County utilizing roundwood will likely have to pay in excess of \$60/BDT. About 10 to 15 percent of the volume by weight would be bark, which is not a desirable pellet feedstock, thus the bark volume would have to be netted out. Additionally, the roundwood material would need to go through a size reduction process that would add additional cost to the raw material. Ultimately, the high cost of raw material in this example versus other producers becomes a fatal flaw.

Table 3.2 – BUF Biomass Utilization Technology Screening Criteria

Count	Criteria Group	Criteria	Max Score
1	Timing	The business/technology can be constructed and be operational within 12 to 18 months of receiving financing.	10
2	Timing	The business/technology has a high likelihood of successfully obtaining required permits, licenses, etc. and they can be obtained within 12-18 months of receiving financing.	8
3	Timing	The business/technology can utilize an existing site to help speed the development process.	8
		Timing Subtotal	***26***
4	TC Context	In order to assist with salvage of standing dead timber but yet be sustainable, the technology can utilize a combination of live and dead raw material.	6
5	TC Context	The technology, in a single location, is scaled to annually utilize the amount of raw material practically available in the California BUF supply region and can be expandable.	8
6	TC Context	The business/technology does not require utilization of a specific tree species.	4
		TC Context Subtotal	***18***
7	Financial	The technology must be able to demonstrate that there is a defined and supportable market segment for the product, with potential demand from multiple customers.	6
8	Financial	The technology, in a single development, should not occupy more than 5% of the total regional market for which it is competing.	6
9	Financial	The technology if receiving, through government mandate, special tax credits allowances, etc., these special circumstances must be shown to be in place for the life of the project debt.	4
10	Financial	The technology proposed must have been successfully demonstrated in a commercial setting, at commercial scale, with similar raw material mix, for at least two years.	8
11	Financial	The technology equipment vendors must offer commercial warranties for performance, environmental compliance and completion, and warranty bonding through commercial sources.	4
		Financial Viability Subtotal	***28***
12	Fatal Flaw	The technology will utilize otherwise unused raw materials (i.e., limited competition with existing users or complementary to existing users).	8
13	Fatal Flaw	Raw material is available to competitors at a substantially lower cost.	6
14	Fatal Flaw	The technology economic structure is such that it can operate profitably (during the majority of an economic cycle) at the delivered raw material costs identified in the California BUF supply study.	8
15	Fatal Flaw	The technology is such that the capital costs are at a level relative to revenues and operating costs where the developer can reasonably expect to have a 10 year or less payback period.	6
		Fatal Flaw Subtotal	***28***
		Total	***100***

3.2.2 Screening Results

Table 3.3 shows the screening scores for the 34 technologies considered. Small-scale biomass heating (e.g., wood-fired boiler), though widely discussed, was not included because the annual biomass usage is very small (e.g., usually less than 500 BDT/year) and the use is only seasonal. Note that all technologies were scored on all criteria, but those possessing one or more fatal flaw have been grayed out and removed from further consideration. See **Appendix 1** for the full scoring breakdown. Based on these results, BECK investigated the feasibility of the non-grayed out businesses including biomass fuel grinding, firewood, post and pole, small biomass power, small/mobile sawmill, and gasification. The feasibility assessment for each of these technologies is described in detail in Chapter 4.

Table 3.3 – Top Rated Technologies

Rank	Technology	Score
1	Biomass Fuel Grinding	79
2	Firewood	75
3	Post and Pole	73
4	Compost/Mulch	71
5	Decorative Chips	70
6	Small Biomass Power	70
7	Small/Mobile Sawmill	68
8	Animal Bedding	68
9	Whole Log Chips for Pulp and Paper	67
10	Logs - for Export	66
11	Erosion Control	65
12	Decorative Bark	64
13	Small Gasification/IC Engine	63
14	Fuel Bricks/Logs	63
15	Small Scale Sawmill	62
16	Biochar	58
17	Air Filtration Media	54
18	Veneer - Plywood	54
19	Activated Carbon	53
20	Veneer - LVL	53
21	Anaerobic Digestion	52
22	Wood Pellets	52
23	Wood Plastic Composite	52
24	Excelsior	52
25	Large Scale Sawmill	49
26	Extractives	47
27	Large Scale Biomass Power	46
28	CLT (and other Mass Timber products)	46
29	OSB	46
30	Charcoal	45
31	Pyrolysis Oils	41
32	Hardboard	41
33	Torrefied Wood Pellets	39
34	Cellulosic Ethanol (and other liquid fuels from woody biomass)	32

CHAPTER 4 – FEASIBILITY ASSESSMENT: SELECTED BUF BUSINESSES

Contained in the following chapter are feasibility assessments of five prospective BUF businesses in Tuolumne County. The business types assessed include:

1. Small scale biomass power
2. Small scale sawmilling
3. Bundled firewood manufacturing
4. Post and pole manufacturing
5. Biomass fuel grinding

The assessment for each business has been organized into four sections including: 1) conceptual plan; 2) market assessment; 3) assessment of existing similar businesses; and 4) feasibility analysis. Note that for the small-scale biomass power analysis four different scenarios of this business were considered, which resulted in one recommended version.

As previously described, the overarching concept applied in the analysis is that these businesses are complementary and operating each in close coordination with the others, which makes the whole suite of businesses more viable than any single business operating independently. This is because such an arrangement would allow sharing of costs and resources and allow for any biomass material delivered to the BUF to be assigned to its highest value use. The exception to the complementary approach is the biomass fuel grinding business, which was assessed on a stand-alone basis.

Any entrepreneur seeking to develop any or all these businesses should independently validate the analysis completed in this study. Also note that to help readers understand various pieces of equipment, BECK included pictures. Use of any particular brand in any picture is not an endorsement by BECK or the State of California of that brand.

4.1 SHARED SERVICES

Before describing the feasibility assessment of each specific business, this section describes how the consulting team assumed that various costs and management functions would be shared among the co-located businesses.

Regarding rolling stock, there are numerous pieces of equipment that are needed for unloading raw material from trucks, placing it into inventory, moving raw material to processing equipment, and moving finished products into inventory or onto trucks for shipment to market. The consulting team assumed all rolling stock would be leased and that the lease, labor, fuel and maintenance costs for rolling stock would be shared among the co-located businesses. **Table 4.1** below summarizes how all rolling stock related costs are shared.

Table 4.1 – Sharing of Rolling Stock Expenses

Equipment Type	Percent of Lease, Fuel, Maintenance, and Labor Cost Allocated to Each Business			
	Power Plant	Sawmill	Post & Pole	Firewood
Large Log Loader	0	80	10	10
Small Log Loader (Posts)	0	0	100	0
Small Log Loader (Firewood)	0	0	0	100
Post Processor	0	0	100	0
Sawmill Forklift	0	100	0	0
Shipping Forklift	0	40	20	40

In addition to shared rolling stock, the consulting team assumed that various managerial functions, repair, and maintenance labor cost, and other general shared administrative costs would be shared across the co-located businesses. **Table 4.2** below summarizes the assumptions about how those functions and the associated costs were assumed to be shared.

Table 4.2 – Sharing of Management, Repair and Maintenance, and General and Administrative Costs

Equipment Type	Percent of Management and General and Administrative Cost Allocated to Each Business			
	Power Plant	Sawmill	Post & Pole	Firewood
General Manager	35	45	15	5
Admin./Clerical/Scale Attendant	35	45	15	5
Fiber Buyer	20	60	15	5
Sales/Shipping Manager	0	60	25	15
Accounting Manager	35	45	15	5
Human Resource Manager	20	50	10	20
Mechanic	0	35	40	25
Maintenance Lead	0	85	10	5
Maintenance II	0	85	10	5
Land Lease	40	40	15	5
Office Lease (triple trailer)	40	40	15	5
Business Insurance	0	60	30	10
Property Insurance	0	60	30	10
Professional Fees & Misc. (incl. tax prep)	40	40	15	5
Office Equipment & Supplies	35	45	15	5

4.2 BUF POWER PLANT

4.2.1 Biomass Power Plant Conceptual Plan

Using biomass to produce electrical power at a small-scale biomass power plant is a business included for detailed feasibility assessment in this study. Historically, very few small-scale biomass power plants (i.e., 5 MW or less) are economically viable. This is primarily because the small plants typically aim to utilize relatively expensive forest derived fuels and because capital costs for developing the small plant are very high per MW of capacity. The high capital and fuel expense outweigh the ability of such small plants to produce enough saleable power and/or thermal energy to recover the capital investment at a rate attractive to investors.

However, in 2012, in order to foster forest management objectives, the California legislature passed Senate Bill 1122, which required Investor Owned Utilities (IOU's) to purchase up to 50 MW of capacity from small biomass power facilities of up to 3 MW, at rates to be determined by a complex pricing mechanism. The program was to be implemented by the California Public Utilities Commission (CPUC) who termed it the Bioenergy Market Adjusting Tariff (BioMAT) program. The rules for that program have evolved over several years, and it now allows for plants of up to 5 MW, selling no more than 3 MW to the IOU. The BioMAT power sales price has been frozen temporarily at $199.72/MWH (fixed power sales price for up to 20 year power purchase agreement). The CPUC is currently reviewing the program, which may cause changes in the power sales price. The current price level is several times that of the current renewable or bulk power markets and may be sufficient to support a small facility.

Additionally, the fuel availability study completed as part of the California BUF study determined that only modest amounts of additional forest derived fuel are available above the current needs of the local forest products industry. Thus, it is the opinion of the project team that a small (3-5MW) facility obtaining a 20 year power contract under the BioMAT program, and possibly supplying heat & power to complementary on-site forest products businesses, would utilize nearly all the currently unused biomass material without markedly competing with existing businesses. Thus, the general conceptual plan considered here is that the biomass power plant would operate under the BioMAT program.

4.2.2 Biomass Power Plant Market

The key customers for the power produced at the prospective California BUF biomass power plant are IOUs such as Pacific Gas & Electric. Under current rules, only the first 3 MW of power can be sold to an IOU. For plants in the 3 MW to 5 MW range, the additional power produced can be sold to an internal user (e.g., sawmill, firewood producer, or post and pole manufacturer) and must also be used to supply the power plant's internal load. California law allows an independent developer to sell power to up to two adjacent entities without the power producer becoming a utility. Since the California power market is typically in excess of 30,000 MW on any given day, the introduction of 50 MW of small biomass power under the BioMAT program is of no consequence to other parties in that larger market.

4.2.3 Existing Biomass Power Producers

A biomass power plant operating under BioMAT, will obtain a 20 year contract to sell power to an IOU at a fixed price of nearly $200/MWH. Thus, so long as a developer is able to obtain a Power Purchase Agreement with an IOU, the sale of the plant’s main product (power) is secured by contract for 20 years. Therefore, the actions of other power plants as they relate to the plant's sales are not a concern as explained above. However, competition for raw material (i.e., biomass fuel) is a concern.

The relationship of the prospective plant to nearby already operating power plants (i.e., Sierra Pacific Industries Standard Sawmill and Pacific Ultrapower) requires further explanation. SPI's facility combusts primarily by-products from its own sawmills. Pacific Ultrapower, operating under a BioRAM contract, has a requirement to utilize primarily fuel from High Hazard Zones (HHZ's) and so would be considered competitive with the proposed BioMAT plant. This should be less of an issue than one would expect, however, as BioRAM plants have been granted additional fuel flexibility under California SB 901. In addition, BioMAT plants have the option (not available to BioRAM plants) to utilize the byproducts from sustainable forest management operations without being in an HHZ.

4.2.4 Biomass Power Plant Feasibility Analysis

Although the basic business concept considered in the biomass power plant analysis is straight forward (i.e., sell power under BioMAT), analysis of the business is complicated by several options related to the size of the plant (i.e., 3 MW versus 5 MW) and several options related to the technology to be used in the plant (i.e., gasification versus direct combustion). Regarding size there are economies of scale that can be gained by making the plant larger. However, those economies of scale are limited by a 5 MW cap on BioMAT projects and further limited by current rules that only allow the first 3 MW of power to be sold at the $200/MWH price.

4.2.4.1 Technology Options

There are currently two primary technology options. *Gasification* involves heating wood in the absence of oxygen. During the heating process volatile gases are released from the wood. Those gases are captured, cooled and cleaned and then combusted in an internal combustion engine to produce power. In contrast, *direct combustion* involves burning wood material in a boiler to produce steam. The boiler steam spins a turbine and generator, which produces electrical power.

4.2.4.2 Four Scenarios Considered

Given the variety of developmental pathways, the consulting team evaluated four scenarios using different combinations of scale and technology. Scenario 3 was the option identified as the preferred approach and is the version for which a more detailed feasibility assessment was completed. The four scenarios considered included:

1. 3 MW standalone plant using gasification/internal combustion (IC) engine technology.
2. 3 MW standalone plant using conventional boiler/steam turbine technology.
3. 5 MW cogeneration plant selling 3MW to the utility and supplying steam heat and power to adjacent businesses as allowed by California law (Preferred Scenario)
4. 5 MW cogeneration plant selling 5 MW to the utility (current CPUC staff proposal) and supplying steam to adjacent businesses. This option presupposes a positive outcome from the staff review of the BioMAT program.

The following common assumptions were used for all four scenarios:

1. 60/40% debt/equity ratio
2. 2021 as first year of operation
3. Construction “bridge” loan for 100% of cost at 2% interest & 2.5% closing cost
4. Term loan for 60% of project cost for 20 years at 2% interest & 2.5% closing cost
5. Project requires $1.0 million in working capital
6. Project obtains $500,000 USFS grant
7. Project qualifies for 100% bonus depreciation in 2021
8. No production tax credit or investment tax credits available
9. Net income taxed at 11% CA income tax and 21% federal income tax
10. Local property tax of 1.2% of full value, declining at 3% annually (assuming land lease and property tax is passed through)
11. All commodities escalate at 2.5% annually for 20 years of evaluation
12. Fuel costs from fuel supply portion of study
13. Project construction exempt from sales and use tax
14. Project obtains BioMAT PPA for 3MW with price of $199.72/MWH fixed for 20 years
15. Environmental analysis required as part of permitting process

The objective in the analysis of each scenario was for the business to obtain a minimum 12% net after tax return on equity over a 20 year analysis period. This is the minimum return that the consulting team believes would attract private investors to a project utilizing biomass fuel primarily from public resources, which is considered riskier than a long-term fuel supply agreement with a private fuel supplier and which requires signing a 20 year power contract with no escalation in the price paid for power. Each of the following subsections, describes the analysis and results of each scenario and the conclusions drawn from the analysis.

Municipal Solid Waste Technology

Another technology option is the combustion of local Municipal Solid Waste (MSW) in combination with biomass. MSW is commonly called garbage and it’s usually disposed of in landfills after recyclable materials are removed. MSW content varies from region-to-region depending on the degree of recycling, but there is always a portion of MSW that could be combusted. From a technical standpoint, this technology is proven. However, from a permitting standpoint combusting MSW dramatically complicates the permitting process, requires significantly greater capital investment in pollution control equipment, and is typically met with strong resistance within the local community. As a consequence, the addition of MSW to the fuel mix for the biomass power facility is not included in this analysis.

4.2.4.2.1 Scenario 1: 3 MW Standalone Gasification/Internal Combustion (IC) Engine Biomass Plant

The project, using the above assumptions, does not meet the 12% IRR target, and in fact has a negative return. Based on BECK’s analysis, in order to meet the IRR target, the project would require construction and long-term debt loans at 0% interest and no closing costs, as well as an additional grant of $4.8 million.

Given the substantial financial assistance needed for this scenario to be economically viable, it was eliminated from further consideration. Nevertheless, included in the following sections are details of the analysis for the benefit of developers interested in gasification technology for biomass power.

Uncertainties in Modeling Biomass Power Using Gasification Technology

Gasification technology has been the technology of choice for several of the initial contracts accepted to date under California's BioMAT program. This is most likely because gasification allows for biochar to be produced as a saleable byproduct of the heat and power generation. There is, however, great difficulty preparing a firm financial analysis of this technology for a BUF application for the following reasons:

1. There is virtually no experience with gasification of mixed forest waste, which is the fuel available to the BUF.
2. A review of available literature indicates that fuels must be dried and sized prior to gasification for a successful operation. There is serious question whether the waste heat from an internal combustion engine is hot enough to dry the fuel without supplemental fuel. Also, the woods fuel, of necessity, will be processed by grinders as opposed to chippers. As a result of grinding there is likely to be a high percentage of rejected fuel in downstream sizing. The exact amount is unknown, but it is likely substantial. The current analysis assumes a reject rate of 50%, which comes from a single screening of ground fuel.
3. The quantity of biochar (as a percentage of incoming fuel) produced has not been established with empirical evidence from an operating unit whose primary function is consistent heat and power production. Also, since the BUF would not come on line until 2021-2022, it is unknown what will happen to biochar pricing. Biochar markets are currently strong and growing, but a small number of new significant producers coming on line could quickly overwhelm the market and cause prices to tumble. This is particularly true in regional markets such as California where BioMAT plants alone may increase biochar production several fold in a short period.
4. Operating costs for gasification plants using mixed forest waste are unknown in the U.S. Virtually every line item in the operations and maintenance budget is an estimate based on other technologies.
5. There is substantial uncertainty over the level of air pollution control technology that will be required for this technology. While gasification equipment vendors claim only low-tech cyclones are required for particulate capture, to BECK's knowledge no project has reached the stage of development and permitting in California that would verify this assumption. Installation of an electrostatic precipitator or baghouse instead of a cyclone would add substantially to cost.

Gasification Financial Model

Under more favorable assumptions, gasification may offer substantial upsides, primarily based on maximization of biochar production and sale. Therefore, BECK developed a financial model (pro forma income statement) included as **Appendix 2**. The model inputs and assumptions are based on a thorough review of the latest International Energy Agency (IEA) Task 33 review of gasification installations, available capital cost offerings for recent California gasification plants, a heat and material balance from IEA Task 33, a review of the Black & Veatch study for the CPUC of gasification technology, a recent Dovetail Partners report on biochar, and discussions with gasification proponents.

Key assumptions included in modeling of a 3 MW gasification installation include:

1. All fuel is dried to 10% moisture using the available waste heat from the gasifier/IC engine combination.
2. The project consists of 3 identical 1 MW gasifier/IC engine trains with common auxiliaries/pollution control equipment
3. The fuel supply does not include the 5,000 bone dry tons/year of mill residuals (sawdust) identified as available in the supply study because that material is too finely sized for the gasifier.
4. The ground woods fuel is screened to a 1 inch size and an estimated 50% is rejected as too fine, with that fraction resold at a net loss of $30/BDT.
5. Plant auxiliary load, including dryer, is estimated at 8% of plant gross load.
6. Gross electrical conversion efficiency of IC engines of 32% of the 75% of total BTU of fuel delivered to gasifier that arrives at IC engines. Gross overall electrical efficiency is thus 24%, with net of 22%.
7. Plant annual operation at full load of 7,000 hours (80% capacity factor) which is understood to be the vendor’s maximum guaranteed operating level.
8. 5% of total incoming bone dry weight of fuel is captured as biochar, with fixed sale value (f.o.b. plant) of $500 per ton.
9. All woods fuel purchased at $55/BDT, escalating at 2.5% annually.
10. Total plant staffing of 6 individuals.

From a financial perspective, the results of the 3 MW gasification scenario are similar to the outcome from a more conventional biomass boiler/steam turbine-generator 3 MW project (Scenario 2). This scenario is hampered by the low utilization factor (80%) due to guarantee constraints, as well as an assumption (verified by a fuel screening test completed as part of this study) that 50% of incoming woods fuel, as well as mill waste, will be too finely sized for the gasifier and must be resold. The project is boosted by the assumption that 5% of all fuel entering the gasifier becomes biochar and can be sold at $500/ton.

In addition to the poor financial performance, gasification technology faces the technical uncertainties described above. Therefore, the consulting team concludes that the conventional technology approach is much more predictable as demonstrated by many currently operational in California. Consequently, the more conventional boiler/turbine arrangement was selected as the basis of the biomass technology utilized in the remaining scenarios.

4.2.4.2.2 Scenario 2: 3 MW Standalone Boiler/Steam Turbine Biomass Plant

This scenario does not meet the 12% IRR target, and in fact has a negative return. In order to meet the target, the project would require construction and long-term debt loans at 0% interest and no closing costs, as well as an additional grant of $4 million. This project is hampered by the assumption that the resulting ash has no value and in fact has a disposal cost. The project also has a high assumed auxiliary power use of 12% of gross output. The financial model (pro forma income statement) for this scenario is included as **Appendix 3**.

With both the 3 MW gasification and 3 MW direct combustion plants having a negative return and needing large grants and zero interest loans to be successful, the consulting team elected to focus on the 5 MW direct combustion cogeneration unit selling 3 MW to the IOU and supplying steam and electricity to adjacent related businesses. The support needed for the 3 MW plants from the available Tuolumne County NDRC grant funds was deemed excessive and therefore, this scenario was eliminated from further consideration.

4.2.4.2.3 Scenario 3 (Preferred Option): 5 MW Boiler/Steam Turbine Cogeneration Biomass Plant

To provide a sense of scale, **Figure 4.1A** illustrates a 3 MW boiler/steam turbine cogeneration power plant located at a sawmill. A 5 MW version, which is what is considered in this scenario would occupy essentially the same footprint for the equipment, but the fuel supply inventory area would be larger. Unlike the two previous scenarios, this scenario provides a positive return. However, to generate a 12% IRR, it requires the project's construction and long-term debt to both be financed at 2% interest and for both loans to have no closing costs. Nevertheless, this scenario was selected as the preferred option because it is the only one that under current BioMAT rules provides a positive return without the needed for significant financial assistance. The financial model (pro forma income statement) for this scenario is included as **Appendix 4**.

Figure 4.1A – 3 MW Boiler/Steam Turbine Cogeneration Power Plant

Preferred Scenario Discussion and Analysis

This scenario assumes that three forest products businesses are co-located on the same site (small sawmill, post and pole manufacturing, and firewood bundling). These businesses would share some resources and costs. Additionally, the businesses would require an average of 4,600 pounds per hour of low-pressure steam for product drying which would be automatically extracted from the turbine at the appropriate pressure. The businesses would purchase an average of 0.25 MW of power for operating electrical motors. The businesses would produce 20,666 BDT per year of biomass fuel as byproducts of their manufacturing processes, which would be sold to the prospective power plant.

The 5 MW cogeneration plant would supply the steam and power needs and would purchase the biomass fuel from the three co-located businesses at $30/BDT escalating at 2.5% annually. The 5 MW plant requires 27,189 BDT of fuel annually during 8,200 hours of annual operation, so that quantity can be supplied by the byproducts of the on-site businesses, plus 5,000 BDT annually of available mill waste (from fuel study) and 1,523 BDT of fuel directly from the woods. The on-site businesses would utilize as raw materials the remainder of the available forest material. These additional revenue streams and lower fuel cost create the positive return.

The 5MW cogeneration plant would use conventional boiler technology, with fuel burned on a rotating or vibrating grate, with up to 60,000 pounds per hour of steam produced at 600 psig, 750 degrees Fahrenheit. The pollution control equipment would consist of urea injection for NOx control and a cyclone and electrostatic precipitator for particulate control. The steam would be directed to a double extraction steam turbine-generator of 5MW nameplate capacity. Automatic extraction of steam would be done for drying loads of customers and for the deaerator. Steam not extracted would be discharged to a hybrid condenser/cooling tower designed to minimize water consumption and eliminate wastewater discharges.

Fuel for the project would be stored on site and blended before entering the boiler. Since the majority of the fuel is from on-site sources or other lumber mills, it is expected that only a small on-site inventory of perhaps three weeks would be required. It will not be necessary to dry the fuel prior to combustion. The 3% of the fuel emerging as ash will be hauled to farm fields for use as a soil additive.

The 5 MW plant would have a total capital cost of $32.56 million, of which $26 million would be the cost of the Engineer Procure Construct (EPC) contract. The remainder of the capital amount is made up of site related costs, project management/permitting, utility interconnection, interest during construction and a working capital amount of $1.0 million. The $3.1 million in initial annual operation expenses are primarily fuel ($930,000), labor and benefits ($840,000), maintenance ($430,000) and property taxes ($390,000). The plant will require a staff of 10 direct employees and will pay a share of consolidated services ($154,000) available on site.

4.2.4.2.4 Scenario 4: 5 MW Boiler/Steam Turbine Cogen Biomass Plant – Continuously Producing 5 MW

An additional variation of the 5 MW project economics was considered. This scenario used a current CPUC staff proposal, which allows 5 MW BioMAT plants to sell up to 5 MW when that power is not needed for internal customers or auxiliary power. Under current BioMAT rules 5 MW plants are limited to 3MW of sales to the utility. If this proposed change in law occurred, it would dramatically enhance project economics, leading to a 30 plus percent IRR even without the discounted loans. This proposal is part of a CPUC staff review of the BioMAT program and is expected to be complete in Spring 2019.

Under this scenario, the plant would consume 41,746 BDT annually, with 16,080 BDT of that coming directly from the woods. The financial model (pro forma income statement) for this scenario is included as **Appendix 5**.

4.2.5 Biomass Power Plant Feasibility - Scenario Summary

In summary, four biomass power scenarios were considered including differing variations of plant size (3 MW vs. 5 MW) and the type of technology used (gasification vs. direct combustion). The analysis was completed using a 12% IRR as a threshold for determining project viability. The results show that Scenarios 1 and 2, both of which are 3 MW plants, do not provide a positive return and require substantial subsidies to achieve a 12% return. Additionally, Scenario 1, utilizes gasification technology and there are several uncertainties about fuel specifications and markets for byproducts (biochar) that add additional risk. Therefore, any combination of biomass plant at the 3 MW scale and direct combustion or gasification technology were not selected as a preferred alternative.

Scenario 3 is the 5 MW plant size scenario in which only 3 MW of power are sold at the BioMAT fixed price of about $200/MWH. This scenario was identified as the preferred scenario because it provides a positive financial return and only modest subsidies are required to boost the return to the 12% threshold established for the analysis.

The fourth scenario was a 5 MW plant continuously producing 5 MW of power and selling all excess to internal needs at the $200/MWH price. The additional revenue generated from increased power sales under this scenario substantially improves economic performance – the plant generates a greater than 30 percent IRR with no subsidies. Despite this scenario's very solid financial performance, it was not selected as a preferred alternative because it is based on a key assumption that is currently only under consideration by the CPUC. If the CPUC determines that BioMAT plants can sell up to 5 MW of power at the $200/MWH price, this scenario would become the preferred alternative.

Table 4.3 below summarizes key metrics associated with each of the small-scale biomass power scenarios considered in this study. As the table shows, capital costs range between $27 million and nearly $34 million. Thus, this business is a substantial capital investment.

Table 4.3 – Summary of Small-scale Biomass Power Scenarios

Biomass Power Plant Scenario	Capital Expense ($ Millions)	External Fuel: forest, mill, etc. (BDT)	Internal Fuel: co-located businesses (BDT)	Total Annual Fuel Needed (BDT)	Delivered Fuel Cost (Year 1 $/BDT)	Incentives Need to Achieve a 12% IRR
Scenario 1: 3 MW Gasification	28.2	0	37,620	37,620	42.50	• Construction loan at 0% interest • Long term debt loan at 0% interest • No loan closing costs • Grant of $4.8 million.
Scenario 2: 3 MW Direct Comb.	27.1	5,000	19,818	24,818	53.00	• Construction loan at 0% interest • Long term debt loan at 0% interest • No loan closing costs • Grant of $4.0 million.
Scenario 3: 5 MW Direct Comb.	32.6	6,523	20,666	27,189	34.00	• Construction loan at 2% interest • Long term debt loan at 2% interest • No loan closing costs
Scenario 4: 5 MW DC/Full Sales	33.8	21,080	20,666	41,746	41.50	• IRR greater than 30% with no incentives needed

4.3 BUNDLED FIREWOOD

This section describes the feasibility analysis for a bundled firewood manufacturing operation including analysis of markets, manufacturing (productivity, yield, and costs), raw material costs, capital costs, and financial performance. Note that this business would operate in coordination with the small-scale sawmill, post and pole, and biomass power businesses considered in this study.

4.3.1 Bundled Firewood Conceptual Plan

There are several firewood market segments including heating, ambiance, and cooking. The heating segment is common to colder climates and users typically produce their own firewood or buy in bulk quantity from a local supplier. The preferred species are typically the locally available hardwood or softwood species that offer the highest heat content when combusted. In the cooking segment the largest users are typically restaurants that buy firewood in bulk and market their food products as being made in a “wood-fired” process. The preferred cooking wood species are often fruit, nut, and other miscellaneous trees including almond, avocado, mesquite, etc. In the ambiance market segment users typically only buy in small quantities for use on a camping or beach trip or for an occasional fire in a home fireplace or backyard fire pit. This group tends to be less discerning about species and thermal content and the material is in demand year-round. Ambiance firewood is most commonly marketed in packaged bundles (see **Figure 4.1B**) distributed through a variety of retail locations (e.g., grocery stores, convenience stores, etc.) and at campgrounds.

Figure 4.1B – Bundled Firewood

Given the characteristics of the various firewood market segments and the species available in the Tuolumne County region, the conceptual plan for the firewood business is to convert smaller diameter roundwood material harvested in Tuolumne County into bundled firewood for the ambiance market. The bundles will be made in Tuolumne County and sold through a distribution network for final sale at a variety of retail outlets within the region. Each bundle will be 0.75 cubic feet, individually wrapped, and unitized into pallet quantities. The firewood will be kiln dried.

4.3.2 Bundled Firewood Markets

As previously described, usage of bundled firewood is generally limited to people living in urban regions who purchase a few bundles at a time for use on a camping trip, backyard fire pit, occasional fire place burning, etc. Estimating the size of California's bundled firewood market is obviously an important consideration. No published information about bundled firewood markets in California was found. Therefore, BECK developed a methodology for estimating the firewood market size. The process involved estimating firewood bundle usage per person per year (i.e., a usage factor) and multiplying the usage factor times the population of a region. To develop the usage factor, BECK estimated usage from a known annual sales volume in a known metropolitan region (Portland, Oregon), which resulted in an estimate of 0.4 bundles per person per year. Because per person usage might differ between Portland and California due to climate differences, BECK adjusted the per person usage in California down to 0.2 bundles per person per year to be conservative in the estimate of the bundled firewood market size.

Table 4.4 below shows California's 24 Metropolitan Statistical Areas (MSA) as designated by the U.S. Census Bureau, the 2015 population of each MSA, the distance between Sonora, CA and each MSA, and the estimated bundled firewood market size in each area. As the results show, the total annual market size in California is estimated to be nearly 7.6 million bundles and within 150 miles of Sonora the market size is estimated to be over 2.4 million bundles. As will be described in a later section, the annual estimated production of the bundled firewood operation will be about 450,000 bundles per year when operating on a 1-shift basis. Thus, the firewood operation would produce an annual number of bundles equaling about 20 percent of the estimated market size within 150 miles of Sonora and about 6 percent of the total estimated market size in California.

One market size consideration needing further analysis is the extent to which home owner's association covenants and local government air-quality related burning bans constrain the use of firewood bundles. A quick review of these issues indicated such restrictions do not appear to be significant.

Table 4.4 – Estimated Annual Bundled Firewood Demand in California (Number of 0.75 cubic foot bundles/year)

Metropolitan Statistical Area	2015 Population (People)	Distance to Sonora	Annual Firewood Bundle Demand
Modesto, CA	538,388	51	108,000
Merced, CA	268,455	57	54,000
Stockton-Lodi, CA	726,106	62	145,000
Madera, CA	154,998	90	31,000
Sacramento–Roseville–Arden-Arcade, CA	2,274,194	94	455,000
Fresno, CA	974,861	112	195,000
San Jose-Sunnyvale-Santa Clara, CA	1,976,836	129	395,000
San Francisco–Oakland–Hayward, CA	4,656,132	132	931,000
Vallejo-Fairfield, CA	436,092	136	87,000
Hanford-Corcoran, CA	150,965	144	30,000
Subtotal (less than 150 miles from Sonora)	*12,157,027*		*2,431,000*
Visalia-Porterville, CA	459,863	154	92,000
Salinas, CA	433,898	158	87,000
Santa Cruz-Watsonville, CA	274,146	169	55,000
Santa Rosa, CA	502,146	170	100,000
Chico, CA	225,411	183	45,000
Bakersfield, CA	882,176	221	176,000
San Luis Obispo-Paso Robles-Arroyo Grande, CA	281,401	248	56,000
Redding, CA	179,533	255	36,000
Santa Maria-Santa Barbara, CA	444,769	280	89,000
Los Angeles-Long Beach-Anaheim, CA	13,340,068	331	2,668,000
Oxnard-Thousand Oaks-Ventura, CA	850,536	336	170,000
Riverside-San Bernardino-Ontario, CA	4,489,159	381	898,000
San Diego-Carlsbad, CA	3,299,521	488	660,000
El Centro, CA	180,191	540	36,000
Subtotal (greater than 150 miles from Sonora)	*25,842,818*		*5,168,000*
Grand Total	**37,999,845**		**7,599,000**

4.3.3 Existing Firewood Producers

The State of California has created the Firewood Task Force (www.firewood.ca.gov) whose mission is initiating and facilitating efforts within the state to protect native and urban forests from invasive pests that can be moved on firewood. According to the CA Firewood Task Force database there are a total of 461 firewood dealers in California including 238 in northern California and 223 in southern California. Most on the list appear to be small operations that sell firewood in bulk. However, there are also those that produce bundles, but again most seem to focus on producing small quantities for nearby campgrounds and small retail outlets. Additionally, based on BECK's experience with other firewood bundling operations, a manufacturer that focuses on providing a product with consistent quality, that is consistently available, and normal standards of customer service should have little difficulty selling their production into the retail distribution chain. Thus, it is believed that competition from other producers will not be a large risk for the operation. However, it is recommended that additional due diligence on this topic be completed for any developer interested in pursuing this business.

4.3.4 Bundled Firewood Feasibility Analysis

Assessing the feasibility of firewood business as conceptually planned involves an analysis of markets, product sales values, plant productivity, operating and capital costs, and a variety of technical and siting considerations. The following sections describe these assessments as they relate to bundled firewood production.

Capital Costs – The capital expenses for this business were estimated on an order of magnitude basis using the best available information from equipment vendors and cost and equipment quotes from past projects completed by BECK. The budgetary capital cost estimate for a bundled firewood business is $389,000 including a 10 percent contingency allowance. Note that several pieces of rolling stock would be required (e.g., a large loader for unloading log trucks, a compact wheeled loader for feeding logs to the firewood processor, and a forklift to load bundles on trucks), but those items were assumed to be leased and shared with other businesses operating on the site.

Table 4.5 below provides a more detailed description of the various components of the estimated capital cost.

Table 4.5 – Budgetary Bundled Firewood Business Capital Cost Estimate

Capital Cost Item	Dollars
Purchased Equipment (e.g. firewood processor, kilns, bundling machines, log transfers, etc.)	171,000
Site Related (prep, footings, shell building, equipment installation, etc.)	88,000
Project Management (permits, licenses, engineering, etc.)	95,000
Sub-Total	*354,000*
10% Contingency	35,000
Grand Total	**389,000**

The key equipment items are described in greater in the following sections.

Firewood Processor – There are numerous firewood processor manufacturers, and all offer various machine types. However, regardless of machine type the process is similar – a long length log is first cut to firewood length (usually 16") and then split into pieces that when used for making firewood bundles are no larger than 5" in width. Two basic types of machines have been developed. In the first a bar saw (similar to a chain saw) is used to cut the pieces to length. This type of processor is generally less expensive to purchase but tends to be less productive and the saw system requires a higher level of maintenance. The second type of processor uses a circular saw to cut the firewood to length. This type is more expensive to purchase but is more productive and requires less maintenance of the sawing equipment. Much of the increase in productivity is due to the kinetic energy stored in the continuously rotating saw blade, which allows for faster cutting time for each firewood block. Regardless of the processor cutting function, all machines include a hydraulic ram that pushes the cut-to-length firewood rounds against a wedge (or wedges) which split the firewood into smaller sizes pieces. See **Figure 4.2** as an example of a bar saw type firewood processor. The estimated capital cost for this type of machine is $50,000.

Figure 4.2 – Example of a Bar Saw Type Firewood Processor

Bundling Machine - Another key piece of equipment in the operation is the firewood bundle wrapper. Again, there are several manufacturers of this kind of equipment and all operate in a similar fashion – a firewood bundle is formed, placed into a specially designed holding tray, and then wrapped with stretch film to hold the bundle together. The machines are typically powered with electric motors but are also available in gas engine powered models. **Figure 4.3** illustrates a typical firewood bundle. The estimated capital cost for this type of machine is $1,500.

Figure 4.3 – Firewood Bundle Wrapping Machine

Product Yield – the yield of finished firewood bundles from the incoming log raw material is described below.

Product Yield – A cord is the standard measurement unit for firewood. It is defined as a volume of wood equaling 4' wide x 4' high x 8' long, or 128 cubic feet. Typically, firewood is cut to 16" lengths, thus a cord is usually thought of as 3 rows of firewood with each row being 16" wide x 4' high x 8' long. If each firewood bundle is 0.75 cubic feet (9" x 9" x 16") then theoretically there are 170.7 bundles per cord. However, to add a degree of conservatism in the financial modeling, a safety factor of 0.9 was applied to the theoretical conversion of cords to bundles. Therefore, it was assumed that a cord of firewood yields 154 saleable bundles.

Additionally, there is a loss of yield because of defects in logs such as crook, rot, and knots. Also, during the process of hauling, unloading, cutting-to-length, and splitting, bark is often lost.

Therefore, it was assumed that only 85% of the incoming raw material volume would end up as a saleable bundle.

Machine Productivity – The following sections provide estimates of the productivity of key machine centers in the firewood bundling business:

Firewood Processor – For the purpose of this study it was assumed that a higher-end, bar saw type machine would be used and that its gross productivity would be just over 2.0 cords per hour (or 2.2 BDT per hour). It was also assumed that after accounting for unscheduled downtime (e.g., waiting for logs, clearing jams, etc.) that the net productivity of the machine would be 85% of the gross productivity, or 1.7 cords per hour (or 1.9 BDT per hour). Also, as described in the preceding yield section an 85% recovery factor was assumed to account for quality defect in logs and bark loss. Thus, the productivity of the firewood processor net of downtime and yield loss is estimated to be 1.5 cords/hour (or 1.6 BDT per hour). **Table 4.6** summarizes the preceding discussion about the productivity of the firewood processor. Note that as shown in the table, the annual raw material purchased by the plant would be the 3,813 BDT which is raw material consumed, net of downtime. To put that volume in perspective, a log truck's payload varies depending on log size, species, and moisture, but assuming the average is 14 bone dry tons per truck, the operation would consume about 270 trucks per year, or just over 1 truckload per working day.

Table 4.6 – Firewood Processor Productivity & Annual Bundle Output

	Cords/Hour	BDT/Hour	Cords/Year	BDT/Year
Gross Productivity	2.04	2.24	4,085	4,486
Productivity Net of Downtime	1.74	1.91	3,472	3,813
Productivity Net of yield loss	1.48	1.62	2,951	3,241
Bundles per Cord (or BDT)			154	140
Bundles per Year (2,000 hours/year)			454,488	454,488

Bundling Machine – Forming and wrapping firewood bundles is a labor intensive process. For the purposes of this study it has been assumed that each laborer can assemble, wrap, and stack on a pallet an average of 60 bundles per hour. This translates into a need for 4 laborers to complete the bundling function (2000 hours/year x 60 bundles per hour x 4 laborers = 480,000 bundles). Note that at 4 laborers there is a small amount of excess capacity since the output of the plant is about 455,000 bundles.

Ongoing Operating Costs – The ongoing operating costs of the business were organized into direct manufacturing costs (e.g., labor, raw materials, drying, supplies, etc.) and fixed costs (e.g., sales, general and administrative, depreciation, etc.). The costs were estimated from a combination of the supply study completed as part of this project, estimated labor costs in the Sonora region, and estimated usage rates and costs of various supplies. The following bulleted list provides more detail on each of the key operating cost categories:

Raw Material – The firewood processor considered for the study can process logs up to 20 inches in diameter. However, it was assumed that the diameter of the logs processed would range from a minimum of 7” to a maximum of 14” with 80% of the volume falling into the 9 to 12 inch range. Based on the CT Bioenergy supply study the range in delivered costs for the different size material is $50 to $80 per ton. For the size mix assumed in the financial analysis the weighted average delivered cost is $65 per bone dry ton. As shown in **Table 4.6** the annual purchased volume of raw material is 3,813 BDT. Thus, the total estimated annual raw material cost is $248,000. Logs would be accepted in random tree-length form to a minimum 4” top size. Maximum log diameter for the firewood processor is 18”.

Labor – The plant would operate 2,000 hours per year and require staffing of six hourly employees. Included would be 1 foreman who would direct and manage the crew’s work and operate the loader to feed logs and move processed/unprocessed firewood; 1 firewood processor operator who would process logs into split firewood pieces; and 4 general laborers who would form the firewood pieces into bundles. The fully-loaded hourly pay rates assumed for these three position types are $39.20, $24, and $22 respectively. Assuming 40% loading for employee benefits, the hourly wage rates for the three position types would be $28.00, $17.14, and $15.71 respectively. Additionally, there would be some sharing of labor costs for processes such as unloading log trucks, loading outgoing freight, etc., the firewood operation’s share was estimated to be $35,280 per year. Thus, the total estimated annual labor cost for the operation including direct hourly at the firewood operation and the allocated labor is $338,000.

Other Operating Costs – Other operating costs included in the financial analysis are fuel, utilities (power), heat for firewood drying, repair and maintenance, rolling stock leases, and packaging supplies. Of these the most significant is packaging supplies with a total estimated annual cost of $98,000. Included packaging costs are the costs for plastic wrap for each bundle, plastic wrap for each pallet, labels for each bundle, and pallets. Key assumptions were $7.00 cost per pallet, 60 bundles per pallet, and a total of $0.08 per bundle for label and wrap, and $0.84/pallet for wrap. Rolling stock leases, kiln drying, utilities, repair and maintenance, and fuel were estimated to annually cost $141,000 combined. Thus, the estimated annual total for all other operating costs is $263,000.

Sales, General, and Administrative Costs – Like the other co-located businesses considered in this study, a key assumption is that there would be sharing of costs and resources so that each business can operate at a lower overall cost level. Included in this assumption is the sharing of functions (and associated costs) such as general management, accounting, human resources, sales, raw material procurement, lease of site and office space, phones, copiers, computers, etc. The firewood business’s share of these shared costs was estimated to total $89,000 per year.

Sales – The following section describes the estimated production of the bundled firewood operation and the estimated revenues generated from bundle sales and sale of byproducts.

> *Firewood Sales* – At the retail level firewood bundles typically sell at somewhere between $4.50 and $6.00 per bundle depending on location, type of wood, retailer, etc. Additionally, it is estimated that on bulky items like firewood bundles, retailers attempt to obtain a 50 percent margin. To be somewhat conservative in the financial modeling, the retail sales value was assumed to average $5.00 per bundle and, given the assumed retailers 50% margin, the delivered to the retailer's distribution center was assumed to be $2.50 per bundle. The price at the firewood plant is net of transportation cost. Transportation costs were calculated as follows: 40 pallets per truckload, 60 bundles per pallet, and an average truck cost of $725 per truckload. These assumptions translate into a per bundle transportation cost of $0.30 and resulted in a calculated f.o.b. plant sales realization of $2.20 per bundle.
>
> *Biomass Fuel Sales* - In addition, to selling firewood, it was assumed that the plant would sell the downfall material produced as part of the manufacturing process. This amount is the difference in annual BDT shown in **Table 4.6** above between productivity net of downtime and productivity net of fiber loss or a total of 572 BDT. However, it was also assumed that only 90 percent of the downfall material would be recoverable for sale. Thus, a total of 515 BDT per year were assumed to be sold to the co-located power plant at a price of $30/BDT.

Financial Analysis – All of the preceding information about capital costs, operating costs, sales realizations, productivity rates and yield factors were entered into a financial model. **Table 4.7** below is a pro forma income statement for the firewood business produced by the model. As the results show, the business is expected to generate just over $1 million in revenue, which is offset by about $977,000 per year in expenses, leaving an operating profit of about $37,000 per year, or about $76,000 per year in annual cash flow (when depreciation cost is added back in). On a 100 percent equity basis, this business is projected to generate about a 20 percent annual return and provides a 5.1 year simple payback.

Discussion - Possible upsides to the business are that a relatively conservative sales price was assumed and slightly conservative safety factors were applied in the yield of raw material to finished bundles. The analysis assumed 100 percent owner equity. If a portion of the business's capital expense were financed with debt, the return on the developer's equity would increase.

Key risks to the business are that raw material costs may be higher than estimated due to uncertainties in competition from other forest products businesses in the region. Also, there may be seasonal and regional "burn bans" that prevent consumers from combusting bundles. The duration and geographic extent of such bans is unknown and unpredictable. There may be periods when sales are constrained by such bans. Finally, it was estimated that the average cost per truck for shipping finished product to market was $725. That estimate is largely based on the assumption that at least a portion of the outbound trucks would be available at a reduced backhaul rate to market. Transportation to market costs could be higher than estimated and are worthy of more detailed due diligence.

Table 4.7 – Projected Proforma Income Statement Tuolumne County BUF Firewood Business

	BDT UNIT BASIS			**BUNDLE UNIT BASIS**		
	BDTs	**Dollars**	**Dollar/BDT**	**Bundles**	**Dollars**	**Dollar/BDT**
Revenues						
Firewood Bundle Sales	3,241	999,000	308.22	454,488	999,000	2.20
Fuel to Cogen Sales	3,241	15,000	4.63	454,488	15,000	0.03
Total Annual Sales	*3,241*	*1,014,000*	*312.87*	*454,488*	*1,014,000*	*2.23*
Expenses						
Raw Material (Net Basis)	3,241	248,000	76.52	454,488	248,000	0.55
Direct Manufacturing - Labor	3,241	338,000	104.29	454,488	338,000	0.74
Direct Manufacturing – All Other	3,241	263,000	81.15	454,488	263,000	0.58
Direct Manufacturing - Subtotal	*3,241*	*849,000*	261.96	*454,488*	849,000	1.87
Fixed – SG&A	*3,241*	*89,000*	27.46	*454,488*	89,000	0.20
Fixed - Depreciation	3,241	*39,000*	12.03	454,488	39,000	0.09
Fixed - Subtotal	*3,241*	*128,000*	39.49	*454,488*	128,000	0.28
Total Annual Cost	*3,241*	*977,000*	*301.45*	*454,488*	*977,000*	*2.15*
EBIT (earnings before interest & taxes)	**3,241**	**37,000**	**17.83**	**454,488**	**37,000**	**0.08**
Plus Depreciation	3,241	39,000	19.28	454,488	39,000	0.09
EBITDA (earnings before interest, taxes, and depreciation)	**3,241**	**76,000**	**37.11**	**454,488**	**101,000**	**0.17**

4.5 POST AND POLE

This section describes the feasibility analysis for a post and pole manufacturing operation including analysis of markets, manufacturing (productivity, yield, and costs), raw material costs, capital costs, and financial performance. Note that this business would operate in coordination with the firewood bundling, small scale sawmill, and biomass power businesses considered in this study.

First, however, it is useful to review some terminology specific to this business. *Posts* are pieces of wood still in round form that are less than 16 feet in length and usually less than 7" in diameter. *Poles* are also pieces still in round form and slightly bigger in diameter than posts, but they are greater than 16 feet in length. Note that poles differ from *utility poles.* The latter are a distinct industry segment where round pieces are typically used to support overhead electrical transmission distribution lines. Given this use, utility poles are subject to more stringent size, species, and strength specifications and tend to be larger and longer than poles. In contrast, poles are used in applications where a somewhat longer piece of roundwood is needed, but where strength is less critical. Peeled, dowelled and treated are also terms with specific meaning in the post and pole industry. *Peeled* refers to posts or poles where the natural diameter taper found in a tree is retained along the length of the post or pole. *Dowelled* refers to posts or poles where the natural taper has been removed through machining so that the post is a constant diameter along its entire length. *Treated* refers to posts or poles that have been infused with chemicals that inhibit decay of the post or pole after it has been placed in use.

4.5.1 Post and Pole Conceptual Plan

The conceptual plan for this business is that small diameter trees sourced from plantation thinning and forest health treatments would be converted to post and pole material. The target market for the posts and poles is the agriculture industry. Therefore, the huge nearby agricultural market in California's Central Valley would be a primary focus area for the business. Since wooden posts and poles are typically placed in the ground and exposed to weather, treating them with chemicals prior to being placed in service extends their useful life. This is because the chemicals inhibit rapid deterioration by the action of mold, bacteria, fungus, and insects. The business considered here would only manufacture untreated posts and poles, which would be sold to wholesalers and/or treaters who would then distribute the materials into the nearby agricultural market. There are a number of wood treating facilities in California.

Additionally, it is anticipated that vast majority of the posts and poles will be manufactured from Ponderosa Pine, which is a predominant species growing in the Tuolumne County region. This is advantageous for the prospective post and pole business because unlike some tree species common to the Western US, Ponderosa Pine more readily absorbs the preservative chemicals injected during the treatment process than many other alternate western conifer species.

4.5.2 Post and Pole Markets

The Western US post and pole market for treated material is comprised of three major end use segments including: fencing, farm/ranch structures; and intensive agricultural applications. Very little published information exists about post and pole manufacturing and markets. The most recent assessment dates back to 2001. In that study, an estimated 60 million linear feet of post and pole material was produced annually in the Western US. Of that amount about two thirds was produced in

Montana and Oregon and only 1 percent or 60,000 linear feet were produced in California. It is likely there has been very little change in California production volumes since the 2001 report, as there is currently only one post and pole manufacturer in California.

Notably, the same study estimated that about 89 million linear feet of post and pole material was treated annually in the Western US. The apparent discrepancy between the 89 million linear feet treated and the 60 million linear feet of post and pole production is due to an imported volume of untreated posts and poles which are subsequently treated in the Western US. Also important, while only a very small amount of post and pole material is manufactured in California, about 23 million linear feet, or just over a quarter of all post and pole treating occurred in California.

This situation reflects several characteristics of the industry. First, the post and pole agriculture market in California is large. Second, the chemicals that are added to posts and poles to enhance service life are heavy. This makes it more cost effective to ship posts and poles to market areas before treatment. Third, Lodgepole Pine has long been a preferred species for post and pole manufacturing because it naturally has little taper, the bark is relatively thin and easy to remove, and it readily accepts chemicals during treatment. Lodgepole Pine is prevalent in Western Montana and Eastern Oregon, which are leading post and pole production areas. Combined, all of these factors explain why historically most posts and poles have been manufactured in the Inland West, while a significant volume was then treated and used in California.

Lodgepole Pine continues to be a preferred species for post and pole manufacturing. However, over the last decade or so, both post and pole manufacturers and consumers have begun utilizing other species including Ponderosa Pine, Douglas fir, True firs, and Western Larch. Therefore, it has been assumed that the use of Ponderosa Pine for this business will be accepted in the marketplace.

The post and pole plant assessed in this study would produce nearly 3 million linear feet of posts and poles per year, or about 3 percent of the 89 million linear foot treated market estimated in 2001. This amounts to approximately 13 percent of California's 23 million linear foot treated post and pole market estimated in 2001. The transportation cost advantage a California post and pole plant would have over manufacturers located in the Inland West is judged to offset any lower sales realization a California post and pole manufacturer may have to bear due to the use of Ponderosa Pine in lieu of Lodgepole Pine.

Finally, not considered in the analysis for this business are markets for untreated material. Nevertheless, it is worth noting that these include roundwood furniture, architectural accents (e.g., rails and balusters for stairs in log home structures), and pole barns and other agricultural industry structures. Thus, there may be potential for selling some of the plant's output to higher value, niche markets that has not been included as part of the analysis.

4.5.3 Existing Post and Pole Producers

As previously described, the most recent publicly available report of the post and pole industry is from 2001. In that study it was found that nearly 60 million linear feet of post and poles were produced annually in the Western US. **Table 4.8** shows the breakdown of that production by state and diameter class. As the results show, California only accounted for about 1 percent of the production. The consulting team believes that little has changed since the 2001 report, since there is only one known post and pole manufacturer in California – Blue Lake Roundstock and it appears that company may have recently stopped operating. Given this situation, the consulting team believes that the prospective business would be in a relatively strong position relative to competitors because competitors would have higher transportation costs for moving untreated posts and poles to treaters in California. As previously described the plant would produce posts and poles from Ponderosa Pine. While lodgepole Pine is the preferred species for post and poles, the data in the table shows states such as South Dakota and Arizona account for nearly 3 million linear feet of production. Ponderosa Pine is the predominant species in these states. This is considered to be further evidence that Ponderosa Pine posts and poles produced by the prospective plant will be accepted by the market place.

Table 4.8 – Estimated Western US Post and Pole Production in 2001 (Millions of Linear Feet)

Diameter Class (inches)	MT	OR	WY	CO	WA	ID	SD	UT	AZ	CA	Total
7 plus	1.03	0.46	0.46	0.30	0.17	0.16	0.14	0.02	0.02	0.00	2.76
5 to 6.9	3.93	5.44	1.22	1.00	1.74	0.55	0.91	0.55	0.14	0.03	15.51
3 to 4.9	12.17	7.72	5.47	3.00	1.66	1.75	1.17	0.52	0.29	0.02	33.77
2 to 2.9	4.00	1.40	1.54	0.20	0.07	0.10	0.10	0.06	0.30	0.01	7.78
Total	21.13	15.02	8.69	4.50	3.64	2.56	2.32	1.15	0.75	0.06	59.8

4.5.4 Post and Pole Feasibility Analysis

Assessing the feasibility of post and pole manufacturing as conceptually planned involves an analysis of markets, product sales values, plant productivity, operating and capital costs, and a variety of technical and siting considerations. The following sections describe these assessments as they relate to post and pole manufacturing.

Capital Costs – The capital expenses for this business were estimated on an order of magnitude basis using the best available information from equipment vendors and cost and equipment quotes from past projects completed by BECK. The budgetary capital cost estimate for a post and pole business is $1.155 million including a 10 percent contingency allowance. Note that several pieces of rolling stock would be required (e.g., a large loader for unloading log trucks, a compact wheeled loader for feeding logs to the dowelling machine, and a processor for cutting logs to post and pole lengths and sorting by diameter in the log yard), but those items were assumed to be leased and shared with other businesses operating on the site.

Table 4.9 below provides a more detailed description of the various components of the estimated capital cost.

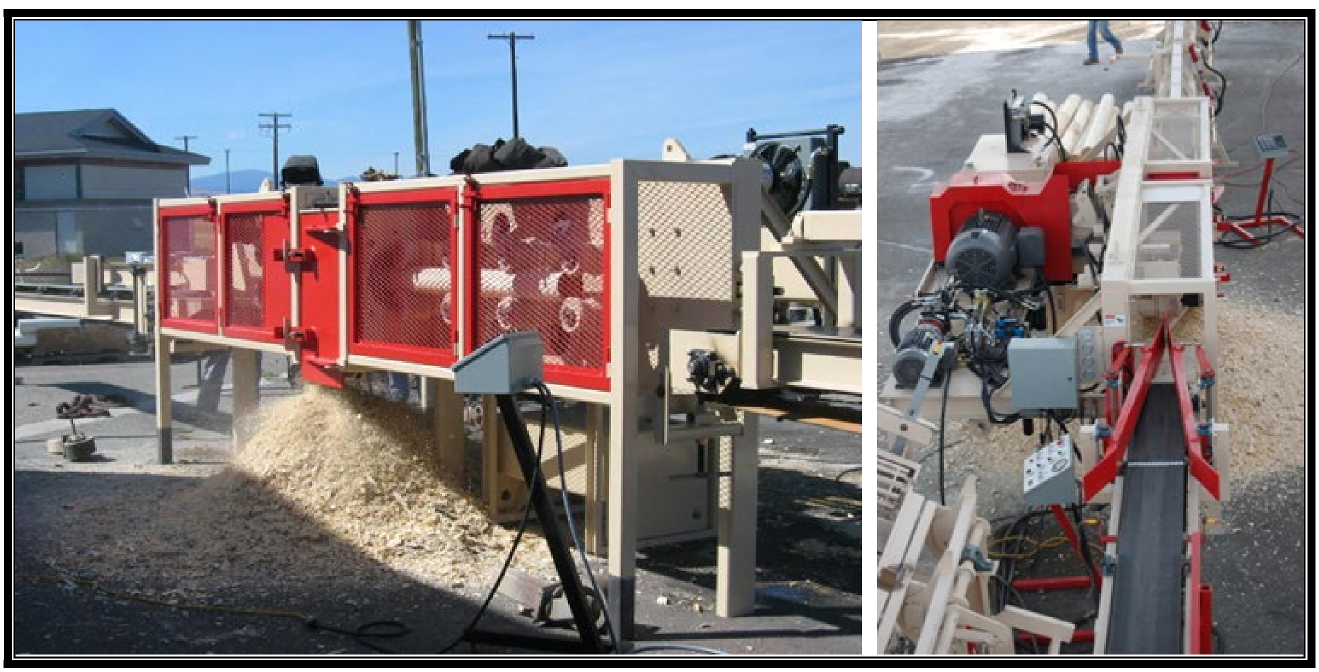
Table 4.9 – Budgetary Post and Pole Business Capital Cost Estimate

Capital Cost Item	Dollars
Purchased Equipment (e.g. dowelling machine, residual handling, packaging station, log transfers, etc.)	625,000
Site Related (shell building, equipment installation, etc.)	375,000
Project Management (permits, licenses, engineering, etc.)	50,000
Sub-Total	*1,050,000*
10% Contingency	105,000
Grand Total	**1,115,000**

The key equipment items are described in greater in the following sections.

Dowelling Machine – The dowelling machine is the key piece of equipment needed for the post and pole manufacturing operation. The version considered in this analysis can process dowels ranging between 2” and 10” in diameter. **Figure 4.4** as an example of dowelling machine produced by Roundwood Systems. As the figure shows dowelling is a linear process by which pieces are fed lengthwise through the dowelling machine’s cutting heads. The estimated capital cost for this type of machine is $300,000.

Figure 4.4 – Example of a Dowelling Machine (source Roundwood Systems)



Log Yard Processor - The consulting team treated the log processor as a leased equipment item, therefore, in our analysis there was no capital cost, only a lease expense. Nevertheless, we have included it in this section because it is a key piece of equipment and some post and pole manufacturers may elect to purchase a log processor as a capital item. A key function in the process of manufacturing posts and poles is cutting the raw material (i.e., tree length stems) into post and pole lengths. Some operations accomplish this task with a log merchandising system whereby tree-length stems are fed into a merchandising line that cuts the pieces to length. Ideally, the merchandising line would also can sort the resulting pieces into diameter groups so that during the dowelling process like-sized pieces can be processed in a large batch. Batch processing of like-size pieces allows for greater yield since the dowel cutting head size can be matched to the diameter sort size. It also allows for enhanced productivity since many like-size pieces can be processed without having to stop the dowelling machine to switch to a different size cutting head. For this business it was assumed that a mobile log processor would be used in the log yard to cut pieces to length and to sort them into like-sized diameter groups. This practice is used at other post and pole operations in the Inland West. **Figure 4.5** illustrates an example of the mobile log processor cutting logs to length and sorting them by diameter in a post and pole yard.

Figure 4.5 – Example of a Log Yard Processor (source Lodgepole Products, Inc.)

Product Yield – The yield of finished posts and poles from the incoming log raw material is described below.

> *Product Yield* – Post/pole diameter and length are critical product specifications when posts are sold. Regarding length, to simplify modeling it was assumed that all pieces produced would be 8' in length. The dowelling machine could, however, produce longer or shorter pieces. Producing longer pieces would have a negative impact on log to post/pole recovery because more fiber is lost to taper as post/pole length increases. For the consulting team's analysis it was assumed that post/poles taper at an average rate of 0.178 inches per lineal foot and that an average of 1" of diameter would be lost from each post/pole to account for bark and sizing the piece to the largest possible size given the small end diameter of the undowelled post/pole. This resulted in a recovery of about 41%. In other words, of all incoming raw material, 41% winds up as finished product and 59% is downfall (e.g., bark, fiber lost to taper, trim ends, and fiber lost to defects such as crook, rot, etc.).

Machine Productivity – The following sections provide estimates of the productivity of key machine centers in the post and pole business:

> *Dowelling Machine* – As previously described the process of dowelling posts/poles is linear. Therefore, machine productivity is directly related to the linear feed rate through the dowelling machine. Feed rate in turn depends on the diameter of the post/pole being processed. For this analysis it was estimated that linear feed rates would range between about 20 and 40 linear feet per minute depending on post/pole size and would average between 25 and 30 feet per linear minute net of downtime and given the estimated post/pole size mix. The result is estimated annual production of about 366,000 posts averaging 8 feet in length.

> *Log Yard Processor* – Importantly, the productivity of the log yard processor must at least match the productivity of the dowelling machine. The average stem length received in the log yard is estimated to be 40'. Thus, each stem will result in five, 8' long posts. It is conservatively estimated that the log yard processor can process 1 stem per minute including sorting the resulting 8 foot lengths into one of about 4 diameter groups. This translates into the ability to process 300 pieces per hour. Over 2,000 hours per year the machine could process 600,000 eight foot pieces, considerably greater than the 366,000 finished posts/poles estimated from the dowelling machine.

Ongoing Operating Costs – The ongoing operating costs of the post and pole business were organized into direct manufacturing costs (e.g., labor, raw materials, drying, supplies, etc.) and fixed costs (e.g., sales, general and administrative, depreciation, etc.). The costs were estimated from a combination of the supply study completed as part of this project, estimated labor costs in the Sonora region, and estimated usage rates and costs of various supplies. The following bulleted list provides more detail on each of the key operating cost categories:

> *Raw Material* – The post and pole operation would require a total of about 14,000 bone dry tons of raw material annually. This material would be a minimum of 16 feet long, have a minimum small end diameter of 4" and a maximum large end diameter of 12". Based on the CT Bioenergy supply study there appear to be thinnings from tree plantations available in the

supply area. The estimated average delivered cost for this material per the supply study is just over $80/BDT. Thus, the total annual raw material cost is estimated to be about $1.13 million.

Labor – The plant would operate 2,000 hours per year and require staffing of four dedicated hourly employees. Included would be 1 foreman who would direct and manage the crew's work and operate the dowel machine; 1 person operating the finished end of the dowelling machine would sort and stack finished units of posts/poles; 1 person operating a small log loader for moving posts/poles to and away from the dowelling machine; and 1 person operating the log yard processor to cut the tree length stems into post/pole size pieces. The total loaded annual cost for the allocated labor across the BUF site and the four hourly employees who are 100 percent dedicated to the post and pole operation is about $284,000 per year. Note there is some additional labor that is shared across the entire facility and that is accounted for in other parts of the financial analysis.

Other Operating Costs – Other operating costs included in the financial analysis are fuel, utilities (power), packaging, repair and maintenance, rolling stock leases, and supplies. The combined annual cost of all these categories is estimated to be $338,000 per year.

Sales, General, and Administrative Costs – Like the other co-located businesses considered in this study, a key assumption is that there would be sharing of costs and resources so that each business can operate at a lower overall cost level. Included in this assumption is the sharing of functions (and associated costs) such as general management, accounting, human resources, sales, raw material procurement, lease for site and office space, phones, copiers, computers, etc. The post and pole operation's share of these shared costs were estimated to total $167,000 per year.

Sales – The following section describes the estimated production of the post and pole operation and the estimated revenues generated from post and pole sales and sale of byproducts.

Post and Pole Sales – There is little publicly available information about post/pole sales values. Therefore, the consulting team relied on a combination of data from the 2001 study and from observing current retail prices for various post diameters and working back from those values to estimate the value a post/pole manufacturer can expect at the plant. The analysis resulted in sales realizations ranging between $0.25 and more than $4.00 per lineal foot depending on diameter. The overall weighted average, however, was $0.68 per linear foot f.o.b. plant or about $5.46 per 8' long piece. Note the wide range in price per lineal foot is caused by differences in post/pole value based on large versus small diameter, not because of poor or limited pricing information. It was estimated that the plant would produce nearly 366,000 posts per year and assuming all are 8' long, the total annual sales of post was nearly $2.0 million.

Biomass Fuel Sales – It was estimated the post and pole plant would generate nearly 8,300 BDT of downfall material (bark, dowel cuttings, and trim ends) that would be sold to the nearby power plant at a rate of $30/BDT. This results in nearly $250,000 per year in sales of byproducts.

Financial Analysis – All of the preceding information about capital costs, operating costs, sales realizations, productivity rates and yield factors were entered into a financial model. **Table 4.10** on the following page is a proforma income statement for the post and pole business produced by the financial model. As the results show, the business is expected to generate just over $2.24 million in revenue, which is offset by about $2.12 million per year in expenses, leaving an operating profit of about $124,000 per year, or about $239,000 per year in annual cash flow when depreciation cost is added back in and working capital cost is accounted for. On a 100 percent equity basis, this business is projected to generate a little over a 20 percent annual return and provide a 4.8 year simple payback.

Discussion - Financial modeling of the post and pole business was approached from a conservative perspective. Possible upsides to the business include: sales price and financing opportunities for initial capitalization. Sales price was conservative due to the species being processed at the plant differing from more broadly preferred species. It may be possible that f.o.b. plant sales realizations modeled here could be higher if the California based plant can capitalize on lower transportation costs to market. In addition, the previously mentioned niche market opportunities exist for producing poles of varying lengths at a higher margin. The plant's location near the robust California agricultural market should provide some longer-term surety in demand for the plant's products. Finally, the analysis assumed 100 percent owner equity. If a portion of the business's capital investment were financed with debt, the return on the developer's equity would increase.

Key risks to the business are that raw material costs may be higher than estimated due to uncertainties in competition from other forest products businesses in the region. Also, limited information about capital cost was available for this business. Therefore, the consulting team used conservative estimates, which likely results in a higher than necessary depreciation expense. Nevertheless, there is the possibility that capital costs could be higher than anticipated for this business.

Table 4.10 – Projected Proforma Income Statement Tuolumne County BUF Post and Pole Business

	Units	Volume	Amount ($)	$/unit
Sales				
Posts and Poles	# of 8' long pieces	365,795	1,997,727	5.46
Downfall (Grindings, Topwood, Bark)	BDT	8,284	248,522	30.00
Sales Subtotal		*365,795*	*2,246,249*	*6.14*
Expenses				
Direct Manufacturing				
Log Cost	# of 8' long pieces	365,795	1,131,814	3.09
Labor	# of 8' long pieces	365,795	284,364	0.78
Utilities	# of 8' long pieces	365,795	78,330	0.21
Packaging	# of 8' long pieces	365,795	32,914	0.09
Maintenance	# of 8' long pieces	365,795	100,000	0.27
Supplies	# of 8' long pieces	365,795	126,680	0.35
Direct Manufacturing Subtotal		*365,795*	*1,754,102*	*4.80*
Fixed				
Depreciation & Leases	# of 8' long pieces	365,795	201,540	0.55
SG&A	# of 8' long pieces	365,795	166,680	0.46
Fixed Expenses Subtotal		*365,795*	*368,220*	*1.01*
Total Operating Costs	*# of 8' long pieces*	*365,795*	*2,122,322*	*5.80*
EBIT (earnings before interest and taxes)	**# of 8' long pieces**	**365,795**	**123,927**	**0.34**
Plus Depreciation	# of 8' long pieces	365,795	115,500	0.32
EBITDA (earnings before interest, taxes, and depreciation)	**# of 8' long pieces**	**365,795**	**239,427**	**0.65**

4.6 SMALL-SCALE SAWMILL

This section contains the feasibility analysis for a small-scale sawmill business including analysis of markets, manufacturing (productivity, yield, and costs), raw material costs, capital costs, and financial performance. Note that this business would operate in coordination with the firewood bundling, post and pole, and biomass power businesses considered in this study.

4.6.1 Small-scale Sawmill Conceptual Plan

Sierra Pacific Industries (SPI) is the largest private timberland owner in California and the company operates two large, industrial-scale sawmills in the Tuolumne County region. Therefore, a key consideration in the conceptual plan for the sawmill considered here is that the mill would focus on processing logs that SPI does not utilize. This means processing logs from oversize and/or standing dead trees where blue stain fungus has lowered the value of the lumber that can be produced but has not affected the lumber's strength properties. Additionally, it means that the sawmill will be limited in scale as a further means of preventing competition for raw material with existing businesses.

Given the limited scale of the operation and the focus on logs with a narrow set of characteristics, other key conceptual plans for the operation are that it would produce a very limited product mix (i.e., only a few lumber sizes), lumber would not be graded but rather sold as "mill run", which means that all lumber produced from the mill is sold at one price regardless of grade or size. The lumber will be kiln-dried, but it will be sold rough (not surfaced/planed). This simple product mix will be targeted to export markets in the Middle East where there is strong and consistent demand for lumber used in concrete forming and as pallet stock, but it's also possible that strong domestic markets for this material may develop. This approach to designing the sawmill allows for keeping capital expenses low, which offsets some of the limitations in scale, output, and opportunities for selling at least a portion of the product mix as higher grade/value products.

4.6.2 Small-scale Sawmill Markets

As previously described the lumber product mix produced by the sawmill would be very simple - only five thickness and width combinations as shown in **Table 4.11**. Note that all lumber would be one length, also note that the sizes are reported in both metric and imperial units. This because the lumber will be exported to various Middle East and North African (MENA) countries. Beck industry contacts with long standing international lumber trading experience report that the region identified as the destination for this lumber consistently consumes about 2 million cubic meters of lumber per year that is used in concrete forming and as pallet stock. The sawmill considered in this analysis will produce about 26,500 cubic meters per year, or a little over 1% of the annual market demand in the targeted geographic market area. In addition, to the consistent demand volume, prices in this region have been very stable for an extended period of time ranging between \$220 and \$230 per cubic meter delivered to port in the Middle East.

While the MENA region is the focus market area for this analysis, there are also markets in Asia and domestically that could be targeted if problems arise in MENA markets.

Table 4.11 – Small-scale Sawmill Lumber Product Mix

Thickness (millimeters)	Width (millimeters)	Length (meters)	Thickness (inches)	Width (inches)	Length (feet)
22	45	4	0.87	1.77	13.12
40	62	4	1.57	2.44	13.12
20	83	4	0.79	3.27	13.12
62	62	4	2.44	2.44	13.12
83	83	4	3.27	3.27	13.12

4.6.3 Small-scale Sawmill Existing Producers

As previously described there are two large, industrial-scale sawmills located near the Tuolumne County region. These include SPI's Standard sawmill and SPI's Chinese Camp sawmill. Both mills are competitive, well-run operations and are likely to remain viable for the foreseeable future. The Standard mill produces a mix of shop and industrial grade boards from pine logs and dimension lumber from fir logs. The Chinese Camp mill primarily processes incense cedar logs into fencing, decking, etc. and into slats for making wooden pencils. As previously described, the small-scale mill considered in this analysis does not plan to compete with either of these mills for logs (or in lumber markets). In fact, it may be possible that either mill will sell their unwanted oversize and cull logs to the small-scale mill.

In addition to the two SPI mills, there is a new mill under development or that just began operations near Fresno. It is Beck's understanding that the new mill has a similar business plan as the mill considered in this study. That mill, however, is about 110 miles from the site considered in this study and therefore, is not considered a competitive threat to the mill assessed in this study.

Additional log users in the region include: 1) the Central Valley Ag Group who is operating a log yard in Oakdale, California. According to the feedstock supply reported conducted as part of this study, that operation plans to ramp up to consuming 10 truckloads of logs per day. The logs are processed into a variety of landscape materials that are used domestically and, in some cases, exported to Asia; and 2) American Wood Shavings in Jamestown, California. This operation converts roundwood logs into bagged shavings that are used as animal bedding. Neither of these operations are considered raw material competitors because both generally utilize small diameter logs than what is planned for the small-scale sawmill considered in this study.

4.6.4 Small Sawmill Feasibility Analysis

Assessing the feasibility of the small-scale sawmill as conceptually planned involves an analysis of markets, product sales values, plant productivity, operating and capital costs, and a variety of technical and siting considerations. The following sections describe these assessments as they relate to small-scale sawmilling.

Capital Costs – The capital expenses for this business were estimated on an order of magnitude basis using the best available information from vendors and from past BECK projects. This includes quotes from equipment vendors for similar types of equipment and quotes specific to this project for other types of equipment. Additional estimates for costs related to buildings, installation, permitting, project management, etc. were modified from similar capital cost estimates on other projects to match the sawmill development plan considered in this study. The budgetary capital cost estimate for the small-scale sawmill is $9.679 million including a 15 percent contingency allowance. Note that several pieces of rolling stock would be required (e.g., a large loader for unloading log trucks, a compact wheeled loader for feeding logs to the sawmill and for sorting and stacking lumber units). Those items were assumed to be leased and shared with other businesses operating on the site. Thus, their cost is not included in the capital spending plan. **Table 4.12** below provides a more detailed description of the various components of the estimated capital cost.

Table 4.12 – Budgetary Small-scale Sawmill Capital Cost Estimate

Capital costs	$ in thousands	Notes
Sawmill equipment & installation	5,320	
Sawmill building	715	
Sawmill subtotal	*6,035*	
Dry kilns	800	Installed
Dry sorting line	500	Breakdown hoist, short pull chain, simple end stacker
Dry sort building	90	Includes area for finished lumber storage
Sprinkler system	250	Sawmill, dry sort, kilns
Truck scales	150	
Other subtotal	*1,790*	
Engineering and Project Management	391	Estimated to be 5% of Capital Cost
Miscellaneous (permits, spare parts, etc.)	200	
Subtotal	*8,416*	
Project contingency	1,262	Estimated to be 15% of total
Grand Total	***9,679***	

The key equipment items are described in greater in the following sections.

Sawmill Machinery – The primary log breakdown in the sawmill will be a horizontal band resaw manufactured by a European firm called Wravor see **Figure 4.6**. Supporting the primary breakdown machine will be several dual horizontal band resaws, a gang edger, and a board edger. All other pieces of equipment in the mill are industry standard design including 2 batch load kilns, various lumber handling, stacking, and sorting systems, and other miscellaneous items. Importantly for the sawmill equipment, a US based company represents the European manufacturer and provides customer support for the equipment. The estimated capital cost for the basic sawmill log breakdown required sawfiling equipment is $2.0 million.

Figure 4.6 – Example of a Small-scale Sawmill

Product Yield – The yield of lumber from the incoming log raw material is described below.

Product Yield – In the Western US yield of lumber from logs is most commonly expressed as a ratio of the board feet of lumber produced over the board feet of lumber estimated to be contained in each log during log scaling. In this case, however, the lumber is targeted for export where, rather than being measured in board feet, it is measured in cubic meters. Since the sawmill expects to purchase the logs on a weight basis, it was estimated that about 48 percent of the cubic volume of each log would be recovered as lumber. The balance of the wood fiber volume in each log not recovered as lumber would be a mix of chips, sawdust, and bark. This estimate of recovery is based Beck project files and log tests conducted at sawmills processing similar size logs using similar breakdown equipment. Any wood fiber not recovered as lumber was considered to be fiber that would be sold to the co-located power plant.

Manufacturing Process – The following section describes the basic manufacturing steps in the sawmill business:

Log Receiving and Storage – Logs will be unloaded from log trucks and placed into storage in the log yard using a large front-end loader. The same loader will also move logs from storage to the log infeed section of the sawmill.

Buck Saw – Logs will be cut down from truck length (~26 feet) to lengths appropriate for processing in the sawmill (4 meter or 13.1 feet).

Primary Breakdown – As previously described the first saw a log will encounter during the sawmilling process is a horizontal bandsaw. Because most of the logs processed will be standing dead, BECK expects that most bark will fall off prior to processing at the sawmill, but the Wravor primary breakdown is equipped with a small cutting head for removing any bark remaining in the saw lines.

Double Resaw – A smaller set of horizontal bandsaws will process “multiples” from the primary breakdown into appropriate thickness for further processing at the board edger or gang edger.

Board Edger – A multi saw board edger will remove “wane” edges to produce square edged pieces ready for end trimming. This machine can also be used to remanufacture boards that to not meet specifications.

Gang Edger – A multi saw gang edger will saw cants into multiple boards ready for end trimming.

Double End Trim – As all lumber produced will be a single length (4 meters), the trimmer will simply trim excess length from each board, so only two, non-moving saws will be required.

Sorting and Stacking – Sawn lumber will be manually sorted and stacked, with kiln sticks between each layer. With a simple product mix and low piece counts (per minute), two people will be able to keep up with the sawmill production.

Kiln Drying – Full stacks of lumber will be taken from the sawmill and placed in one of two dry kilns. Steam is supplied to the kilns from the biomass cogeneration plant.

Dry Sorting Line – Rough, dry lumber will be taken by forklift from the kilns and taken to the dry sorting line, where the kiln sticks will be removed, any reject lumber will be removed, and the lumber will be solid packed and banded, ready for shipping. Finished packs of lumber will be moved to finished product storage by forklift.

Shipping – Lumber will be “stuffed” into standard cargo shipping containers using a forklift. The full containers will then be placed onto trucks and taken to the Oakland port for overseas shipping.

Ongoing Operating Costs – The ongoing operating costs of the small-scale sawmill business were organized into direct manufacturing costs (e.g., labor, raw materials, drying, supplies, etc.) and fixed costs (e.g., sales, general and administrative, depreciation, etc.). The costs were estimated from a combination of the supply study completed as part of this project, estimated labor costs in the Sonora region, and estimated usage rates and costs of various supplies. The following bulleted list provides more detail on each of the key operating cost categories:

Raw Material – The small-scale sawmill would require a total of 25,000 bone dry tons of raw material annually. It is estimated that this material would be comprised of long logs (e.g., 32 to 40 feet long) and have an average bucked log (4 meter long) small end diameter of over 18”. Based on the CT Bioenergy supply study there appears to be over 100,000 bone dry tons of standing dead, large diameter logs available annually, in the supply region. The estimated average delivered cost for this material per the supply study is about $65/BDT. Thus, the total annual raw material cost is estimated to be $1.625 million.

Labor – The plant would operate 2,000 hours per year and require direct staffing of 13 hourly employees, with modest overtime allowance for non-production tasks such as machinery startup and cleanup. Additionally, two employees would operate rolling stock and a portion of their costs were allocated to the sawmill. The average base wage rate for all of the hourly employees is $21.69 per hour and ranges between a low of $18 per hour and a high of $32 per hour. A 40 percent fringe loading factor was applied to all hourly costs. The total annual loaded wages paid to hourly employees at the sawmill is estimated to be about $830,000 per year. **Table 4.13** below shows the staffing plan for the sawmill.

Table 4.13 – Small-scale Sawmill Staffing Plan

Position	Base Wage $/Hour	Position	Base Wage $/Hour
Log Loading	Allocated	Kiln sticks	$ 18.00
Log Bucking	$ 23.00	Green forklift operator	Allocated
Primary Breakdown	$ 23.00	Dry unstacking	$ 18.00
Twin Resaw	$ 23.00	Dry stacking	$ 18.00
Gang Edger	$ 23.00	Cleanup	$ 15.00
Board Edger	$ 23.00	Saw filing	$ 30.00
Sort station	$ 18.00	Supervisor	$ 32.00
Lumber Stacking	$ 18.00		

Other Operating Costs – Other operating costs included in the financial analysis are supplies, utilities, lease costs for the site and office space, and miscellaneous other expenses. The combined annual cost of all these categories is estimated to be $514,000 per year.

Allocated and Sales, General, and Administrative Costs – Like the other co-located businesses considered in this study, a key assumption is that there would be sharing of costs and resources so that each business can operate at a lower overall cost level. Included in this assumption is the sharing of functions (and associated costs) such as general management, accounting, human resources, sales, raw material procurement, office space, phones, copiers, computers, rolling stock and rolling stock labor, etc. The small-scale sawmill's costs in this area include $355,000 for rolling stock (equipment lease, maintenance, and operator labor costs included), $496,000 for administrative salaries, and $43,000 in general and administrative for a total annual cost in this category of $894,000.

Sales – the following section describes the estimated production of the small-scale sawmill operation and the estimated revenues generated from lumber sales and sale of byproducts.

Lumber & Byproducts Sales – the price of lumber delivered to port in the Middle East was estimated to be $225 per cubic meter. After accounting for ocean freight, associated fees, transport to outbound port, the f.o.b. mill sales price was estimated to be about $175 per cubic meter. Additionally, it was estimated that the sawmill would produce and sell about 26,500 cubic meters of lumber annually. Thus, total annual revenue from lumber (net of freight costs) was estimated to be over $4.6 million. In addition, it was calculated that the sawmill would produce about 11,900 bone dry tons of byproducts sold as fuel to the nearby power plant at a transfer price of $30 per BDT, which results in an additional $357,000 of annual sales. Thus, the total annual sales of the sawmill are estimated to be $4.989 million.

Financial Analysis – All of the preceding information about capital costs, operating costs, sales realizations, productivity rates and yield factors were entered into a financial model. **Table 4.14** on the following page is a proforma income statement for the small-scale sawmill business produced by the financial model. As the results show, the business is expected to generate just under $5.0 million in annual revenue. That revenue is offset by about $4.8 million in cost (including depreciation). However, when the non-cash deprecation cost is taken back out, the sawmill produces annual pre-tax cash flow of $1.126 million. On a 100 percent equity basis, this business is projected to generate about a 12 percent annual return, or an 8.6 year simple payback period.

Discussion – The sawmill business model is focused on producing lumber products for overseas export markets from low cost, low value logs. In order for this business to work, simplicity and manufacturing cost controls are important throughout the process. The primary equipment vendor, Wravor, provided a list of equipment and budgetary capital cost estimate based on the desired daily production level and general description of the log supply (large, dead timber – primarily Ponderosa pine). While the Estonia based company has installed equipment in a variety of locations around the world, they do not have any example mills in North America processing similar logs. More research and analysis is recommended to validate the equipment productivity and lumber yields assumed in this feasibility study.

BECK assumed that the sawmill equipment would be installed in an elevated position with byproduct handling systems positioned below, as is typical in larger scale industrial sawmills. This added significant capital costs but reduced operating costs through eliminating low skilled labor positions. It would be possible to reduce capital requirements by more than $1 million by setting the sawmill equipment near ground level, but operating labor costs would be increased, and it is possible that mill productivity would suffer as waste materials are accumulated at various points in the process.

Regarding lumber export markets, the MENA region was selected because this is a relatively stable market with predictable demand and pricing. China is another potential outlet with very large demand as well as similar lumber product quality requirements and delivered pricing. However, the current trade dispute between the U.S. and China, including tariffs on U.S. lumber products entering China, reduces the attractiveness of that market. Assuming that the Chinese trade dispute is eventually resolved, a sawmill based in California would not be totally dependent on the MENA markets over the long term.

It would also be possible to add a planer operation for surfacing lumber. Although this would increase the total capital and operating costs, it would open up a wider variety of markets to the sawmill, some of which would bring higher lumber prices to the mill. However, the relatively low quality of the logs (i.e. blue stain, etc.) means that the operation would not be able serve the same markets as the other sawmills in the area.

A key risk in the business is that there are two existing sawmills in the region. While the consulting team believes this mill would not be competing with those mills for log supply, it is possible that competition for logs could arise. The economic performance of this business quickly deteriorates as log cost increases.

Table 4.14 – Projected Proforma Income Statement
Tuolumne County BUF Small-scale Sawmill Business

	BDT Basis				M3 Basis			
	Unit	**Volume**	**$(000)**	**$/Unit**	**Unit**	**Volume**	**$(000)**	**$/Unit**
Revenue								
Lumber Sales	BDT	13,109	4,632	353.32	M3	26,450	4,632	175.12
Byproduct Sales	BDT	11,891	357	30.00			357	
Subtotal Sales	*BDT*	*13,109*	*4,989*	*380.53*	*M3*	*26,450*	*4,989*	*188.60*
Expenses								
Logs								
Delivered Log Cost	BDT	25,000	1,625	65.00	M3	57,979	1,625	28.03
Yield	%	52%			%	46%		
Log Cost Lumber Basis	BDT	13,109	1,625	123.96	M3	26,450	1,625	61.44
Manufacturing								
Labor	BDT	13,109	829	63.24	M3	26,450	829	31.34
Supplies	BDT	13,109	300	22.88	M3	26,450	300	11.34
Utilities	BDT	13,109	199	15.16	M3	26,450	199	7.51
Other	BDT	13,109	15	1.14	M3	26,450	15	0.57
Allocated Manufacturing								
Rolling stock	BDT	13,109	355	27.10	M3	26,450	355	13.43
Salaries	BDT	13,109	496	37.84	M3	26,450	496	18.76
S,G&A	BDT	13,109	43	3.28	M3	26,450	43	1.63
Subtotal Cash Costs	*BDT*	*13,109*	*2,237*	*170.66*	*M3*	*26,450*	*2,237*	*84.58*
Depreciation	BDT	13,109	968	73.83	M3	26,450	968	36.59
Total Manufacturing Costs	*BDT*	*13,109*	*3,205*	*244.48*	*M3*	*26,450*	*3,205*	*121.17*
Total Costs	*BDT*	*13,109*	*4,830*	*368.44*	*M3*	*26,450*	*4,830*	*182.61*
EBIT (earnings before interest and taxes)	**BDT**	**13,109**	**158**	**12.09**	**M3**	**26,450**	**158**	**5.99**
EBITDA (earnings before interest, taxes, and depreciation)	**BDT**	**13,109**	**1,126**	**85.92**	**M3**	**26,450**	**1,126**	**42.58**

4.7 BIOMASS FUEL GRINDING

This section contains the feasibility analysis for a mobile biomass fuel grinding business including analysis of markets, manufacturing (productivity, yield, and costs), raw material costs, capital costs, and financial performance. Note that this business would “stand alone” from the other businesses analyzed in this study. Also note that a stationary grinding fuel business is also possible, but it has not been evaluated in this study. Under a stationary scenario, biomass would be brought to a central location for processing rather than processing in the field. Finally, note that the business considered would only focus on processing biomass into fuel. Transporting the fuel to consumers would be a function completed by other businesses.

4.7.1 Biomass Fuel Grinding Business Conceptual Plan

Biomass power plants consume large volumes of fuel annually. The plants typically use conveyors, screw augers, or pneumatics to move biomass fuel from storage into the combustion zone of a boiler. Each of those types of systems are sensitive to the physical size and shape of biomass and preparing fuel to an appropriate size and shape is an important aspect of efficient biomass plant operation. Fuel sizing and preparation is often accomplished with a mobile grinder.

Three biomass power plants currently operate in the region surrounding Tuolumne County including Sierra Pacific Industries’ 7.5 MW plant at the Standard sawmill in Sonora; Pacific Ultrapower’s 20 MW plant in Chinese Station; and DTE Stockton, LLC’s 45 MW plant in Stockton. Additionally, another possible customer is one of the businesses considered in this feasibility study (i.e., a 5 MW biomass power plant that would operate under California’s BioMAT program). Except for mill byproducts and some agricultural residues (e.g., almond shells) nearly all forms of biomass fuel need to be ground prior to combustion. The need for grinding wood fiber from forest-derived, ag/orchard, and urban wood waste sources creates a business opportunity. Therefore, this portion of the feasibility analysis assesses development of a biomass fuel grinding business. While the business could process all types of biomass (e.g., urban, ag/orchard, etc.) focus is given to processing forest-derived biomass (e.g., logging slash and small diameter trees harvested during forest health and wildfire hazard reduction treatments) into fuel and then selling it to nearby power plants.

4.7.2 Biomass Grinding Markets

A biomass fuel grinding business processes various forms of wood fiber into small pieces, which are then sold as biomass fuel. Thus, the key customers for such a business’s products are power plants that purchase biomass fuel and combust it to produce power and/or thermal energy. As described in the preceding section, there is a total of 72.5 MW of existing biomass power plants operating relatively close to Tuolumne County. Additionally, this study assesses the feasibility of a 5 MW plant that would operate in or near Sonora.

Table 4.15 summarizes the total estimated annual demand for fuel from each of these plants. Note that each of the power plants listed only sources a portion of their total fuel needs from sources that require grinding. That portion varies with market conditions, supply, and seasonality which makes it difficult to precisely estimate the portion of the overall fuel supply procured from forest derived sources. Therefore, the columns in the table headed by 100, 75, 50, and 25 percent show annual fuel demand as a given percentage of the total. For example, if all of the existing and prospective plants obtained 50% of their fuel from forest derived sources the total annual demand would be 230,000 BDT. SPI uses predominantly mill byproducts. For the other plants, however, it is almost certain that at least 50 percent of all fuel is ground and possibly as much as 80 to 90 percent. Thus, there is a substantial annual market for ground biomass fuel in the region. Finally, note that the estimated fuel demand assumes that each plant operates at 90 percent capacity and that each plant consumes 1 BDT of fuel per MWH of power produced.

Table 4.15 – Estimated Annual Fuel Demand at Nearby Existing and Prospective Biomass Power Plants (BDT per year)

Existing Power Plant	Capacity (MW)	Current Status	Distance from Camage Ave. Industrial Site (Miles)	Estimated Annual Fuel Demand (BDT)			
				100%	75%	50%	25%
SPI	7.5	Operating	0	59,000	44,000	22,000	6,000
Pacific Ultrapower	20	Operating	16	158,000	119,000	60,000	15,000
DTE Stockton	45	Operating	68	355,000	266,000	133,000	33,000
Subtotal	*72.5*			*572,000*	*429,000*	*215,000*	*54,000*
Prospective Power Plant	**Capacity (MW)**	**Current Status**		**100%**	**75%**	**50%**	**25%**
Sonora BioMAT	5	Feasibility	0	39,000	29,000	15,000	4,000
Grand Total	*77.5*			*611,000*	*458,000*	*230,000*	*58,000*

4.7.3 Biomass Fuel Grinding Existing Producers

Biomass grinding businesses are typically mobile and because they are often included as an “add-on” to an existing business (e.g., a logging contractor will often add a grinding operation), they are by their very nature difficult to monitor and assess. Nevertheless, it is estimated that within the Tuolumne County region there are currently nearly a dozen grinding operations. Included are seven that focus on processing forest derived biomass and four that primarily process biomass arising from orchard removals. Of those focused on processing forest biomass, four are grinders that logging contractors use to supplement their logging operations when needed. The remaining three operate as smaller scale forest material processing yards where forest material is accumulated and then a grinder is periodically brought to the site to process the material into biomass fuel. Any entrepreneur considering a grinding business should conduct further analysis about the capacity of existing grinding operations in the region.

Another aspect of a grinding business is that after fuel has been processed to size, it must be transported to a power plant. This is typically accomplished in what is called a chip truck which is a combination of a semi-tractor and an open top trailer (often called a van) for hauling biomass (see

Figure 4.7). There are currently an estimated 40 to 45 chip vans operating in the Tuolumne County region. Included are about 10 dedicated to transporting forest biomass; 10 to 15 dedicated to transporting mill byproducts and landscape material from SPI's nearby sawmills; and 20 or more dedicated to transporting orchard removal biomass. For the feasibility analysis, it has been assumed that the existing fleet of chip trucks in the region could absorb the output of another grinding operation. Any entrepreneur considering a grinding business should conduct further analysis about trucking capacity in the region.

Figure 4.7 – Chip Van Being Loaded to Transport Biomass Fuel

4.7.4 Biomass Fuel Grinding Feasibility Analysis

Assessing the feasibility of biomass fuel grinding involves an analysis of markets, product sales values, productivity, operating and capital costs. The following sections describe these assessments as they relate to biomass fuel grinding.

Capital Costs – The capital expenses for this business were estimated on an order of magnitude basis using the best available information from equipment vendors and cost and equipment quotes from past projects completed by BECK. The budgetary capital cost estimate for a biomass fuel grinding business is $1.665 million including a 10 percent contingency allowance.

Table 4.16 shows the list of key equipment needed to support a biomass fuel grinding operation. As shown, in addition to a grinder, the operation also requires an excavator/loader for feeding biomass to the grinder, a bladed skidder or bulldozer for moving fiber into piles, a trailer for moving equipment, a service truck, a fuel tank, and a water truck. A "high-level" budgetary capital cost for all of this equipment is $1,515,000. With respect to staffing, a single grinding operation would likely require three people – two equipment operators and a manager. However, if staffed at that low level, it would require people with a unique blend of skills including heavy equipment operation, mechanical knowledge, and administrative and management skills.

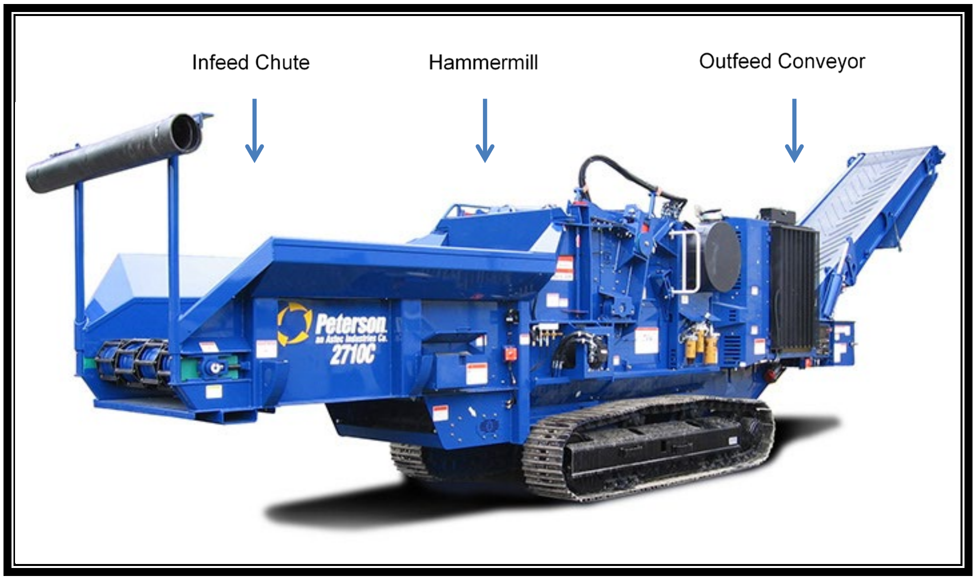
Table 4.16 – Estimated Capital Expense for Grinding Operation

Equipment Item	Estimated Capital Cost ($)
Horizontal track grinder	850,000
Excavator/Loader	275,000
Front End Loader	200,000
Equipment trailer	50,000
Service truck	60,000
Fuel tank	5,000
Water truck	35,000
Pick-up truck	40,000
Subtotal	*1,515,000*
Contingency (~10%)	150,000
Grand Total	*1,665,000*

The key equipment items are described in greater in the following sections.

Horizontal Grinder – There are numerous biomass grinder manufacturers and most offer similar designs. **Figure 4.8** is an example of typical of mobile, diesel powered units. For the business considered in this study, a mobile diesel-powered unit is recommended since fuel will be processed at a variety of sites and mobility is required. Mobile grinders are self-propelled and mounted on tracks, with a maximum speed of 1.5 mph. They are typically operated by remote control that start and stop the grinding mechanism, infeed and outfeed belts, and to move the machine from place to place, as needed. Because of their slow movement speed, productivity is typically highest when dealing with large piles of unground biomass where movement is minimized, and productive grinding time is maximized.

Figure 4.8 – Horizontal Grinder



Tracked Loader - The grinder operates in tandem with a tracked loader, which feeds the biomass to the grinder. The loaders are typically equipped with a grapple that grabs large "scoops" of biomass (logging slash, roundwood, etc.) and places the material onto the infeed of the grinder. Although not necessary, a grapple head capable of rotating a full 360 degrees is helpful to ensure maximum productivity. Many operations maintain additional equipment so that the grapple head can be quickly swapped for other tools for breaking up slash piles, scooping fuel, etc. **Figure 4.9** illustrates a loader (behind the grinder) feeding small diameter roundwood/topwood into a horizontal grinder. From a staffing perspective, it is important to note that the loader operator also controls the grinder via remote control. Thus only 1 person is needed to operate both pieces of equipment.

Figure 4.9 – Tracked Loader

Machine Productivity – This is a critical aspect in the ultimate profitability of any grinding operation. Several machines must operate in close coordination including the trucks, the grinder, and the loader. For example, for the system to operate efficiently the grinder must be placed close to large biomass piles, the loader must be able to keep the grinder loaded with material to grind and moving the grinder from pile to pile must be kept to a minimum. Additionally, chip vans must always be available so that the grinder can feed its output directly into a waiting truck.

Given the variability in terrain and the associated size of slash piles at landings and the difficulty in scheduling trucks, grinder productivity can be highly variable. However, for the purposes of this analysis it has been assumed that the grinder can produce an average of 25 BDT per hour. This rate is consistent with that of a published study.[5] Additionally, it was assumed that the operation would run 6 days per week for 33 weeks per year and 10 hours per day. This results in annual output of nearly 43,000 BDT per year.

Operating Expenses – The ongoing operating expenses of this business were organized into four categories: labor, fuel, all other direct operating expenses (e.g., supplies, repair & maintenance, etc.), and general and administrative expenses. Expressed on a dollars per ton basis, the estimated operating costs for the biomass fuel operation are estimated to be about $24.50/BDT.

Labor – It was assumed that the operation would require two employees a loader/grinder operator and a helper. The two would perform routine preventative maintenance on the various pieces of equipment and would operate the equipment to produce biomass fuel. Any more extensive repair and maintenance would be performed by others and those costs are included in the "all other" category below. The loader/grinder operator would act is the crew lead and be compensated at a rate of $31.50 per hour (fully loaded at 40% fringe loading). The helper would be compensated at a rate of $22.40 per hour (fully loaded at 40% fringe loading). Each would work 2000 hours per year. Labor is estimated to cost nearly $2.00/BDT.

Fuel – This is one of the biggest expenses of the operation and daily diesel fuel consumption is estimated to be nearly 300 gallons. The per gallon cost was estimated to be $3.50 per gallon. Fuel is estimated to cost nearly $5.00/BDT

All Other - This category includes all other operating expenses such as lube, repair and maintenance, etc. These costs were estimated to be nearly $7.00/BDT.

General and Administrative – These expenses were estimated to total $149,000 annually and included nearly $100,000 in loaded salaries for a manager and part time clerical support. Additionally, an annual expense of $50,000 was included for business and liability insurance, professional fees, etc.

Depreciation – As described in the capital expense section, the estimated capital costs for this business are about $1.67 million. Based on a 5 year depreciation schedule and production of nearly 43,000 BDT per year, the depreciation cost for this business is estimated to be nearly $8/BDT.

[5] A Productivity and Cost Comparison of Two Systems for Producing Biomass Fuel from Roadside Forest Treatment Residues. 2012. Nathaniel Anderson et al. https://www.fs.fed.us/rm/pubs_other/rmrs_2012_anderson_n002.pdf

Sales – In many regions biomass fuel is commonly sold at a price resulting from a buildup of the cost of producing the material. In other words, the unprocessed fuel has virtually no inherent market value, therefore, it sells at a price just high enough to cover the producer's cost and allow for profit. In this case, based on the estimated operating costs, a profit allowance of approximately 30% was added to the production cost, or about $7.70 per BDT. A profit allowance at that rate allows for the owner's profit to essentially equal the depreciation cost (5 year depreciation schedule).

Given the preceding assumptions, this analysis results in an "all-in sales price" of about $32/BDT for biomass fuel. If the fuel averages 40 percent moisture, the average payload per truck is just over 15 BDT, the average round trip time is 2.5 hours, and the average truck cost is $115 per hour then the average transportation cost of the fuel would be about $22.50 per BDT. Thus, the delivered price of the fuel would be about $54 per BDT, a price that is consistent with current market conditions in the Tuolumne County region.

Financial Analysis – All of the preceding information about capital costs, operating costs, sales realizations, and productivity rates were entered into a financial model. **Table 4.17** below is a proforma income statement for the biomass fuel grinding business produced by the model. As the results show, the annual sales revenue of the business is estimated to be about $1.375 million, which is offset by about $1 million in operating expenses leaving an operating profit of about $325,000 per year.

This business is affected by seasonality – during the winter little grinding can happen because of weather related constraints. Therefore, a possible upside to the business is to move the grinder to lower elevation during the winter and grind ag/orchard and/or urban wood wastes during the winter. The additional output would reduce the per unit operating costs on the fixed cost portion of the operation (General and Administrative and Depreciation expenses). Another possible upside is for a biomass fuel grinding business to be an incremental business area added to an existing business. In other words, the economic feasibility of this business would be improved if a logging contractor added a grinding operation. This is because the logging contractor would already have in place some of the equipment and administrative staff needed to operate the business. Thus, the capital and operating expenses would be lower in this scenario.

There are several significant risks to this business. First, a key assumption in the financial analysis is that all biomass produced would have no cost. In other words, the landowner would be willing to give any material to the biomass business in order to avoid the cost and risk associated with open pile burning of logging slash and/or small diameter trees. Another key risk is that a 30 percent profit allowance on costs was included. Under current market conditions and the other cost estimates included in the analysis, the profit allowance assumption still allows for total delivered costs within current market conditions. However, a drop in market prices would quickly have serious negative financial consequences. A third key risk is that the economics of the business are highly sensitive to the productivity of the grinding operation. For example, a 10 percent drop in productivity increases costs by about 12 percent. Finally, the high capital cost relative to the annual revenue and the short useful life of the equipment is a significant risk factor for this business.

Table 4.17 – Biomass Fuel Grinding Business Proforma Income Statement

	BDT	Dollars	$/BDT
Revenues			
Annual Sales (Fuel Delivered to Biomass Plant)	42,830	2,329,000	54.38
Trucking Expense (performed by contractors)	42,830	966,000	22.55
Total Annual Net Revenue	42,830	1,363,000	31.82
Expenses			
Labor	42,830	77,000	1.80
Fuel	42,830	202,000	4.72
All other (supplies, repair & maintenance, etc.)	42,830	287,000	6.70
Sales General & Administrative	42,830	149,000	3.48
Depreciation	42,830	333,000	7.77
Subtotal Expenses	42,830	1,048,000	24.47
EBIT (earnings before interest and taxes)	**42,830**	**314,000**	**7.33**
+ Depreciation	42,830	333,000	7.77
EBITDA (earnings before interest, taxes, and depreciation)	**42,830**	**647,000**	**15.11**

CHAPTER 5 – APPENDICES

5.1 APPENDIX 1 – FULL CALIFORNIA BUF SCREENING MATRIX

(Columns/Rows with grayed out cells indicate a Fatal Flaw)

Technology	Screening Criteria	Screen 1	Screen 2	Screen 3	Screen 4	Screen 5	Screen 6	Screen 7	Screen 8	Screen 9	Screen 10	Screen 11	Screen 12	Screen 13	Screen 14	Screen 16	Total Score
	Max Score	**10**	**8**	**8**	**8**	**6**	**6**	**8**	**4**	**8**	**6**	**6**	**6**	**4**	**8**	**4**	**100**
Whole Log Chipping/Grinding for biomass heat and/or power		10	7	7	7	3	6	7	4	5	4	4	5	1	5	4	79
Firewood		10	6	8	7	3	5	4	1	5	4	4	5	4	5	4	75
Post and Pole		8	5	5	3	2	5	7	3	7	4	5	6	4	5	4	73
Compost/Mulch		9	6	7	6	1	6	8	4	1	1	5	4	4	5	4	71
Decorative Chips		9	6	6	7	1	6	6	4	1	1	5	5	4	5	4	70
Small Biomass Power		2	2	6	7	2	6	7	4	7	3	5	6	4	5	4	70
Small/Mobile Sawmill		10	7	8	2	3	6	2	2	5	4	4	4	4	3	4	68
Animal Bedding		9	6	8	1	1	5	7	3	5	4	4	2	4	5	4	68
Whole Log Chips for Pulp and Paper		10	7	8	6	2	4	4	3	1	1	2	6	4	5	4	67
Logs - for export		9	6	8	1	3	6	1	3	4	4	3	5	4	5	4	66
Erosion Control		9	6	6	6	1	6	6	4	1	1	3	3	4	5	4	65
Decorative Bark		9	6	6	6	1	2	6	4	1	1	5	4	4	5	4	64
Small Gasification/IC Engine		2	2	6	7	2	6	7	4	7	3	5	6	4	1	1	63
Fuel Bricks/logs		8	6	6	6	1	4	2	2	3	2	5	5	4	5	4	63
Small Scale Sawmill		8	6	5	1	2	5	6	3	1	1	5	6	4	5	4	62
Biochar		8	6	8	6	1	5	7	4	3	2	1	1	4	1	1	58
Air filtration media		8	5	6	6	1	4	7	4	1	1	1	2	4	3	1	54
Veneer - Plywood		3	4	2	1	2	4	2	2	7	4	5	5	4	5	4	54
Activated carbon		6	5	6	6	1	4	7	4	3	2	1	2	4	1	1	53
Veneer - LVL		3	4	2	1	2	4	2	1	7	4	5	5	4	5	4	53
Anaerobic digestion		5	5	6	6	1	4	7	4	1	1	1	3	4	3	1	52
Wood Pellets		4	5	2	6	1	5	2	2	3	2	2	5	4	5	4	52
Wood Plastic Composite		5	4	2	6	1	5	2	3	3	1	3	4	4	5	4	52
Excelsior		6	5	6	6	2	1	7	1	1	1	2	2	4	5	3	52
Large Scale Sawmill		1	2	1	1	3	5	1	1	5	4	6	6	4	5	4	49
Extractives		5	4	5	6	1	2	6	1	3	2	2	2	4	3	1	47
Large Scale Biomass Power		1	2	2	1	2	6	1	4	4	2	5	5	2	5	4	46
CLT (and other Mass Timber products)		4	5	5	1	3	1	2	1	4	3	2	4	4	4	3	46
OSB		1	1	1	2	2	5	1	2	7	1	5	5	4	5	4	46
Charcoal		2	2	2	2	1	5	2	4	3	1	4	4	4	5	4	45
Pyrolysis oils		5	4	4	3	1	3	4	2	1	1	2	2	4	3	2	41
Hardboard		1	1	1	2	1	2	2	4	4	2	5	3	4	5	4	41
Torrefied Wood Pellets		3	4	2	4	1	5	2	3	1	1	2	2	4	3	2	39
Cellulosic Ethanol (and other liquid fuels from woody biomass)		2	2	1	6	1	4	2	4	1	1	2	3	1	1	1	32

5.2 APPENDIX 2 – 3 MW, NO COGEN, GASIFICATION, BIOMASS PLANT

20 Year Income Statement

All Units ($)	Year 0	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	Total
REVENUE																						
Electric Sales		4,180	4,180	4,180	4,180	4,180	4,180	4,180	4,180	4,180	4,180	4,180	4,180	4,180	4,180	4,180	4,180	4,180	4,180	4,180	4,180	83,603
Steam Sales		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Green Tag Sales		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Carbon Credit Sales		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other Revenue		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Revenue		**4,180**	**4,180**	**4,180**	**4,180**	**4,180**	**4,180**	**4,180**	**4,180**	**4,180**	**4,180**	**4,180**	**4,180**	**4,180**	**4,180**	**4,180**	**4,180**	**4,180**	**4,180**	**4,180**	**4,180**	**83,603**
EXPENSES																						
Operating (including chemicals)		1,421	1,438	1,456	1,475	1,494	1,515	1,537	1,560	1,584	1,609	1,635	1,662	1,691	1,720	1,750	1,782	1,815	1,849	1,884	1,920	32,797
Maintenance		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Fuel (gas)		1,599	1,639	1,680	1,722	1,765	1,809	1,854	1,901	1,948	1,997	2,047	2,098	2,150	2,204	2,259	2,316	2,374	2,433	2,494	2,556	40,842
Ash Disposal		(752)	(752)	(752)	(752)	(752)	(752)	(752)	(752)	(752)	(752)	(752)	(752)	(752)	(752)	(752)	(752)	(752)	(752)	(752)	(752)	(15,048)
Total Operating Expenses		**2,267**	**2,324**	**2,383**	**2,444**	**2,507**	**2,572**	**2,639**	**2,708**	**2,780**	**2,853**	**2,929**	**3,008**	**3,088**	**3,172**	**3,257**	**3,345**	**3,436**	**3,529**	**3,625**	**3,724**	**58,591**
OPERATING INCOME		**1,913**	**1,856**	**1,797**	**1,736**	**1,673**	**1,608**	**1,541**	**1,472**	**1,400**	**1,327**	**1,251**	**1,172**	**1,092**	**1,009**	**923**	**835**	**744**	**651**	**555**	**456**	**25,012**
Interest		$665	$643	$620	$595	$570	$544	$517	$489	$459	$429	$397	$364	$330	$294	$257	$218	$178	$136	$92	$47	$7,843
Depreciation		2,822	2,822	2,822	2,822	2,822	2,822	2,822	2,822	2,822	2,822	0	0	0	0	0	0	0	0	0	0	28,215
Pretax Income		**(1,574)**	**(1,608)**	**(1,644)**	**(1,681)**	**(1,719)**	**(1,757)**	**(1,797)**	**(1,838)**	**(1,880)**	**(1,924)**	**854**	**808**	**762**	**715**	**666**	**617**	**567**	**515**	**463**	**409**	**(11,047)**
Taxes (before federal/state credits)		(8,096)	320	314	306	298	290	279	267	255	242	229	215	202	188	173	171	168	153	137	122	(3,767)
Net Income - Book		**6,522**	**(1,929)**	**(1,958)**	**(1,987)**	**(2,017)**	**(2,047)**	**(2,077)**	**(2,106)**	**(2,135)**	**(2,165)**	**625**	**593**	**561**	**527**	**493**	**446**	**398**	**362**	**325**	**288**	**(7,280)**
PROJECT CASH FLOW & BENEFITS																						
Pretax Income		(1,574)	(1,608)	(1,644)	(1,681)	(1,719)	(1,757)	(1,797)	(1,838)	(1,880)	(1,924)	854	808	762	715	666	617	567	515	463	409	(11,047)
Plus: Book Depreciation		2,822	2,822	2,822	2,822	2,822	2,822	2,822	2,822	2,822	2,822	0	0	0	0	0	0	0	0	0	0	28,215
Less: Loan Principal		(558)	(581)	(604)	(628)	(653)	(679)	(707)	(735)	(764)	(795)	(827)	(860)	(894)	(930)	(967)	(1,006)	(1,046)	(1,088)	(1,131)	(1,177)	(16,629)
Pretax Cash Flow		**689**	**632**	**573**	**513**	**450**	**385**	**318**	**248**	**177**	**103**	**27**	**(51)**	**(132)**	**(215)**	**(301)**	**(389)**	**(479)**	**(573)**	**(669)**	**(767)**	**540**
Debt Service Coverage Ratio		**8.2**	**1.3**	**1.2**	**1.2**	**1.1**	**1.1**	**1.0**	**1.0**	**0.9**	**0.9**	**0.8**	**0.8**	**0.7**	**0.7**	**0.6**	**0.5**	**0.5**	**0.4**	**0.3**	**0.3**	**1.2**
Taxes/Credits/Grants																						
State Taxes		(2,819)	119	116	114	111	107	103	99	94	90	85	80	75	69	64	63	62	57	51	45	(1,215)
State Credits/Grants		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Federal Taxes		(5,277)	202	198	193	188	182	176	168	160	152	144	136	127	118	109	108	106	96	86	77	(2,552)
Federal Credits/Grants		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Net Taxes		(8,096)	320	314	306	298	290	279	267	255	242	229	215	202	188	173	171	168	153	137	122	(3,767)
NET CASH FLOWS																						
Capital Investment	(28,215)																					(28,215)
Amount to Finance	16,629																					16,629
Operating Pretax Cash Flows		689	632	573	513	450	385	318	248	177	103	27	(51)	(132)	(215)	(301)	(389)	(479)	(573)	(669)	(767)	540
STATE CREDITS / TAXES	500	2,819	(119)	(116)	(114)	(111)	(107)	(103)	(99)	(94)	(90)	(85)	(80)	(75)	(69)	(64)	(63)	(62)	(57)	(51)	(45)	1,715
FEDERAL CREDITS / TAXES	0	5,277	(202)	(198)	(193)	(188)	(182)	(176)	(168)	(160)	(152)	(144)	(136)	(127)	(118)	(109)	(108)	(106)	(96)	(86)	(77)	2,552
TOTAL CASH FLOW BENEFITS	**(11,086)**	**8,785**	**312**	**260**	**206**	**151**	**95**	**38**	**(19)**	**(78)**	**(139)**	**(202)**	**(267)**	**(333)**	**(403)**	**(474)**	**(560)**	**(648)**	**(726)**	**(806)**	**(889)**	**(6,780)**
Cumulative Pretax Cash Flow		689	1,321	1,895	2,407	2,857	3,242	3,559	3,808	3,984	4,087	4,114	4,063	3,931	3,716	3,416	3,027	2,548	1,975	1,307	540	
Cumulative After Tax Cash Flow		8,785	9,097	9,356	9,563	9,714	9,809	9,847	9,828	9,750	9,611	9,410	9,143	8,810	8,407	7,933	7,374	6,726	6,001	5,195	4,306	

5.3 APPENDIX 3 – 3 MW, NO COGEN, DIRECT COMBUSTION/STEAM TURBINE, BIOMASS PLANT

20 Year Income Statement

All Units ($)	Year 0	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	Total
REVENUE																						
Electric Sales		4,900	4,900	4,900	4,900	4,900	4,900	4,900	4,900	4,900	4,900	4,900	4,900	4,900	4,900	4,900	4,900	4,900	4,900	4,900	4,900	98,000
Steam Sales		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Green Tag Sales		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Carbon Credit Sales		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other Revenue		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Revenue		**4,900**	**4,900**	**4,900**	**4,900**	**4,900**	**4,900**	**4,900**	**4,900**	**4,900**	**4,900**	**4,900**	**4,900**	**4,900**	**4,900**	**4,900**	**4,900**	**4,900**	**4,900**	**4,900**	**4,900**	**98,000**
EXPENSES																						
Operating (including chemicals)		1,809	1,837	1,865	1,895	1,926	1,958	1,992	2,027	2,063	2,101	2,140	2,180	2,222	2,265	2,310	2,356	2,403	2,452	2,503	2,555	42,859
Maintenance		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Fuel (gas)		1,315	1,348	1,382	1,416	1,452	1,488	1,525	1,563	1,602	1,642	1,683	1,725	1,769	1,813	1,858	1,904	1,952	2,001	2,051	2,102	33,591
Ash Disposal		13	14	14	14	15	15	16	16	16	17	17	18	18	18	19	19	20	20	21	21	342
Total Operating Expenses		**3,138**	**3,198**	**3,261**	**3,326**	**3,392**	**3,461**	**3,533**	**3,606**	**3,682**	**3,760**	**3,840**	**3,923**	**4,008**	**4,096**	**4,187**	**4,280**	**4,375**	**4,474**	**4,575**	**4,679**	**76,792**
OPERATING INCOME		**1,762**	**1,702**	**1,639**	**1,574**	**1,508**	**1,439**	**1,367**	**1,294**	**1,218**	**1,140**	**1,060**	**977**	**892**	**804**	**713**	**620**	**525**	**426**	**325**	**221**	**21,208**
Interest		637	616	594	571	546	521	495	468	440	411	380	349	316	281	246	209	170	130	88	45	7,515
Depreciation		2,706	2,706	2,706	2,706	2,706	2,706	2,706	2,706	2,706	2,706	0	0	0	0	0	0	0	0	0	0	27,057
Pretax Income		**(1,581)**	**(1,620)**	**(1,660)**	**(1,702)**	**(1,745)**	**(1,789)**	**(1,834)**	**(1,880)**	**(1,928)**	**(1,976)**	**679**	**628**	**576**	**522**	**468**	**412**	**355**	**296**	**237**	**176**	**(13,365)**
Taxes (before federal/state credits)		(7,782)	284	276	267	258	247	235	221	207	193	178	163	147	131	115	110	105	88	70	52	(4,432)
Net Income - Book		**6,201**	**(1,904)**	**(1,936)**	**(1,969)**	**(2,002)**	**(2,036)**	**(2,069)**	**(2,102)**	**(2,135)**	**(2,169)**	**501**	**465**	**429**	**391**	**353**	**301**	**249**	**208**	**166**	**124**	**(8,932)**
PROJECT CASH FLOW & BENEFITS																						
Pretax Income		(1,581)	(1,620)	(1,660)	(1,702)	(1,745)	(1,789)	(1,834)	(1,880)	(1,928)	(1,976)	679	628	576	522	468	412	355	296	237	176	(13,365)
Plus: Book Depreciation		2,706	2,706	2,706	2,706	2,706	2,706	2,706	2,706	2,706	2,706	0	0	0	0	0	0	0	0	0	0	27,057
Less: Loan Principal		(535)	(557)	(579)	(602)	(626)	(651)	(677)	(704)	(732)	(762)	(792)	(824)	(857)	(891)	(927)	(964)	(1,002)	(1,042)	(1,084)	(1,127)	(15,934)
Pretax Cash Flow		**590**	**529**	**467**	**402**	**335**	**266**	**195**	**122**	**46**	**(32)**	**(113)**	**(196)**	**(281)**	**(369)**	**(459)**	**(552)**	**(648)**	**(746)**	**(847)**	**(951)**	**(2,242)**
Debt Service Coverage Ratio		**8.1**	**1.2**	**1.2**	**1.1**	**1.1**	**1.0**	**1.0**	**0.9**	**0.9**	**0.8**	**0.8**	**0.7**	**0.6**	**0.6**	**0.5**	**0.4**	**0.4**	**0.3**	**0.2**	**0.1**	**1.1**
Taxes/Credits/Grants																						
State Taxes		(2,711)	105	102	99	95	92	87	82	77	71	66	60	55	49	43	41	39	33	26	19	(1,470)
State Credits/Grants		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Federal Taxes		(5,071)	179	174	168	162	156	148	139	130	121	112	103	93	83	72	69	66	55	44	33	(2,962)
Federal Credits/Grants		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Net Taxes		(7,782)	284	276	267	258	247	235	221	207	193	178	163	147	131	115	110	105	88	70	52	(4,432)
NET CASH FLOWS																						
Capital Investment	(27,057)																					(27,057)
Amount to Finance	15,934																					15,934
Operating Pretax Cash Flows		590	529	467	402	335	266	195	122	46	(32)	(113)	(196)	(281)	(369)	(459)	(552)	(648)	(746)	(847)	(951)	(2,242)
STATE CREDITS / TAXES	500	2,711	(105)	(102)	(99)	(95)	(92)	(87)	(82)	(77)	(71)	(66)	(60)	(55)	(49)	(43)	(41)	(39)	(33)	(26)	(19)	1,970
FEDERAL CREDITS / TAXES	0	5,071	(179)	(174)	(168)	(162)	(156)	(148)	(139)	(130)	(121)	(112)	(103)	(93)	(83)	(72)	(69)	(66)	(55)	(44)	(33)	2,962
TOTAL CASH FLOW BENEFITS	**(10,623)**	**8,372**	**245**	**191**	**135**	**78**	**19**	**(40)**	**(100)**	**(161)**	**(225)**	**(291)**	**(358)**	**(428)**	**(500)**	**(574)**	**(662)**	**(753)**	**(834)**	**(918)**	**(1,004)**	**(8,432)**
Cumulative Pretax Cash Flow		590	1,119	1,586	1,988	2,323	2,589	2,784	2,906	2,952	2,919	2,807	2,611	2,330	1,962	1,503	951	303	(443)	(1,291)	(2,242)	
Cumulative After Tax Cash Flow		8,372	8,617	8,808	8,943	9,020	9,039	8,999	8,899	8,737	8,512	8,222	7,863	7,435	6,935	6,361	5,699	4,946	4,112	3,194	2,190	

5.4 APPENDIX 4 – 5 MW (SELL 3 MW), COGEN, DIRECT COMBUSTION/STEAM TURBINE, BIOMASS PLANT

20 Year Income Statement

All Units ($)	Year 0	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	Total
REVENUE																						
Electric Sales		5,234	5,276	5,318	5,361	5,403	5,447	5,490	5,534	5,578	5,623	5,668	5,713	5,759	5,805	5,852	5,898	5,946	5,993	6,041	6,089	113,030
Steam Sales		189	193	198	203	208	213	219	224	230	236	241	247	254	260	266	273	280	287	294	302	4,818
Green Tag Sales		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Carbon Credit Sales		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other Revenue		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Revenue		**5,423**	**5,469**	**5,516**	**5,564**	**5,612**	**5,660**	**5,709**	**5,758**	**5,808**	**5,859**	**5,909**	**5,961**	**6,013**	**6,065**	**6,118**	**6,172**	**6,226**	**6,280**	**6,335**	**6,391**	**117,847**
EXPENSES																						
Operating (including chemicals)		2,123	2,154	2,187	2,222	2,258	2,296	2,335	2,375	2,417	2,461	2,506	2,553	2,602	2,652	2,704	2,758	2,813	2,870	2,929	2,990	50,206
Maintenance		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Fuel (gas)		929	952	976	1,000	1,025	1,051	1,077	1,104	1,132	1,160	1,189	1,219	1,249	1,280	1,312	1,345	1,379	1,413	1,449	1,485	23,724
Ash Disposal		15	15	15	16	16	17	17	17	18	18	19	19	20	20	21	21	22	22	23	23	375
Total Operating Expenses		**3,066**	**3,121**	**3,179**	**3,238**	**3,299**	**3,363**	**3,429**	**3,497**	**3,567**	**3,639**	**3,714**	**3,791**	**3,871**	**3,953**	**4,037**	**4,124**	**4,214**	**4,306**	**4,401**	**4,499**	**74,305**
OPERATING INCOME		**2,356**	**2,348**	**2,338**	**2,326**	**2,312**	**2,297**	**2,280**	**2,262**	**2,242**	**2,219**	**2,196**	**2,170**	**2,142**	**2,113**	**2,081**	**2,048**	**2,012**	**1,974**	**1,934**	**1,892**	**43,542**
Interest		769	744	717	689	660	629	598	565	531	496	459	421	381	340	297	252	206	157	107	54	9,072
Depreciation		3,256	3,256	3,256	3,256	3,256	3,256	3,256	3,256	3,256	3,256	0	0	0	0	0	0	0	0	0	0	32,560
Pretax Income		**(1,669)**	**(1,652)**	**(1,635)**	**(1,619)**	**(1,603)**	**(1,588)**	**(1,574)**	**(1,560)**	**(1,546)**	**(1,532)**	**1,736**	**1,749**	**1,761**	**1,773**	**1,784**	**1,796**	**1,806**	**1,817**	**1,828**	**1,838**	**1,910**
Taxes (before federal/state credits)		(9,311)	430	440	449	457	465	471	475	479	483	487	491	494	498	501	519	536	540	543	546	(8)
Net Income - Book		**7,642**	**(2,082)**	**(2,075)**	**(2,068)**	**(2,061)**	**(2,053)**	**(2,045)**	**(2,035)**	**(2,025)**	**(2,016)**	**1,249**	**1,258**	**1,267**	**1,275**	**1,283**	**1,277**	**1,270**	**1,278**	**1,285**	**1,292**	**1,918**
PROJECT CASH FLOW & BENEFITS																						
Pretax Income		(1,669)	(1,652)	(1,635)	(1,619)	(1,603)	(1,588)	(1,574)	(1,560)	(1,546)	(1,532)	1,736	1,749	1,761	1,773	1,784	1,796	1,806	1,817	1,828	1,838	1,910
Plus: Book Depreciation		3,256	3,256	3,256	3,256	3,256	3,256	3,256	3,256	3,256	3,256	0	0	0	0	0	0	0	0	0	0	32,560
Less: Loan Principal		(646)	(672)	(699)	(727)	(756)	(786)	(817)	(850)	(884)	(919)	(956)	(994)	(1,034)	(1,076)	(1,119)	(1,163)	(1,210)	(1,258)	(1,309)	(1,361)	(19,236)
Pretax Cash Flow		**941**	**932**	**922**	**910**	**897**	**882**	**865**	**846**	**826**	**804**	**780**	**754**	**727**	**697**	**666**	**632**	**597**	**559**	**519**	**477**	**15,234**
Debt Service Coverage Ratio		**8.2**	**1.4**	**1.3**	**1.3**	**1.3**	**1.3**	**1.3**	**1.3**	**1.2**	**1.2**	**1.2**	**1.2**	**1.2**	**1.1**	**1.1**	**1.1**	**1.0**	**1.0**	**1.0**	**1.0**	**1.5**
Taxes/Credits/Grants																						
State Taxes		(3,237)	159	163	166	169	172	174	176	178	179	180	182	183	184	186	192	199	200	201	202	210
State Credits/Grants		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Federal Taxes		(6,074)	271	277	283	288	293	296	299	302	304	307	309	311	313	316	327	338	340	342	343	(218)
Federal Credits/Grants		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Net Taxes		(9,311)	430	440	449	457	465	471	475	479	483	487	491	494	498	501	519	536	540	543	546	(8)
NET CASH FLOWS																						
Capital Investment	(32,560)																					(32,560)
Amount to Finance	19,236																					19,236
Operating Pretax Cash Flows		941	932	922	910	897	882	865	846	826	804	780	754	727	697	666	632	597	559	519	477	15,234
STATE CREDITS / TAXES	500	3,237	(159)	(163)	(166)	(169)	(172)	(174)	(176)	(178)	(179)	(180)	(182)	(183)	(184)	(186)	(192)	(199)	(200)	(201)	(202)	290
FEDERAL CREDITS / TAXES	0	6,074	(271)	(277)	(283)	(288)	(293)	(296)	(299)	(302)	(304)	(307)	(309)	(311)	(313)	(316)	(327)	(338)	(340)	(342)	(343)	218
TOTAL CASH FLOW BENEFITS	**(12,824)**	**10,252**	**502**	**482**	**462**	**440**	**417**	**394**	**371**	**347**	**321**	**293**	**264**	**233**	**199**	**165**	**113**	**60**	**19**	**(24)**	**(69)**	**2,418**
Cumulative Pretax Cash Flow		941	1,873	2,796	3,706	4,603	5,484	6,349	7,196	8,022	8,826	9,606	10,361	11,087	11,785	12,450	13,083	13,679	14,238	14,757	15,234	
Cumulative After Tax Cash Flow		10,252	10,754	11,237	11,698	12,138	12,555	12,949	13,320	13,667	13,988	14,281	14,545	14,777	14,976	15,141	15,254	15,315	15,334	15,310	15,241	

5.5 APPENDIX 5 – 5 MW (SELL 5 MW), COGEN, DIRECT COMBUSTION/STEAM TURBINE, BIOMASS PLANT

20 Year Income Statement

All Units ($)	Year 0	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	Total
REVENUE																						
Electric Sales		8,204	8,229	8,253	8,278	8,303	8,328	8,353	8,378	8,403	8,428	8,453	8,479	8,504	8,530	8,555	8,581	8,607	8,633	8,658	8,684	168,840
Steam Sales		189	193	198	203	208	213	219	224	230	236	241	247	254	260	266	273	280	287	294	302	4,818
Green Tag Sales		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Carbon Credit Sales		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other Revenue		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Revenue		**8,393**	**8,422**	**8,451**	**8,481**	**8,511**	**8,541**	**8,571**	**8,602**	**8,633**	**8,664**	**8,695**	**8,726**	**8,758**	**8,790**	**8,822**	**8,854**	**8,887**	**8,919**	**8,953**	**8,986**	**173,657**
EXPENSES																						
Operating (including chemicals)		2,198	2,231	2,265	2,301	2,338	2,377	2,417	2,459	2,502	2,548	2,594	2,643	2,693	2,745	2,799	2,854	2,911	2,970	3,031	3,094	51,971
Maintenance		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Fuel (gas)		1,729	1,773	1,817	1,862	1,909	1,957	2,006	2,056	2,107	2,160	2,214	2,269	2,326	2,384	2,444	2,505	2,567	2,631	2,697	2,765	44,176
Ash Disposal		23	23	24	24	25	26	26	27	27	28	29	30	30	31	32	33	33	34	35	36	576
Total Operating Expenses		**3,950**	**4,027**	**4,106**	**4,187**	**4,272**	**4,359**	**4,449**	**4,541**	**4,637**	**4,735**	**4,837**	**4,941**	**5,049**	**5,160**	**5,274**	**5,391**	**5,512**	**5,636**	**5,764**	**5,895**	**96,723**
OPERATING INCOME		**4,442**	**4,395**	**4,346**	**4,294**	**4,239**	**4,182**	**4,123**	**4,061**	**3,996**	**3,928**	**3,858**	**3,785**	**3,709**	**3,630**	**3,548**	**3,463**	**3,375**	**3,283**	**3,189**	**3,091**	**76,934**
Interest		800	773	745	716	686	655	622	588	553	516	478	438	396	353	309	262	214	163	111	57	9,434
Depreciation		3,384	3,384	3,384	3,384	3,384	3,384	3,384	3,384	3,384	3,384	0	0	0	0	0	0	0	0	0	0	33,837
Pretax Income		**258**	**238**	**217**	**194**	**169**	**144**	**117**	**89**	**59**	**29**	**3,380**	**3,347**	**3,312**	**3,276**	**3,239**	**3,201**	**3,161**	**3,120**	**3,078**	**3,034**	**33,663**
Taxes (before federal/state credits)		(9,043)	1,028	1,026	1,023	1,020	1,016	1,010	1,001	993	984	974	964	954	943	932	935	938	926	914	901	9,439
Net Income - Book		**9,302**	**(789)**	**(809)**	**(830)**	**(851)**	**(872)**	**(893)**	**(912)**	**(933)**	**(955)**	**2,406**	**2,383**	**2,359**	**2,333**	**2,307**	**2,265**	**2,222**	**2,194**	**2,164**	**2,133**	**24,224**
PROJECT CASH FLOW & BENEFITS																						
Pretax Income		258	238	217	194	169	144	117	89	59	29	3,380	3,347	3,312	3,276	3,239	3,201	3,161	3,120	3,078	3,034	33,663
Plus: Book Depreciation		3,384	3,384	3,384	3,384	3,384	3,384	3,384	3,384	3,384	3,384	0	0	0	0	0	0	0	0	0	0	33,837
Less: Loan Principal		(672)	(699)	(727)	(756)	(786)	(817)	(850)	(884)	(919)	(956)	(994)	(1,034)	(1,075)	(1,118)	(1,163)	(1,210)	(1,258)	(1,308)	(1,361)	(1,415)	(20,002)
Pretax Cash Flow		**2,970**	**2,923**	**2,874**	**2,822**	**2,767**	**2,710**	**2,651**	**2,589**	**2,524**	**2,456**	**2,386**	**2,313**	**2,237**	**2,158**	**2,076**	**1,991**	**1,903**	**1,811**	**1,717**	**1,619**	**47,498**
Debt Service Coverage Ratio		**9.2**	**2.3**	**2.3**	**2.2**	**2.2**	**2.2**	**2.1**	**2.1**	**2.0**	**2.0**	**2.0**	**1.9**	**1.9**	**1.8**	**1.8**	**1.7**	**1.7**	**1.6**	**1.5**	**1.5**	**2.3**
Taxes/Credits/Grants																						
State Taxes		(3,145)	381	380	379	378	376	374	371	368	364	361	357	353	349	345	347	348	343	339	334	3,703
State Credits/Grants		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Federal Taxes		(5,898)	647	646	644	642	640	636	630	625	619	613	607	600	594	587	589	591	583	575	567	5,736
Federal Credits/Grants		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Net Taxes		(9,043)	1,028	1,026	1,023	1,020	1,016	1,010	1,001	993	984	974	964	954	943	932	935	938	926	914	901	9,439
NET CASH FLOWS																						
Capital Investment	(33,837)																					(33,837)
Amount to Finance	20,002																					20,002
Operating Pretax Cash Flows		2,970	2,923	2,874	2,822	2,767	2,710	2,651	2,589	2,524	2,456	2,386	2,313	2,237	2,158	2,076	1,991	1,903	1,811	1,717	1,619	47,498
STATE CREDITS / TAXES	500	3,145	(381)	(380)	(379)	(378)	(376)	(374)	(371)	(368)	(364)	(361)	(357)	(353)	(349)	(345)	(347)	(348)	(343)	(339)	(334)	(3,203)
FEDERAL CREDITS / TAXES	0	5,898	(647)	(646)	(644)	(642)	(640)	(636)	(630)	(625)	(619)	(613)	(607)	(600)	(594)	(587)	(589)	(591)	(583)	(575)	(567)	(5,736)
TOTAL CASH FLOW BENEFITS	**(13,335)**	**12,014**	**1,896**	**1,848**	**1,798**	**1,747**	**1,694**	**1,641**	**1,587**	**1,531**	**1,473**	**1,412**	**1,349**	**1,283**	**1,215**	**1,144**	**1,056**	**964**	**885**	**803**	**718**	**24,724**
Cumulative Pretax Cash Flow		2,970	5,894	8,768	11,589	14,357	17,067	19,718	22,307	24,831	27,287	29,673	31,986	34,223	36,381	38,457	40,448	42,351	44,162	45,879	47,498	
Cumulative After Tax Cash Flow		12,014	13,909	15,757	17,555	19,303	20,997	22,638	24,226	25,757	27,230	28,642	29,991	31,274	32,489	33,633	34,688	35,653	36,538	37,341	38,059	

5.6 APPENDIX 6 – IMPLEMENTATION FUNDING SOURCES

Funding Program	Funding Agency	Funding Type	Website
Calseed	CA Energy Commission	Grants for Technology and Business Development	http://calseed.fund/
Rural Energy for America	USDA	Direct Loans	https://www.rd.usda.gov/programs-services/rural-energy-america-program-renewable-energy-systems-energy-efficiency
New Market Tax Credits	Federal Treasury	Federal Tax Credits	NCCLF: https://www.ncclf.org/new-markets-tax-credits/
Brown Field Clean up	Center for Creative Land Recycling	Loans and Grants	https://www.cclr.org/
Community Development Block Grant (CDBG) National Disaster Resilience (NDR) Funding	HCD	Planning, Direct Loans & Public Improvements	Website to be posted upon release of funding.
Community Development Block Grant (CDBG) Over the Counter (OTC) Funding	City or County via HCD	Direct Loans & Public Improvements	http://www.hcd.ca.gov/grants-funding/nofas/docs/Appendix-E-ED-OTC-Application-Process.pdf
County of Tuolumne Business Assistance Programs	Economic Development Authority	Various Loan Programs	https://tceda.net/financing/
Small Business Development Center	California Infrastructure Bank	Various Loan Programs	http://www.ibank.ca.gov/programs/
Cal Competes	GOBiz	State Tax Credits	https://www.ftb.ca.gov/
Wood Innovations Grant	**USDA Forest Service**	**Grants**	https://www.fs.fed.us/science-technology/energy-forest-products/wood-innovations-grants