Dead Tree Utilization Assessment

Completed for:

CALFIRE & California Tree Mortality Task Force

The Beck Group

Project Report
May 2017
TABLE OF CONTENTS

CHAPTER 1 – EXECUTIVE SUMMARY

1.1 Introduction ........................................................................................................ 1
1.2 Conclusions & Recommendations ................................................................... 1
   1.2.1 Large Scale of the Problem Dictates a Focus on Highest Priority Areas .... 1
   1.2.2 Current Dead Tree Utilization ................................................................... 2
   1.2.3 What is Making Current Dead Tree Utilization Efforts Work .................. 2
   1.2.4 Obstacles to Increased Dead Tree Utilization ........................................... 2
   1.2.5 Expanded Dead Tree Utilization Through Development of New Business Opportunities ........................................................................................................ 4

CHAPTER 2 – SUMMARY OF RECOMMENDATIONS

2.1 General Recommendations .................................................................................. 7
2.2 Log Exporting Related Recommendations .......................................................... 7
2.3 Chip Exporting Related Recommendations .......................................................... 8
2.4 Low Capital/Simple Product Mix Sawmill Related Recommendations .............. 8

CHAPTER 3 – STUDY BACKGROUND

3.1 California Tree Mortality .................................................................................... 10
3.2 Tree Mortality Emergency Proclamation ............................................................ 14
3.3 Tree Mortality Task Force .................................................................................. 15
3.4 Study Objectives and Research Approach ........................................................... 16

CHAPTER 4 – WOOD UTILIZATION OPPORTUNITY SCREENING

4.1 Technology Screening Context .......................................................................... 17
4.2 Potential Business Opportunities ....................................................................... 18
4.3 Screening Criteria ............................................................................................... 19
4.4 Screening Results ............................................................................................... 20

CHAPTER 5 – DISCUSSION OF SELECTED OPPORTUNITIES

5.1 High Capital/High Volume Opportunities ........................................................... 21
   5.1.1 Log Exports ............................................................................................... 21
   5.1.2 Exporting Whole Log Chips for Pulp & Paper or Energy ......................... 23
   5.1.3 Low Capital/Simple Product Mix Sawmill ............................................... 24
   5.1.4 Large Scale Biomass .................................................................................. 24
5.2 Low Capital/Low Volume Opportunities ............................................................. 25
   5.2.1 Decorative Bark/Landscape/Mulch ............................................................. 25
   5.2.2 Small Scale Biomass .................................................................................. 26
   5.2.3 Firewood – Bundles & Bulk ....................................................................... 26
# Table of Contents (Continued)

**APPENDIX 1 - Tier 1 and Tier 2 Tree Mortality Zones** .......................................................... I

**APPENDIX 2 - Industry Interviews** ......................................................................................... II

- Arauco North America ............................................................................................................... ii
- Bailey’s Forestry and Logging Equipment ............................................................................... ii
- Green Diamond Resource Company ....................................................................................... iv
- Large Biomass Power Contribution to Dead Tree Removal .................................................. vii
- MDI Forest Products ................................................................................................................. viii
- Oriented Strand Board (OSB) ................................................................................................. ix
- Air Burners, Inc. ...................................................................................................................... x
- RJJ Resource Management Corporation .............................................................................. xii
- Sierra Forest Products .............................................................................................................. xii
- Sierra Pacific Industries ........................................................................................................... xiv
- Sierra Resource Management ................................................................................................. xvi
- Small Scale Biomass Power/CHP Under The BIOMAT Program ........................................... xvii
  - 5.2.4 Current Status ................................................................................................................. xviii
  - 5.2.5 Subsequent Changes ...................................................................................................... xviii
- Soper-Wheeler Company ......................................................................................................... xx
- Timber Products Company ....................................................................................................... xx
- Wood Shavings in Porterville, CA ........................................................................................... xxii

**APPENDIX 3 - Dead Tree Utilization Opportunity Screening Matrix** ............................... XXIV
CHAPTER 1 – EXECUTIVE SUMMARY

1.1 INTRODUCTION

Aerial detection surveys of California forestlands have revealed high tree mortality. Based on the surveys, as of late 2016 there are an estimated 102 million standing dead trees in the state that have been killed by drought, beetles, wildfire, and other damaging agents. Removing and utilizing as many dead trees as practically and economically as possible is a high priority given the public safety hazard posed by dead trees close to roads, powerlines, buildings, etc.; possible wildfire; and to reestablish productive forests. CALFIRE engaged The Beck Group (BECK), a Portland, Oregon forest products planning and consulting firm, to survey members of the forest products industry about their utilization of dead trees and about their ideas for increasing dead tree utilization. Generally, each entity interviewed was operating in California, but also included were several businesses considering the possibility of establishing California manufacturing operations. Interviewees were selected to cover major utilization technologies and geographic regions from a list provided by study organizers and from BECK industry contacts. In addition, BECK screened nearly 50 wood utilization technologies to identify those which presented business opportunities judged to be best suited for utilizing California’s dead trees. The screening aspect of BECK’s work built on a prior California statewide business opportunity assessment prepared for the U.S. Forest Service and National Forest Foundation. The methodology of the current effort, however, focused on utilizing dead trees rather than the small diameter tree utilization focus of the prior study.

1.2 CONCLUSIONS & RECOMMENDATIONS

The following are BECK’s conclusions and recommendations from the industry interviews and from evaluating options for expanding dead tree utilization.

1.2.1 Large Scale of the Problem Dictates a Focus on Highest Priority Areas

Per an unpublished U.S. Forest Service estimate of standing dead tree volume and weight\(^1\), the 102 million dead trees equate to an estimated 65 billion board feet, which in turn equates to 178 million bone dry tons (BDT).\(^2\) To provide perspective, California’s statewide saw timber harvest in 2015 was 1.6 billion board feet. Thus, the dead tree volume at the end of 2016 is equal to over a 40-year timber harvest supply if harvesting occurred at 2015 levels.

BECK concludes full utilization of dead trees is improbable because of the large dead tree volume, limited funds to subsidize removal and transportation of harvested trees, expected log and wood fiber quality degradation, and limited access (i.e. no roads) to large areas of dead trees. Therefore, BECK recommends that removal and utilization efforts should focus on the highest priority areas within Tier 1 and Tier 2 High Hazard Zones\(^3\). See Appendix 1 for a map of Tier 1 and Tier 2 zones as of early 2017.

\(^1\) Unpublished report from U.S. Forest Service, State and Private Forestry, Vallejo, California.

\(^2\) A BDT is a measurement unit used in the forest products industry. It is derived by calculating wood’s weight after subtracting the portion of the weight that is water. Normally, about 50 % of the weight of live trees is water. In this case, it is likely that water is only about 35 percent of the weight of the standing dead trees. Therefore, the estimated actual or “green” weight of the 102 million dead trees is 274 million tons.

\(^3\) Tier 1 Zones are defined as those areas near communities, roads, and utility lines that represent a direct threat to public safety. Tier 2 zones are watersheds that have significant tree mortality, combined with community and natural resource assets.
1.2.2 Current Dead Tree Utilization

Based on industry interviews, BECK estimates that current utilization of dead trees by sawmills is approximately 475,000 BDT per year. This occurs mostly in the Southern Sierra region. Current utilization of dead trees by biomass power plants isn’t known definitively. However, BECK estimates that biomass power plants could utilize as much as 1.1 million BDT per year under the BioRAM program4. The volume of other existing uses for dead trees such as landscape material, soil amendments, firewood, etc. is also not known with certainty. However, based on estimated statewide production of sawmill by-products, which supply much of this market, BECK estimates these uses could be as high as 250,000 BDT per year. Importantly, utilizing dead trees for landscape material and soil amendments faces difficult economics. This is because those products, when produced from sawmill residuals, are lower cost than when produced from dead trees. Thus, even under the most optimistic scenario of 1.825 million BDT per year of dead tree utilization among current users (475,000 BDT from sawmills + 1,100,000 BDT from biomass + 250,000 BDT from landscape, etc.), it would take nearly 100 years to fully utilize the current dead tree volume of 178 million BDT.

1.2.3 What is Making Current Dead Tree Utilization Efforts Work

BECK concludes from the industry interviews that two key factors allow for effective current dead tree utilization efforts. A brief description of each follows:

Quick Response – Industrial scale private timberland owners experiencing tree mortality reported quickly responding to tree mortality outbreaks so that the trees can be salvaged before their highest economic value is lost due to quality degradation. Interviewees added that quick response also helps limit further spread of mortality from secondary damaging agents (e.g., insects or wildfire).

Existing Infrastructure – Related to private firms being able to respond quickly, the dead trees currently being utilized are all being harvested by existing contractors; the resulting material flows through established supply chains, to existing conversion facilities; and is being marketed through existing distribution channels into well-defined and developed markets. In contrast, any new conversion facilities and/or businesses developed to utilize dead trees will require planning, construction, commissioning, and operational ramp-up. Further, if such businesses are focused on new technologies or new markets, additional time may be needed for addressing start-up problems with the technology and for market development. BECK concludes that since there is a quality degradation process associated with dead trees, focusing utilization efforts on existing markets, infrastructure, and businesses is essential.

1.2.4 Obstacles to Increased Dead Tree Utilization

BECK concludes, based on industry interviews, the following issues are perceived as obstacles to increased utilization of dead trees.

Market Constraints – Even very large markets such as softwood lumber are affected by surges in supply. Over supplied markets cause prices to drop, which creates economic difficulties for manufacturers. In the case of dead trees, attempts to utilize large volumes are likely to over

4 Biomass Renewable Auction Mechanism - BioRAM
CHAPTER 1 – EXECUTIVE SUMMARY

supply markets, which in turn limits the ability to cost effectively utilize dead trees. For example, blue-stained softwood lumber (a characteristic of lumber from dead trees) is a thin market. BECK recommends that dead tree utilization efforts focus on large, existing forest products markets such as lumber, chips for pulp or energy, logs, and biomass heat/power.

**NEPA** - Legal challenges arising from the National Environmental Policy Act (NEPA) process constrain national forests' ability to quickly respond to mortality outbreaks. This is problematic for effective dead tree utilization because the economic value of dead trees drops quickly and substantially from quality degradation. Industry contacts consistently reported that significant degradation can occur within just a few months of the tree dying. The result is that national forests are left to manage forestlands without sufficient revenue to support those efforts. An unpublished U.S. Forest Service report estimated that 59 percent of the dead trees are located on national forests as of late 2016. BECK recommends that California’s Tree Mortality Task Force focus on identifying mechanisms for expediting the salvage and utilization of dead trees on publicly managed lands, especially national forests.

**Trucking Capacity** – Industry contacts reported limited forest products trucking capacity in the Southern Sierra region. This is apparently due to an aging workforce of independent trucking contractors who owned older equipment and who were faced with the choice of retiring, or recapitalizing their businesses with trucks that comply with California requirements for diesel engine emissions. Many apparently did not recapitalize their businesses. BECK recommends that California’s Tree Mortality Task Force study log trucking capacity in the Southern Sierra region, and if a shortage exists, explore options (e.g., reducing regulatory obstacles, incentives for business formation, etc.) for expanding trucking capacity.

**Permitting** – Industry contacts reported that lengthy, costly, and complicated air quality permitting processes caused existing forest products manufacturers to decide not to move forward on plans to install biomass boilers for producing heat, power, or both. The result of regulatory constraints is that boilers that could have potentially utilized dead trees, logging slash, mill residues, or ag waste were not installed at existing forest products conversion facilities. BECK recommends that California’s Tree Mortality Task Force explore options for streamlining the regulatory process for biomass boiler installation. One possibility is adding mechanisms for allowing permitting agencies to take into consideration how biomass heat/power would reduce emissions from trucks and other fossil fuels and open burning of logging slash.

**Log Specifications** – Industry contacts reported that a portion of the trees removed from high hazard areas could be utilized as logs, but were not being utilized in that manner because tree service contractors often cut tree stems into short lengths that do not match sawmill log purchasing specifications. Part of the reason for this may be that tree service contractors are not aware of log specifications among nearby mills, so efforts aimed at increasing awareness and education may be needed. Second, the tree service contractors may lack the heavy equipment needed to handle 30’ to 40’ long, large diameter logs. BECK recommends that California’s Tree Mortality Task Force assess whether dead tree utilization might be improved through education efforts aimed at assuring that tree service contractors are aware of log markets and sawmill log specifications. BECK also recommends that the Tree Mortality Task Force explore whether...
incentives, grants, low interest loans, etc. may be beneficial for tree service contractors so that they can more fully capitalize their businesses with equipment for handling large, long logs.

1.2.5 Expanded Dead Tree Utilization Through Development of New Business Opportunities

Both BECK’s screening of wood utilization technologies and BECK’s industry interviews resulted in the identification of opportunities for increasing dead tree utilization. The opportunities are summarized in the following sections.

Wood Utilization Technology Screening — BECK developed a methodology to screen nearly 50 wood utilization technologies to identify the business opportunities judged to have the greatest potential for utilizing dead trees. To better understand the range in utilization options, the technologies were categorized into a low capital/low volume group and a high capital/high volume group. The main criterion for grouping was annual raw material consumption with 30,000 BDT per year at a single site being the approximate dividing point. The highest rated low capital/low volume business opportunities arising from BECK’s screening process were firewood manufacturing, decorative landscape materials from bark and wood chips, essential oils, and animal bedding. The highest rated high capital/high volume opportunities were two sawmilling options, log exporting, whole log chipping for pulp/paper & energy markets, and large scale biomass power. More detail about the screening methodology and the business opportunities is provided in Chapter 3.

Specific Business Opportunities for Expanded Utilization — Based on the combined results of the wood technology screening process and the industry interviews, BECK identified four business opportunities judged to offer the highest potential for significantly expanding utilization of dead trees. BECK estimates these four opportunities could lead to a combined total of about 2.0 million BDT per year of additional dead tree utilization, if fully developed. This includes 350,000 BDT from log exports, up to 250,000 BDT from wood chips, as much as 300,000 BDT from low capital, simple product mix sawmills, and 1.1 million BDT from large scale biomass plants. The following sections provide more detail about each opportunity.

1.2.5.1 Log Exports

Logs harvested in the U.S. have long been exported to other countries for processing into various forest products. BECK concludes that exporting logs is a business that potentially offers a significant opportunity to utilize dead trees. This is because: 1) a large global market exists for logs and there are substantial log export markets in Asia that are well suited for California’s U.S. West Coast location. For example, over the last 10 years the total volume of log exports from all U.S. West Coast ports has averaged 867 million board feet per year (roughly 2.6 million bone dry tons); 2) the lower log quality that may be associated with logs from dead trees may not a critical factor in some Asian log markets (e.g., China) because the types of lumber produced (e.g., concrete forming and pallet stock) are less quality sensitive; 3) existing companies in California are already actively engaged in exporting logs to Asian markets and could expand their operations.

A key obstacle to this option is that domestic forest products manufacturers are protected by log export restrictions on logs harvested from state or federal lands. Despite nearly 60 percent of the dead trees being located on national forests, any trees harvested from those lands cannot be
exported. There is, however, precedent set in Alaska for obtaining a waiver on national forest log export regulations as defined in 36 CFR 223.185 to 223.203. Please see Chapter 4 and Appendix 3 for more detail on this utilization option. BECK recommends that California’s Tree Mortality Task Force analyze whether such a waiver can be obtained for California.

1.2.5.2 Exporting Whole Log Chips for Pulp/Paper & Energy Production

Whole log chipping is the process of converting entire tree stems into wood chips. BECK concludes that exporting wood chips produced from whole log chipping dead trees is a significant utilization opportunity. There are two potential markets for wood chips. The first is that Japan and China represent well-established and sizable markets for chips used in pulp/paper manufacturing. For example, in 2016 about 90,000 bone dry tons of chips were exported from a chip export facility in Samoa, California. In addition, per U.S. International Trade Commission data, during the last 20 years annual wood chip exports from Washington and Oregon to Asia have averaged 250,000 and 1,000,000 BDT respectively. The second potential whole log chip market is due a 2012 Feed-In-Tariff program enacted in Japan in 2012. It is designed to stimulate the development of renewable energy sources, including biomass power. In response to the program, several biomass fueled plants are in the development process in Japan, including plants which will source wood chips from international suppliers. While the energy market for chips is clearly still developing, energy chips produced in California would appear to have some advantages for serving this market. First, California’s dead trees are relatively dry, and therefore, chips from these trees would have low transportation costs (relative to higher moisture chips). Also, dry chips would yield more net energy during combustion. Finally, per industry interviews with existing California chip exporters, Japanese buyers are concerned about sustainability and it is believed that salvaging dead trees would be appealing to those buyers.

There are also several significant obstacles to this utilization option. First, the dead tree problem is centered in the Southern Sierra Range. The ports within cost effective shipping distance are in Stockton and West Sacramento. They have a maximum draft depth of 35’ and 30’ respectively. A fully loaded chip vessel requires 38’ to 39’ of draft. Thus, any vessels originating from either of those ports could only be partially filled. In the past, chip exporters using those ports have dealt with this problem by sending partially loaded vessels to deeper ports in Samoa, California or Coos Bay, Oregon to be fully filled. This practice is costly, but per industry contacts may not be cost prohibitive. Second, utilizing dead trees as chips would require investment in whole log chipping equipment and trucking equipment to process and transport the chips to port facilities. BECK industry contacts indicated that as the general number of forest industry businesses has declined in California, contractor capacity for such operations has become limited in recent years, especially in the South Sierra region. Please see Chapter 4 and Appendix 3 for more detail on this utilization option. BECK recommends that California’s Tree Mortality Task Force carry out a more detailed analysis of wood chip exporting feasibility.

1.2.5.3 Low Capital/Simple Product Mix Sawmill

BECK concludes that a low capital, simple product mix sawmill is a dead tree utilization option that may be viable. Envisioned is a low capital (e.g., < $2 million), simple-design facility that would target production of rough, undried, ungraded lumber for specific overseas markets. Such a facility could likely be operational within about a year and could be replicated at multiple sites.
As currently conceived, a single such mill would consume between 10 and 15 million board feet of logs annually (about 30,000 to 45,000 BDT). The areas of this concept that need further analysis include raw material supply (annual volume, delivered cost, log size, and degradation rate), market analysis (market size, market pricing, transportation costs), capital costs, financial modeling of the business. Please see Chapter 4 and Appendix 3 for more detail on this utilization option. BECK recommends that California’s Tree Mortality Task Force carry out a more detailed analysis of the feasibility of this sawmilling concept.

1.2.5.4 Large Scale Biomass Power

While not a focus area of this study, BECK concludes that large scale biomass power represents a significant opportunity for increased dead tree utilization. Specifically, the California Legislature’s BioRAM mandate will have a substantial impact on the utilization of dead trees. BioRAM requires that no less than 175 MW of 5 year contracts be offered to California’s existing fleet of large biomass power facilities, so long as they agree to utilize 80 percent of fuel from high hazard zones. BECK estimates that if the full 175 MW of BioRAM contracts are awarded, and recipients meet the 80 percent standard, fully 1.1 million bone dry tons of high hazard zone material will be utilized annually as fuel. Over the 5-year BioRAM contract life, that is 5.5 million bone dry tons, a substantial fraction of which is likely to be dead trees. Compared to other opportunities being considered, this program will have a major positive impact in a relatively short period.

A key advantage that large scale biomass has over numerous other opportunities evaluated is that the deteriorated condition of the dead tree is not a serious utilization obstacle. In fact, there are some advantages. Standing dead trees have a much lower moisture content than typical forest fuels, allowing the hauling of more BDT per load and a more efficient combustion. Another significant advantage of this technology is that there is an existing infrastructure in place, which means utilization efforts could begin quickly. Potential obstacles include the perception among industry contacts that the biomass plants operating under BioRAM contracts are likely to struggle to secure the required volumes of high hazard fuels. This is because there is limited forest industry infrastructure for chipping or grinding the material and for transporting it from the woods to biomass facilities. This problem is likely to be even more pronounced in the South Sierra region where the dead tree problem is concentrated currently.

---

5 CALFIRE is responsible for identifying Tier 1 and Tier 2 high hazard zones. See here for details: http://www.fire.ca.gov/treetaskforce/downloads/WorkingGroup_Minutes/March_14_2016_MAPPING_MONITORING_HHZ_Tier2_Presentatio n.pdf
CHAPTER 2 – SUMMARY OF RECOMMENDATIONS

The following is a summary of the recommendations developed by BECK for increasing the utilization of dead trees in California:

2.1 GENERAL RECOMMENDATIONS

- BECK recommends that dead tree removal and utilization efforts focus on the highest priority areas within Tier 1 and Tier 2 High Hazard Zones.
- BECK recommends that dead tree utilization efforts focus on large, existing forest products markets such as lumber, chips for pulp or energy, logs, and biomass heat/power.
- BECK recommends research and analysis about the rate of degradation associated with the standing dead trees, which will affect their utility for various utilization options.
- BECK recommends identification of policy mechanisms for expediting the salvage and utilization of dead trees on publicly managed lands, especially national forests.
- BECK recommends analysis of log trucking capacity in the Southern Sierra region, and if a shortage exists (as reported in interviews), exploration of options for expanding trucking capacity (e.g., reducing regulatory obstacles, incentives for business formation, etc.).
- BECK recommends identification of options for streamlining the regulatory process for biomass boiler installation. For example, create a mechanism for allowing permitting agencies to take into consideration how biomass heat/power would reduce emissions from trucks and other fossil fuels and open burning of logging slash and allow for more cost-effective forest management.
- BECK recommends assessing whether dead tree utilization might be improved through education efforts aimed at assuring that tree service contractors are aware of log markets and sawmill log specifications.
- BECK recommends establishing programs to provide incentives, grants, low interest loans, etc. for tree service contractors, so that they can more fully capitalize their businesses with equipment for efficiently handling large long logs.
- BECK recommends exploration of options for expanded firewood production in either bulk or bundles as an option for utilizing dead trees, but that other opportunities should take higher priority.

2.2 LOG EXPORTING RELATED RECOMMENDATIONS

- BECK recommends an assessment of whether a log export waiver can be obtained for logs harvested on state and federal lands in California including analysis of the benefits the State of California could expect from log exports relative to the costs that might be incurred (i.e., possible loss of domestic timber processing infrastructure).
- BECK recommends analysis of port infrastructure capacity for bulk loading logs destined for export.
• BECK recommends the following criteria as a basis for the U.S. Forest Service Regional Forester to decide in granting a waiver (per U.S. Forest Service regulatory procedures):
  – Initiation of exporting availability based on a state or federal agency declaring a specific region (e.g., county, watershed, national forest, etc.) to be in a “state of emergency”.
  – Only logs harvested from the emergency zone would be available for export.
  – Within the emergency zone, allowing log exports would be considered on a timber sale by timber sale basis.
  – It must be demonstrated that there are no domestic purchasers of the logs.
  – A person or group of reviewers (e.g., the U.S. Forest Service Regional Forester) would be assigned the task of reviewing all conditions required for granting export approval (e.g., state of emergency, timber sale within the emergency zone, no domestic purchasers, etc.).

2.3 CHIP EXPORTING RELATED RECOMMENDATIONS

• BECK recommends analysis of the feasibility of whole log chipping of dead trees for wood chip exporting including:
  – A supply study to identify where the largest volume of dead trees suitable for making whole log chips are located.
  – Capital expenses associated with development of a chip export facility located close to the highest concentration of dead trees.
  – A market analysis of the long-term demand and pricing for chips in Asian markets.
  – An analysis of logging and hauling costs, chipping costs, forest to port chip transportation costs, and ocean freight costs.

2.4 LOW CAPITAL/SIMPLE PRODUCT MIX SAWMILL RELATED RECOMMENDATIONS

• BECK recommends analysis of the feasibility of the low capital/simple product mix sawmilling concept. Including:
  – Verify the capital expense for the sawmill equipment and other capital costs, including land, buildings, rolling stock, and other miscellaneous project development costs (e.g., planning, permitting, engineering, financing, etc.)
  – Verify that the low capital cost sawmill, as conceptualized, can produce an average of 60,000 board feet of lumber per 8-hour shift.
  – Complete further market research concerning the ability of off-shore pallet and concrete forming markets to absorb additional supply, especially if this sawmill concept was replicated at multiple sites and each sawmill was producing the same lumber product mix.
  – Complete research about the value of the lumber delivered to foreign ports and all costs associated with transporting the lumber from the sawmill to the port facility.
CHAPTER 2 – SUMMARY OF RECOMMENDATIONS

- Complete research about the volume of salvage logs expected to be available on an annual basis, their characteristics (size, grade, species, etc.), and the expected delivered to the mill price per thousand board feet of salvage logs.
- Like the log export option, the rate of degradation in the standing dead trees will play a critical role in the viability of this option. Thus, a good understanding of the expected “shelf-life” of salvaged logs is required.
CHAPTER 3 – STUDY BACKGROUND

3.1 CALIFORNIA TREE MORTALITY

In California, an extended drought combined with an insect outbreak has led to high levels of tree mortality across extensive areas in the Southern Sierra Nevada Mountains and along the coast range in Southern and Northern California. Per a U.S. Forest Service\(^6\) press release, the most recent aerial survey identified an additional 36 million dead trees across California. This brings the total number of dead trees identified since 2010 to over 102 million across 7.7 million acres of forest land. The data also revealed that the scope of the problem is increasing rapidly. In 2016 alone, an estimated 62 million trees died.

Figure 3.1 illustrates the increase in the area affected by advanced levels of tree mortality in the Southern Sierra Nevada Mountains between 2014 and 2016. Please note that the total area in California affected by elevated tree mortality is much more extensive than just the area shown in the figure. Also note that the aerial survey methodology does not allow for measurement of the size (diameter) and height of the dead trees. However, based on photos, on-the-ground inspection, and videos of affected areas, a significant number of the dead trees appear to be large diameter (> 20” in diameter at breast height).


Figure 2.1 source: USDA Forest Service. Accessed at: http://www.fs.usda.gov/Internet/FSE_DOCUMENTS/fseprd506701.pdf
Per an unpublished U.S. Forest Service Report, about 59 percent of the dead trees are located on national forests. That finding is supported by the map shown in Figure 3.2, which shows most the area hardest hit by mortality (areas in yellow/orange/red) during the 2016 aerial surveys are on national forest lands (area shaded in green). Similarly, unpublished Forest Service reports indicate that on the Stanislaus National Forest about 45 percent of the reserved and non-reserved 620,000 acres of productive forest have been affected by tree mortality.

Figure 3.2 – Forest Mortality Survey Results Overlaid on U.S. National Forest Boundary Map
Data from the U.S. Forest Service Pacific Southwest Region showing the cumulative number of dead trees per year on select national forests in California (see Table 3.1). As the table shows, the incidence of tree mortality has spiked dramatically in the last 3 years. It is also worth noting that the nearly 51 million dead trees over the last six years on the six national forests represented in the table account for half of the total dead trees estimated statewide. Since there are 19 national forests in California, if data from all forests were included in the table, the proportion of the total dead trees in the state on national forests would undoubtedly be higher.

Table 3.1 - Estimated Cumulative Number of Dead Trees on Select National Forests of the Sierra: 2010 to 2016 (thousands of trees)

<table>
<thead>
<tr>
<th>National Forest</th>
<th>2010</th>
<th>2011</th>
<th>2012</th>
<th>2013</th>
<th>2014</th>
<th>2015</th>
<th>2016</th>
<th>All Years</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eldorado</td>
<td>78</td>
<td>21</td>
<td>5</td>
<td>7</td>
<td>62</td>
<td>210</td>
<td>1,028</td>
<td>1,411</td>
</tr>
<tr>
<td>LTBMU</td>
<td>15</td>
<td>6</td>
<td>1</td>
<td>1</td>
<td>6</td>
<td>35</td>
<td>72</td>
<td>136</td>
</tr>
<tr>
<td>Sequoia</td>
<td>191</td>
<td>33</td>
<td>63</td>
<td>89</td>
<td>323</td>
<td>6,130</td>
<td>10,147</td>
<td>16,976</td>
</tr>
<tr>
<td>Sierra</td>
<td>82</td>
<td>66</td>
<td>72</td>
<td>103</td>
<td>190</td>
<td>5,900</td>
<td>18,563</td>
<td>24,976</td>
</tr>
<tr>
<td>Stanislaus</td>
<td>49</td>
<td>15</td>
<td>55</td>
<td>81</td>
<td>414</td>
<td>1,251</td>
<td>4,896</td>
<td>6,761</td>
</tr>
<tr>
<td>Tahoe</td>
<td>165</td>
<td>42</td>
<td>21</td>
<td>9</td>
<td>30</td>
<td>93</td>
<td>358</td>
<td>718</td>
</tr>
<tr>
<td>Total</td>
<td>580</td>
<td>183</td>
<td>217</td>
<td>290</td>
<td>1,025</td>
<td>13,619</td>
<td>35,064</td>
<td>50,978</td>
</tr>
</tbody>
</table>

Source: unpublished U.S. Forest Service Report

Regarding the volume of the dead trees, staff at the U.S. Forest Service State and Private Forestry office in Vallejo, California developed an estimate of the standing dead tree volume. The estimate is based on the distribution of tree sizes on 255 tree mortality plots collected on the Sierra National Forest over a 2-year period. The results indicated that the diameters of the dead trees are normally distributed (see Figure 3.3). As shown in the figure, trees greater than the 24” diameter category account for about 30 percent of the stems. However, given the large size of each tree greater than 24” in diameter, they account for 70 percent of the volume (see Table 3.2).

Note that per the unpublished U.S. Forest Service report, an additional 2.5 billion board feet of dead trees was added to the total shown in Table 3.2 to account for dead trees in other parts of the state having a different diameter size class distribution than that found in the Sierra National Forest mortality plots. **Thus, the total estimated volume of dead trees is approximately 65 billion board feet.** The dead tree volume was then converted to a weight estimate using key assumptions of 6 green tons of logs per MBF and the dead trees having an average moisture content of 35 percent. The result is an estimated **178 million bone dry tons of standing dead trees.**
CHAPTER 3 – STUDY BACKGROUND

Figure 3.3 – Distribution of Tree Diameter on Tree Mortality Plots in Sierra National Forest (% of stems on Y axis and Tree Diameter on X axis)

Table 3.2 – Estimated Volume of Standing Dead Trees (Partial Estimate)

<table>
<thead>
<tr>
<th>Diameter Class (inches)</th>
<th>% of Stems in Diameter Class</th>
<th>Number of Dead Trees</th>
<th>Average MBF/Stem</th>
<th>MBF</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>9</td>
<td>9,180,000</td>
<td>0.11</td>
<td>1,010,000</td>
</tr>
<tr>
<td>6</td>
<td>12</td>
<td>12,240,000</td>
<td>0.11</td>
<td>1,346,000</td>
</tr>
<tr>
<td>12</td>
<td>13</td>
<td>13,260,000</td>
<td>0.18</td>
<td>2,367,000</td>
</tr>
<tr>
<td>18</td>
<td>18</td>
<td>18,360,000</td>
<td>0.18</td>
<td>3,305,000</td>
</tr>
<tr>
<td>24</td>
<td>17</td>
<td>17,340,000</td>
<td>0.59</td>
<td>10,231,000</td>
</tr>
<tr>
<td>30</td>
<td>12</td>
<td>12,240,000</td>
<td>0.59</td>
<td>7,222,000</td>
</tr>
<tr>
<td>36</td>
<td>7</td>
<td>7,140,000</td>
<td>1.91</td>
<td>13,637,000</td>
</tr>
<tr>
<td>42</td>
<td>5</td>
<td>5,100,000</td>
<td>1.91</td>
<td>9,741,000</td>
</tr>
<tr>
<td>48</td>
<td>2</td>
<td>2,040,000</td>
<td>1.91</td>
<td>3,896,000</td>
</tr>
<tr>
<td>54</td>
<td>1</td>
<td>1,020,000</td>
<td>1.91</td>
<td>1,949,000</td>
</tr>
<tr>
<td>60</td>
<td>1</td>
<td>1,020,000</td>
<td>1.91</td>
<td>1,949,000</td>
</tr>
<tr>
<td>66</td>
<td>1</td>
<td>1,020,000</td>
<td>1.91</td>
<td>1,949,000</td>
</tr>
<tr>
<td>72</td>
<td>1</td>
<td>1,020,000</td>
<td>1.91</td>
<td>1,949,000</td>
</tr>
<tr>
<td>78</td>
<td>1</td>
<td>1,020,000</td>
<td>1.91</td>
<td>1,949,000</td>
</tr>
<tr>
<td>Totals</td>
<td>100%</td>
<td>102,000,000</td>
<td></td>
<td>62,500,000</td>
</tr>
</tbody>
</table>
### 3.2 TREE MORTALITY EMERGENCY PROCLAMATION

Given the rapidly increasing volume of dead trees described in the previous section of this report, on October 30, 2015, California Governor Brown issued a Proclamation declaring a State of Emergency regarding the issue of tree mortality. The proclamation ordered:

1. Identification of high hazard zones for wildfire and falling trees.
2. State agencies, utilities, and local governments to protect public safety and health by undertaking efforts to remove dead or dying trees in high hazard zones.
3. Identification of potential storage locations for removed trees.
4. Removal of dead and dying trees that are adjacent to highways.
5. Identification of highway and road corridors where dead trees can be used as mulch.
6. Government agencies to work with impacted counties to distribute portable equipment for removing and processing wood waste in high hazard zones.
7. Expansion of prescribed burns by temporarily expanding the number of days prescribed burning is allowed for burning tree waste removed from high hazard zones.
8. Government agencies to work with impacted counties to distribute portable equipment for removing and processing wood waste in high hazard zones.
9. That for purposes of carrying out directives 1, 2, and 5 through 8, Division 13 (commencing with section 21000 of the Public Resources Code and regulations adopted pursuant to that Division) are hereby suspended.
10. That equipment and services necessary for emergency response can be procured quickly.
16. Suspension of Chapter 3.5 (commencing with section 11340) of Part 1 of Division 3 of the Government Code for the development and adoption of regulations or guidelines pursuant to the proclamation.

17. The Office of Emergency Services to provide local government assistance, as appropriate, under the authority of the California Disaster Assistance Act, California Government Code section 8680 et seq. and California Code of Regulations, Title 19 Section 2900 et seq.

18. State agencies to actively monitor tree removal efforts directed by the proclamation.

3.3 TREE MORTALITY TASK FORCE

To address the objectives set forth in the emergency proclamation, a variety of state and federal agencies, local governments, utilities, and various stakeholders established a Tree Mortality Task Force. The Tree Mortality Task Force has been organized into eight working groups, including:

1. Forest Health and Resilience
2. Mapping and Monitoring
3. Prescribed Fire
4. Public Outreach
5. Regulations
6. Resource Allocation
7. Utilization – Bioenergy
8. Utilization – Market Development

With respect to the Utilization Market Development Working Group, their objectives include:

1. Working with affected counties and existing wood product markets to determine the feasibility for expanding wood product markets in California.
2. Providing for highest and best use of wood products.
3. Identifying and developing new opportunities for biomass products (laminated wood products, etc.)
4. Identifying rules or regulations which may block the development of a utilization market.
5. Providing regular updates at Task Force meetings to ensure effective communication and geographic coordination among all task force groups and stakeholders.
3.4 STUDY OBJECTIVES AND RESEARCH APPROACH

In accordance with the Market Development Group’s objectives, the State of California engaged The Beck Group (BECK), a forest products planning and consulting firm based in Portland, Oregon to complete a study aimed at identifying the most viable options for increasing the utilization of dead trees in high hazard zone areas.

To meet those objectives, BECK developed and used a “Wood Utilization Business Opportunity Screening Matrix” for narrowing a list of wood fiber utilization opportunities to a select few judged to have the highest probability of being viable solutions for increased dead tree utilization. The effort built on earlier work completed for the U.S. Forest Service and National Forest Foundation aimed at identifying opportunities for utilizing small diameter trees in California\(^7\). For this study, nearly 50 wood utilization opportunities were screened using a combination of the information obtained during the interviews and using the following key screening criteria:

1. A preference for lower capital investment opportunities, or those that can utilize existing equipment, sites, or other infrastructure that is currently underutilized
2. A preference for opportunities that can be fully operational by the end of 2017, including a focus on mobile or semi-permanent facilities
3. A preference for opportunities that can utilize large volumes of material, but smaller scale opportunities will also be considered
4. A preference for opportunities that have a strong market outlook
5. A preference for opportunities that can utilize the tree species most affected (e.g., ponderosa pine, white fir, and red fir)
6. A preference for opportunities that create products whose sales value exceeds the sum of all costs associated with the creation of the product. Note that opportunities which are not a net positive in terms of cash flow were also given consideration since such opportunities offset at least a portion of the dead tree removal cost, and would therefore, allow for more acres to be treated from a given amount of money relative to a technology that created no saleable product. In these cases, a subsidy from state, federal, or other sources would be required.
7. A preference for opportunities that produced a product for which there is a very large national or international market which would be able to absorb the additional production without major market disruptions.

Second, BECK interviewed many current California based forest products industry members to gather information about their plans and ideas for utilizing dead trees. The results of the screening are documented in Chapter 4. A discussion of utilization options is included in Chapter 5. Appendix 2 is a summary of the interviews.

\(^7\) CAWBIOM study completed for the National Forest Foundation with funding from the U.S. Forest Service: https://www.nationalforests.org/assets/pdfs/Phase-II-Report-MASTER-1-4-16.pdf
CHAPTER 4 – WOOD UTILIZATION OPPORTUNITY SCREENING

BECK completed a screening of utilization opportunities. The objective of this effort was to identify the opportunities best suited to utilizing dead trees. In this chapter the results are reported as well as a listing of the opportunities considered, the screening criteria used, and the methodology applied in using the screening criteria.

4.1 TECHNOLOGY SCREENING CONTEXT

This is an unusual study due to the time sensitive nature of the resource. With 102 million dead trees and counting, the resource is both huge and deteriorating in quality daily. Though the rate of deterioration is variable and not known exactly, it can be assumed that within 2-5 years the current batch of dead trees will not be suitable for most forest products uses. Also, the dead trees are in California, a state known for the complexity and length of its permitting and approval process for factors such as air quality. These two factors push any technology discussion towards existing infrastructure, and the ability to quickly expand that infrastructure. Industry interviews indicated that already dead and burned trees are displacing green trees as a raw material supply for existing mills and other businesses. So, in this regard, the industry is already responding to the current crisis.

The other unusual issue regarding this study is that the volume of material to be removed is very large. So, in looking for solutions, the size of potential markets is more important than the technology to utilize the dead trees. The study included the evaluation of numerous small volume, low capital cost opportunities because they can be established quickly, are low capital/low risk, are often mobile, and can be replicated in numerous locations. But, if they are all targeting the same fixed market, firewood for example, the market will quickly become saturated, prices will drop, and the businesses are likely to disappear as quickly as they appeared. So, while these small businesses may aggregate to a substantial volume of material if successful, the market must first be there now rather than waiting for it to be developed.

In looking to remove the highest priority and accessible portions of the 178 million bone dry tons of material over a short period, only a few uses could absorb large amounts of material. One is energy, which is also more forgiving as to wood quality. A significant portion of that material could be absorbed into electric generation, transportation fuel or space heating without creating a market disruption. With respect to traditional forest products, only log exports and pulp/paper & energy chips can absorb large volumes without dramatically affecting markets. The bottom line to this discussion is that opportunities that rank well will be: already commercial, will process substantial volumes of material into existing large markets and may already be in place and can displace existing feedstocks with the products of the dead trees.

While, for instance, a medium density fiberboard (MDF) plant or an oriented strand board (OSB) plant may use exactly the materials that are available, and use them in large quantity with good potential economics, the fact that such plants could not be operational in California for several years causes such options to be rated poorly. This is part of the frustration in finding solutions to the current dead tree crisis.
4.2 POTENTIAL BUSINESS OPPORTUNITIES

Table 4.1 identifies the full list of potential business opportunities/opportunities BECK considered for converting dead trees into products. There was a total of 47 opportunities considered. The list was organized into four technology categories consisting of: 1) Energy Related; 2) “Traditional” or Engineered Wood Products; 3) By-Products Users – note this includes whole logs converted to chips, shavings, etc.; and 4) Other. The list was derived from a combination of prior work completed by the U.S. Forest Service, the consulting team’s experience, and industry contacts.

Table 4.1 – Full Listing of Business Opportunities Considered for Detailed Analysis

<table>
<thead>
<tr>
<th>Energy Related</th>
<th>“Traditional” and Engineered Wood Products</th>
<th>By-Products Users</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td>Small Biomass CHP</td>
<td>Laminated Veneer Lumber (LVL)</td>
<td>Biofilter Media</td>
<td>Air Curtain Burner (power)</td>
</tr>
<tr>
<td>Cellulosic Ethanol</td>
<td>Fencing</td>
<td>Animal Bedding</td>
<td>Activated Carbon</td>
</tr>
<tr>
<td>Charcoal</td>
<td>Glulam</td>
<td>Mulch &amp; Soil Amendment</td>
<td>Biochar</td>
</tr>
<tr>
<td>Firewood (bulk)</td>
<td>Large Scale Sawmill</td>
<td>Decorative Bark</td>
<td>Cross Laminated Timber</td>
</tr>
<tr>
<td>Firewood (bundles)</td>
<td>Medium Density Fiberboard</td>
<td>Decorative Chips</td>
<td>Erosion Control Mulch</td>
</tr>
<tr>
<td>Fuel Bricks/Logs</td>
<td>Oriented Strand Board (OSB)</td>
<td>Hardboard</td>
<td>Excelsior</td>
</tr>
<tr>
<td>Large Scale Biomass Power</td>
<td>Parallam</td>
<td>Chips – for pulp/paper/energy</td>
<td>Extractives (essential oil)</td>
</tr>
<tr>
<td>Pyrolysis</td>
<td>Particleboard</td>
<td>Wood Plastic Composites</td>
<td>Log Exports</td>
</tr>
<tr>
<td>Small Biomass w/o CHP</td>
<td>Plywood</td>
<td></td>
<td>Nanocellulose</td>
</tr>
<tr>
<td>Small Gasification CHP</td>
<td>Post and Pole</td>
<td></td>
<td>Scrimber</td>
</tr>
<tr>
<td>Small Gasification w/o CHP</td>
<td>Pulp and Paper</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Torrefied Wood Pellets</td>
<td>Semi-Mobile Sawmill</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wood Pellets</td>
<td>Shingles</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Small Scale Sawmill</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: for detailed background information about the technologies listed in Table 4.1 please see the report available at this link:

4.3 SCREENING CRITERIA

The screening criteria applied to the list of opportunities were developed by the consulting team. Thirteen criteria were identified (Table 4.2). The thirteen criteria were sorted into three groups based on the consulting team’s judgment of their importance relative to the objective of utilizing dead trees. Four criteria were placed in the low importance category. Scoring for the low importance category ranged between values of 0 and 3. Six criteria were placed in the medium importance category. Scoring for the medium importance category ranged between values of 0 and 6. Three criteria were placed in the high importance category. Scoring for the high importance category ranged between values of 0 and 10. The opportunities with the highest scores were judged to have the greatest potential for being able to utilize dead trees. The last step of the screening involved breaking the results into two groups: Large Scale and Small Scale based on the amount of material such a business would consume on an annual basis. The dividing point between the two categories was 30,000 bone dry tons per year.

<table>
<thead>
<tr>
<th>Relative Importance</th>
<th>Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low</td>
<td>The technology proposed must have been demonstrated in a commercial setting, at commercial scale, for at least two years</td>
</tr>
<tr>
<td>Low</td>
<td>The technology supplier/developer must be able to offer commercial warranties as to performance, environmental compliance and completion, and must be able to bond such warranty through commercial sources</td>
</tr>
<tr>
<td>Low</td>
<td>The business/technology must be capable of being financed through normal commercial channels, with debt/equity ratios in line with other opportunities of similar risk</td>
</tr>
<tr>
<td>Low</td>
<td>If the business/technology is receiving, through government mandate, special tax credits allowances, etc., the special circumstances must be shown to be in place for the life of the project debt</td>
</tr>
<tr>
<td>Medium</td>
<td>The business/technology must be able to demonstrate that there is a defined and supportable market segment for the product, with potential demand from multiple customers</td>
</tr>
<tr>
<td>Medium</td>
<td>The technology/business is not dependent on tree species and can utilize a high percentage of ponderosa pine</td>
</tr>
<tr>
<td>Medium</td>
<td>The business can be replicated on multiple sites</td>
</tr>
<tr>
<td>Medium</td>
<td>The business is mobile such that it can be moved to multiple sites</td>
</tr>
<tr>
<td>Medium</td>
<td>The total level of capital investment in the technology is less than $1,000,000</td>
</tr>
<tr>
<td>Medium</td>
<td>The business has raw material or regulatory constraint that is unique to operating in California</td>
</tr>
<tr>
<td>High</td>
<td>If this technology is implemented or expanded in CA it will have a measurable impact on the utilization of dead/dying trees</td>
</tr>
<tr>
<td>High</td>
<td>The level of capital investment in the business/technology is such that the project has a payback of 4 years or less using financial modeling, industry comparables</td>
</tr>
<tr>
<td>High</td>
<td>The business/technology could become fully operational in less than 1 year from initiation of planning to commissioning, particularly on sites where an existing business is operational</td>
</tr>
</tbody>
</table>
4.4 SCREENING RESULTS

Using a combination of prior project work completed by BECK, the industry interviews completed as part of this study, and the project team’s experience; three members of BECK’s project team gathered as a group to score the various opportunities using the screening criteria. Table 4.3 displays the screening results for the 10 highest ranked small scale opportunities. Table 4.4 displays the screening results for the 5 highest ranked large scale opportunities. The full Technology Screen Matrix is included as Appendix 3.

Table 4.3 – Top Rated Low Capital/Low Volume Opportunities

<table>
<thead>
<tr>
<th>Rank</th>
<th>Technology</th>
<th>Screening Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Firewood - Bundles</td>
<td>65</td>
</tr>
<tr>
<td>2</td>
<td>Firewood - Bulk</td>
<td>62</td>
</tr>
<tr>
<td>3</td>
<td>Decorative Bark</td>
<td>60</td>
</tr>
<tr>
<td>4</td>
<td>Decorative Chips</td>
<td>59</td>
</tr>
<tr>
<td>5</td>
<td>Extractives (Essential Oils)</td>
<td>56</td>
</tr>
<tr>
<td>6</td>
<td>Animal Bedding</td>
<td>55</td>
</tr>
<tr>
<td>7</td>
<td>Mulch &amp; Soil Amendment</td>
<td>52</td>
</tr>
<tr>
<td>8</td>
<td>Biofilter Media</td>
<td>50</td>
</tr>
<tr>
<td>9</td>
<td>Small Biomass CHP (Combined Heat &amp; Powers)</td>
<td>49</td>
</tr>
<tr>
<td>10</td>
<td>Post and Pole</td>
<td>47</td>
</tr>
</tbody>
</table>

Table 4.4 – Top Rated High Capital/High Volume Opportunities

<table>
<thead>
<tr>
<th>Rank</th>
<th>Technology</th>
<th>Screening Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Low Capital/Simple Product Mix Sawmill</td>
<td>63</td>
</tr>
<tr>
<td>2</td>
<td>Semi-Mobile Sawmill (Hew Saw)</td>
<td>58</td>
</tr>
<tr>
<td>3</td>
<td>Log Exports</td>
<td>55</td>
</tr>
<tr>
<td>4</td>
<td>Whole Log Chips for Pulp/Paper and Energy</td>
<td>50</td>
</tr>
<tr>
<td>5</td>
<td>Large Scale Biomass Power</td>
<td>44</td>
</tr>
</tbody>
</table>
CHAPTER 5 – DISCUSSION OF SELECTED OPPORTUNITIES

The following sections provide background, discussion, and recommended next steps for advancing selected technologies. The information presented is a combination of BECK’s industry interviews, the technology screening matrix, and the opinions of BECK’s staff and associates.

5.1 HIGH CAPITAL/HIGH VOLUME OPPORTUNITIES

5.1.1 Log Exports

BECK concludes log exporting is a technology that potentially offers a significant opportunity for a new business to have a measurable impact on the utilization of dead trees. There is a large, global market for exported logs and key log export markets in Asia (e.g., China) are not as discriminating about log quality as other markets and therefore would likely be more receptive to utilizing logs derived from salvaged trees in California.

Table 5.1 shows the volume of logs exported from all U.S. West Coast ports (including Alaska) between 2006 and 2015. It also shows the volume exported from California ports and California as a percentage of all exports. As illustrated, the total U.S. West Coast average export volume over the 10-year period is 867 million board feet (about 2.6 million BDT). California only accounted for an average of 23 million board feet per year or 2.6 percent of the total. If California set a goal of expanding its export volume by a factor of 5, the annual volume would reach 115 million board feet, but the higher export volume from California would still only account for about 13 percent of the historic log export market share. It seems reasonable that California could meet this objective with little disruption in the log export market. BECK estimates that 115 million board feet of logs is approximately the equivalent of 350,000 bone dry tons per year.

Table 5.1 – History of Log Exports from U.S. West Coast (MMBF)\(^8\)

<table>
<thead>
<tr>
<th>Year</th>
<th>2006</th>
<th>2007</th>
<th>2008</th>
<th>2009</th>
<th>2010</th>
<th>2011</th>
<th>2012</th>
<th>2013</th>
<th>2014</th>
<th>2015</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>MMBF (all)</td>
<td>514</td>
<td>574</td>
<td>632</td>
<td>596</td>
<td>908</td>
<td>1,280</td>
<td>1,030</td>
<td>1,237</td>
<td>1,101</td>
<td>799</td>
<td>867</td>
</tr>
<tr>
<td>MMBF (CA)</td>
<td>10</td>
<td>13</td>
<td>13</td>
<td>13</td>
<td>24</td>
<td>42</td>
<td>31</td>
<td>17</td>
<td>42</td>
<td>31</td>
<td>23</td>
</tr>
<tr>
<td>CA as % of all</td>
<td>2.0</td>
<td>2.2</td>
<td>1.9</td>
<td>2.2</td>
<td>2.6</td>
<td>3.3</td>
<td>3.0</td>
<td>1.4</td>
<td>3.8</td>
<td>3.8</td>
<td>2.6</td>
</tr>
</tbody>
</table>

A limiting factor for this utilization option may be log quality. The impact of this factor will vary depending on the forest conditions, amount of time the tree has been dead, and tree size. The extent of these factors on utilization is difficult to judge with accuracy, but China, for example, is

---

\(^8\) Please note that the data in the table is based on U.S. International Trade Commission log export data, which is reported in cubic meters. BECK elected to use a conversion factor of 7 cubic meters per MBBF of logs. Historically, however, a factor of 4.53 cubic meters per MBF has been used. Thus, the MBF volumes in the table may seem lower than other published sources. The factor of 7 cubic meters per MBF is believed to be more accurate.
less discriminating about log quality than most markets. This is because a significant volume of their lumber is used in applications such as concrete forming, which can utilize lower quality lumber.

Despite the massive volume of dead trees, two existing California log exporting businesses looking to export more logs reported they have been unable to expand sales. Per the industry interviews, several factors are limiting log exports.

First, regarding log processing capacity, log debarking capacity is important since regulations require that logs need to be either fumigated or debarked prior to export. Debarking is the most commonly used option by log exporters. Debarking is a well-developed technology and equipment vendors are readily available to supply machinery needed to increase debarking capacity so long as log exporting companies are willing to invest the required capital. Also needed would be trucking capacity to move logs from processing yards to port. As mentioned earlier in this report, current trucking capacity is limited. It is logical, however, that capital would flow to investments in log trucks if there is demand for such services.

Second, current port infrastructure may limit export capacity. BECK found that the current practice for exporting logs in California is loading logs into containers. Most other U.S. West regions ship logs in bulk (i.e., logs are loaded onto ships without first being loaded into containers). If log exporting in California were expanded significantly, it is likely that the prevailing practice would shift to bulk exports. BECK is not aware of the capacity for California ports to export logs in bulk. Requirements for bulk loading of logs are deep water ports and ship loading capacity. BECK recommends further analysis of port infrastructure capacity for bulk loading logs.

A third, key limiting factor is current restrictions on exporting logs harvested from state and federal lands. Such restrictions have a long history and have been implemented to protect and sustain domestic timber processors. Alaska is one region where an exception has been made to allow exporting of logs harvested from publicly owned lands. The basis for the exception is set forth in national forest log export regulations as defined in 36 CFR 223.185 to 223.203.

Obtaining a similar waiver in California would have to be approached with caution, but if certain conditions were met, it seems that practice could be allowed and at the same time protect domestic timber processors. For example, BECK recommends the following as a basis for the U.S. Forest Service Regional Forester to decide in granting a waiver (per U.S. Forest Service regulatory procedures):

1. Initiation of exporting availability based on a state or federal agency declaring a specific region (e.g., county, watershed, national forest, etc.) to be in a “state of emergency”
2. Only logs harvested from the emergency zone would be available for export
3. Within the emergency zone, allowing log exports would be considered on a timber sale by timber sale basis
4. It must be demonstrated that there are no domestic purchasers of the logs
5. A person or group of reviewers (e.g., the U.S. Forest Service Regional Forester) would be assigned the task of reviewing all conditions required for granting export approval (e.g., state of emergency, timber sale within the emergency zone, no domestic purchasers, etc.)

BECK recommends further analysis of the benefits the State of California could expect from log exports relative to the costs that might be incurred (i.e., possible loss of domestic timber processing infrastructure). BECK also recommends research and analysis about the rate of degradation associated with the standing dead trees. If the rate of degradation is too rapid, it will likely greatly limit the viability of this option since log customers will not accept logs with excessive defect.

5.1.2 Exporting Whole Log Chips for Pulp & Paper or Energy

Whole log chips may offer the opportunity to utilize an estimated 250,000 bone dry tons of dead trees annually. This is because despite declining domestic demand for chips, existing and new chip markets in Asia appear to be growing. The relatively dry moisture content of chips from salvaged trees would allow greater capture of energy for power production, and the salvage aspect of the material would likely be appealing to Japanese buyers.

However, developing such businesses would also face several significant challenges. First, existing ports in Stockton and West Sacramento lack the required draft depth for shipping fully loaded vessels of chips. Despite this obstacle, chips have been exported from West Sacramento in the past by only partially loading vessels. The vessels are then fully loaded at ports with deeper draft in Samoa, California or Coos Bay, Oregon.

Second, exporting chips requires port facilities capable of efficiently receiving, storing, and loading chips. The status of such equipment as West Sacramento is unknown, but in the past Marubeni operated a whole log chipping and export operation at the port. Central Valley Ag reportedly has the required equipment at the Port of Stockton, but up to this point has yet to handle chips. Efficient facilities allow for tighter cost control. For example, recent bulk vessel charter rates ranged widely between $7,500 per day to as much as $20,000 per day, depending on the size and age of the ship and the route.9 This means that both slow loading and partially loading ships at two different ports to achieve a full load costly practices. Each “extra day” needed for loading would increase the ocean freight cost by about $0.35 to $0.90 per bone dry ton (assuming a 22,000 bone dry ton payload). In other words, each extra day and the associated extra cost equates to roughly 0.5 percent of the product’s value.

It may be possible to export chips originating in the southern Sierras from existing chip export terminals in Northern California and Oregon. However, the differential in freight cost between transporting chips from the forest to a port near the South Sierras versus transporting chips to the Samoa, California port is estimated to be $60 to $70 per bone dry U.S. short ton and could be higher depending on the origin site of the chips. Despite this high cost, it may be advantageous to bear the transportation cost versus making significant capital investments in port infrastructure if the utility of the dead trees for use as pulp chips is limited to just a few years.

9 http://thebalticbriefing.com/bulk-report/
CHAPTER 5 – DISCUSSION OF SELECTED OPPORTUNITIES

BECK recommends further due diligence of the following key aspects of such a business:

1. A supply study to identify where the largest volume of dead trees suitable for making whole log chips are located.
2. Capital expenses associated with development of a chip export facility located close to the highest concentration of dead trees.
3. A market analysis of the long-term demand and pricing for chips in Asian markets.
4. An analysis of logging and hauling costs, chipping costs, forest to port chip transportation costs, and ocean freight costs.

5.1.3 Low Capital/Simple Product Mix Sawmill

BECK concludes that multiple low capital/simple product mix sawmills represent another dead tree utilization option that merits further analysis. The industry interview process identified a sawmill concept that has a relatively low capital cost, can be operational in less than a year, and, if replicated at multiple sites, could make a significant contribution to utilizing dead trees. For example, if each sawmill consumed between 10 and 15 million board feet of logs annually and if seven sawmills were developed, it would translate to 70 to 105 million board feet of logs consumed annually, which BECK estimates is the equivalent of 210,000 to 315,000 bone dry tons per year.

BECK recommends further due diligence of the following key aspects of such a business:

1. Verify the capital expense for the sawmill equipment and other capital costs, including land, buildings, rolling stock, and other miscellaneous project development costs (e.g., planning, permitting, engineering, financing, etc.)
2. Verify that the low capital cost sawmill, as conceptualized, is capable of producing an average of 60,000 board feet of lumber per 8-hour shift.
3. Complete further market research concerning the ability of off-shore pallet and concrete forming markets to absorb additional supply, especially if this sawmill concept was replicated at multiple sites and each sawmill was producing the same lumber product mix.
4. Complete research about the value of the lumber delivered to foreign ports and all costs associated with transporting the lumber from the sawmill to the port facility.
5. Complete research about the volume of salvage logs expected to be available on an annual basis, their characteristics (size, grade, species, etc.), and the expected delivered to the mill price per thousand board feet of salvage logs.
6. Like the log export option, the rate of degradation in the standing dead trees will play a critical role in the viability of this option. Thus, a good understanding of the expected “shelf-life” of salvaged logs is required.

5.1.4 Large Scale Biomass

The Governor and Legislature have recognized that existing large scale biomass facilities have a significant role to play in addressing the current crisis of dead trees. BECK concurs, concluding that the California Legislature’s mandate will have a substantial impact on the utilization of dead
trees. The mandate requires that no less than 175 MW of 5 year contracts be offered to California’s existing fleet of large biomass power facilities so long as they agree to utilize 80 percent or more of fuel from high hazard zones. BECK industry contacts reported that to date, 6 existing biomass power plants have secured contracts under this arrangement. The amount of power to be sold under those contracts is 154 MW as of early January 2017, with the Publicly Owned Utilities still to contract for an additional 29 MW. However, BECK estimates that when the full 175 MW of contracts are awarded, and recipients meet the 80 percent standard, fully 1.1 million bone dry tons of high hazard zone material will be utilized annually as fuel. Over the 5-year contract life, that is 5.5 million bone dry tons, a substantial fraction of which is likely to be dead trees. Compared to other opportunities being considered, this program will have a major positive impact in a relatively short period.

A key advantage that large scale biomass has over numerous other opportunities evaluated is that the deteriorated condition of the dead tree is not a serious consideration. Conversely, the dead tree has a much lower moisture content than typical forest fuels, allowing the hauling of more BDTs per load and a more efficient combustion. Another significant advantage of this technology is significant in place infrastructure, which likely means quick utilization startup.

BECK industry contacts also indicated that the biomass plants operating under BioRAM contracts are likely to struggle to secure the required volumes of high hazard fuels. This is because it is believed that there is limited forest industry infrastructure for chipping the material and for transporting from the woods to biomass facilities. This problem is likely to be even more pronounced in the South Sierra region where the dead tree problem is currently concentrated. Anecdotally, industry contacts indicated that while logging contractors know how to operate chipping and grinding equipment, they have increasingly moved out of this business in recent years. Also, with respect to transportation, many independently operating truckers faced with expensive equipment upgrades to meet California’s diesel truck regulations, elected to leave the business. Thus, it is believed there is currently limited capacity for hauling biomass.

### 5.2 LOW CAPITAL/LOW VOLUME OPPORTUNITIES

#### 5.2.1 Decorative Bark/Landscape/Mulch

Given the results of the screening process, there appears to be an opportunity for converting dead trees into various landscape materials, including decorative bark as a landscape covering, chips (either colored or uncolored) as a landscape covering, or various blends of sawdust and fines as a soil amendment or compost type material. BECK, however, believes developing a stand-alone business to serve this market should be approached with caution for several reasons. First, based on information reported during the industry interviews, it appears that markets for these materials may be somewhat limited in size relative to the scale of the tree mortality problem. Second, existing sawmills and other companies in the forest products and mulch/soil amendment industries are already serving this market and have well-established distribution networks. Thus, new entrants may encounter difficulty establishing their businesses. Third, existing sawmills generate chips, bark, sawdust, etc. as a by-product of their sawmilling operations. This means the cost of gathering and processing chips, bark, etc. is borne by the sawmill. Thus, it is possible for the sawmills to view chips, bark, etc. as a product to be sold that has virtually no associated manufacturing cost. In contrast, a stand-alone bark/chip/mulch
CHAPTER 5 – DISCUSSION OF SELECTED OPPORTUNITIES

operation would have to bear the cost of harvesting, transporting, and processing logs into bark and chips in preparation for sale. Thus, a stand-alone business would be at a significant cost disadvantage to a sawmill serving this market. A potential upside of these business types is that BECK believes they would be able to utilize trees with some level of degradation.

5.2.2 Small Scale Biomass

The 50 MW set aside for small scale biomass utilizing the material from sustainable forest management activities and from high hazard zones has dramatically improved the outlook for small biomass facilities. Though not mobile by any means, the plants are likely to be well distributed throughout the range of tree mortality and thus provide substantial markets for salvage material. If fully subscribed, the market for material might rise to 400,000 bone dry tons annually. The program has been slow to develop, however, with first contracts likely to be signed in fall 2017, and operations commencing only in late 2019. While this program offers no early markets for material, the condition of the trees at the time will matter little. BECK believes the current BioMAT program will result in real markets for dead tree material within this decade.

5.2.3 Firewood – Bundles & Bulk

Firewood production also emerged as a high scoring technology in the screening process. This was largely due to the low-capital cost for entering this business, the quick start up time, the ability to replicate the business, and the fact that such businesses could be mobile. Limitations on this type of business are that they tend to be small-scale, and therefore, would have relatively little impact in addressing dead tree utilization given the massive number of dead trees.

Also, most of the dead trees are ponderosa pine, which is generally viewed as a less desirable firewood species. BECK slightly downgraded the scoring on that criteria for bulk firewood because bundled firewood users are generally campers or occasional users in a fireplace, backyard fire pit, etc. and are less likely to be concerned about the heating quality of the firewood (i.e., energy content, ash, etc.) Bulk firewood users, on the other hand, are more likely to discriminate their purchasing based on species, and the score was therefore lowered for bulk firewood on the species criteria. In addition, broad areas in California have restricted the use of firewood for home heating because of air quality concerns. Therefore, the market is limited by regulatory issues as well as milder climate in Southern California that limits the need for home heating. A potential bright spot is that per California customs district data a total of about 6,000 to 8,000 green tons (3,000 to 4,000 bone dry tons) of firewood has been imported to California annually. Any material produced locally would likely displace the firewood currently being imported. BECK recommends that the Tree Mortality Task Force explore options for expanded firewood production in either bulk or bundles be pursued as an option for utilizing dead trees, but that other opportunities (e.g., log exports, small scale sawmill, etc.) should take higher priority.
Figure A1.1 illustrates the location of the Tier 1 and Tier 2 zones as of January 2017, and a 10 county high-priority area.
APPENDIX 2 - INDUSTRY INTERVIEWS

BECK contacted nearly 20 forest products industry members via telephone and email to interview them about their company’s plans for addressing and responding to the tree mortality issue. Interviewees were selected from a list of contacts provided by the study organizers and from BECK industry contacts. Selections were made to cover major utilization technologies and geographic regions.

ARAUCO NORTH AMERICA

BECK interviewed Mr. Brian Sarginson, Director Strategic Projects, Arauco North America. Arauco, parent company of Arauco North America, is a manufacturer of wood products including plywood, millwork, lumber and a variety of composite wood panels (e.g., medium density fiberboard (MDF), high density fiberboard (HDF), hardboard, and particleboard). Mr. Sarginson indicated that California is a large market for MDF panels. Therefore, Arauco North America is actively looking for opportunities to develop and operate a modern, world-class MDF manufacturing facility on the U.S. West Coast.

MDF is a composite panel that is widely used in applications such as home and office furniture, moldings, fixtures, etc. The manufacturing process involves the use of clean wood (i.e., no bark), which is first reduced in size to wood fibers that are then mixed with a resin, and formed into a panel under heat and pressure. The resulting panel has a very smooth surface that is ideal for laminating. MDF plants in North America typically use a combination of chips, sawdust, and shavings as raw material feed stocks. In some areas, MDF plants have chipping operations to convert pulpwood size logs into chips, which are then further reduced in size as part of the normal manufacturing process. Therefore, it is possible that Arauco could utilize a combination of mill residuals and diseased trees/pulpwood/topwood material sourced directly from the forest if the company were to develop a plant in California.

BAILEY’S FORESTRY AND LOGGING EQUIPMENT

BECK interviewed Mr. Jim Haas, Industrial Sales Director, for Bailey’s, a company founded in Laytonville, California in 1975 by Bill and Judith Bailey. Bailey’s originated as a mail-order catalog business that specialized in selling logging supplies. As the company has grown, it continues to focus on serving the forestry and logging customers, but the product lines offered have grown considerably. Today, customers can purchase arborist and tree care equipment, chainsaws, portable sawmills, wood chippers, and other industrial equipment.

Because of the company’s focus on supplying forestry and logging related equipment and because of their location in California, Mr. Haas reported that the firm is well-aware of the tree mortality issue in the state and that it has affected Bailey’s business. As an example, Mr. Haas reported that he had recently sold a horizontal grinder to a contractor who planned to use the machine to process dead trees into biomass fuel for sale to a sawmill in California, that, in turn, would burn the material to produce heat and power. The chippers sold by Mr. Haas include both towable small-scale chippers and industrial size grinders. Mr. Haas also reported that contractors who have been retained to remove dead and dying trees along road right-of-ways and near
communities have been purchasing equipment such as chippers and other items to aid in their work.

More importantly, for this study, Mr. Haas also described his analysis of a low capital/simple product mix sawmilling business. The analysis was completed on behalf of Bailey’s in furtherance of their efforts to sell sawmilling equipment manufactured in Europe to U.S. customers. Prior to working at Bailey’s, Mr. Haas was a manager at a sawmill operated by Soper-Wheeler Company, which is based in Strawberry Valley, California. He has also been a salesperson for International Forest Products, a U.S. based firm that specializes in international trading of lumber and other forest products. Given Mr. Haas’ sawmilling and lumber sales background, he researched the feasibility of developing a low-capital investment sawmilling operation to utilize dead trees. The key parameters underlying Mr. Haas’ assessment were that:

1. Any sawmill developed would have to produce lumber products that differ from those produced by existing, large-scale sawmills operating in California.
2. The mix of lumber products produced would have to be very simple (i.e., no grading needed, no kiln drying needed, and no planing needed)
3. Any sawmill developed would have to have a low capital investment to maximize the chances that the investment would be paid back within the limited “viability window” afforded by the utilization of dead trees.

Given those parameters, the solution identified by Mr. Haas is outlined as follows:

1. A horizontal band mill coupled with a downstream gang edger, trim saw, and an edger. The equipment configuration should be capable of producing as much as 60,000 board feet per 8-hour shift.
2. A capital cost for the sawmill, edger, trim-saw, transfers and its installation of approximately $500,000.
3. The sawmill would produce ungraded, undried, and unplaned lumber sawn to a variety of metric sizes (thickness, width, and length), which would be used for concrete forming and pallet manufacturing.
4. The initial target market for those products would be various Middle Eastern countries where Mr. Haas’ experience has shown demand and pricing for those products to be relatively stable.
5. Logs to supply the mill would have to be delivered to the sawmill at a value close to the cost of harvesting and hauling (i.e., no payment to landowners for stumpage).

BECK believes the small-scale sawmilling concept outlined by Mr. Haas has merit, but BECK has not completed a feasibility analysis. In BECK’s view the key feasibility questions to be answered are:

1. Can the low-capital cost mill envisioned produce as much as 60,000 board feet of lumber per shift?
2. What additional capital expenses would be associated with the project (e.g., land, building(s), by-product handling systems, rolling stock for unloading logs from trucks and
feeding logs to sawmill, rolling stock for moving/loading lumber, a kiln for heat treating lumber to meet export requirements prior to shipment, permitting, etc.)

3. Can the mill be fully supplied with log costs equal to only the costs of harvesting and trucking (i.e., no stumpage value)?

4. Aside from the cost of purchasing logs, what are the other operating costs of the sawmill (e.g., labor, power, repairs and maintenance, supplies, administrative and overhead, etc.)?

5. What recovery factor (MBF lumber per MBF logs) would the mill experience?

6. What is the value of the lumber to be produced (f.o.b. mill)?

7. Related to the previous question what is the value of the lumber delivered to the customer, and what are the costs for transporting the lumber from the sawmill to the customer?

8. What is the development timeline for such a business and does it match the log degradation timeline?

9. What is the return on investment for such a project?

**GREEN DIAMOND RESOURCE COMPANY**

BECK interviewed Mr. Jason Carlson, General Manager, Samoa Chip Export Facility, Green Diamond Resource Company. Green Diamond Resource Company (GDRC) is a family-owned forest products company that owns and manages forest land in California, Oregon, and Washington. GDRC’s California timberlands cover nearly 400,000 acres in Del Norte and Humboldt Counties and all are certified to Forest Stewardship Council forest management standards. Company-wide, GDRC harvests, on average, less than 2 percent of its timber annually.

In addition to its timberland holdings, GDRC operated a sawmill in Korbel, California. The mill was shut down in late 2014 and was recently sold to Trinity River Lumber Company. GDRC also operates the Samoa Chip Export Facility located in Humboldt Bay, California. The primary focus of that business is exporting wood chips to customers in China and Japan.

Mr. Carlson reported that the Samoa Chip Export Facility was shut down between 2002 and 2013. GDRC invested $7 million in the Samoa Chip Export Facility to bring it back to operational status. The facility was operational in 2013 following the refurbishment, but it was not until 2014 that the first wood chip filled ships left the facility. During 2016, a total of four vessels exported chips from the facility, with the potential for a fifth ship to leave the port yet this year.

Per Mr. Carlson, each ship has a capacity of 3.6 million cubic feet. Given the current species mix and moisture content averages, that cubic volume translates into about 45,000 green metric tons per vessel or about 20,000 to 21,000 bone dry metric tons per vessel. Thus, up to this point in 2016, GDRC has shipped approximately 85,000 to 95,000 bone dry tons of wood chips.

Most the chips exported up to this point have been sourced from sawmills in the Northern California region. However, Mr. Carlson indicated that GDRC recently accumulated a large deck of tan oak logs that were chipped using mobile chippers. Those chips were intended for export to an offshore customer, but the deal fell through, so GDRC shipped the tan oak chips to domestic markets in Oregon and Washington via Sierra Pacific Industries barge facility.
APPENDIX 2 – INDUSTRY INTERVIEWS

Mr. Carlson said that GDRC has been investigating the possibility of developing a stationary whole log chipping operation as a means of increasing the capacity of the exporting operations. If a stationary chipping facility were developed, he stated it would have a production capacity of about 225,000 green tons per year, or about 105,000 bone dry short tons per year. In the meantime, the company will continue pursuing whole log chipping on an opportunistic basis using mobile chippers.

The chips that have been exported from Samoa are “pulp quality” (i.e., limited bark, limited fines, and limited oversize). The chips were sold to buyers in Japan and China for both pulp and paper manufacturing and for energy use. Mr. Carlson believes there is an opportunity to increase the volume of chips exported from the Samoa facility because of continued demand in both countries. More specifically, Mr. Carlson stated that because of new energy policies in Japan, there has been increased interest in pulp quality chips to be used as fuel for power production at the country’s biomass energy plants. He did not believe that similar market expansion opportunities exist in China since the buyers there are much more price sensitive.

Some basic specifications for these chips are:

1. Not more than five percent by green weight of the chips shall remain on a screen with holes of diameters of 28.6 millimeters (remaining chips would be “oversize”)

2. Not less than ninety two percent (92 percent) by green weight of woodchips shall pass through a screen with holes of diameter 28.6mm and remain on a screen with holes of diameter 4.8mm

3. Not more than three per cent (5 percent) by green weight of woodchips shall pass through a screen with holes of diameters 4.8mm, such materials to be called “Undersize Woodchips” or “Fines”

4. The quantity of bark and rot over 1 percent by green weight combined included in the total Vessel load will be deducted from the total Vessel load

He reported that Japanese buyers were recently willing to pay $140 to $145 per bone dry metric ton for pulp quality (about $125 to $130 per bone dry U.S. short ton) for chips loaded onto a vessel at Samoa, California. He further stated that he believes the Japanese energy chip buyers would be willing to pay even higher prices for chips derived from dead trees since the moisture content of that material is much lower and would therefore yield more net energy for generating power. As evidence of that claim, he cited recent British Columbia chip exports to Japan using material derived from dead lodgepole trees in that province’s Inland Region.

Mr. Carlson also noted that Japanese chip buyers are very interested in the sources and sustainability of the chips they purchase. Thus, he believes that the concept of salvaging dead trees to reduce hazards along roads and powerlines and to reduce the chance for wildfire would be of interest to Japanese buyers.

Exporting wood chips may be a viable means of utilizing California’s dead trees. However, there are several issues that present roadblocks:

1. The ports of Stockton and West Sacramento could potentially export chips since they are much closer to the Southern Sierra (where most of the dead trees are located) than the
APPENDIX 2 – INDUSTRY INTERVIEWS

Samoa facility. However, at Stockton the maximum draft is 35 feet and at West Sacramento maximum draft is 30 feet. A fully loaded chip vessel typically requires 38 to 39 feet of draft. Therefore, under current conditions neither the Stockton nor West Sacramento facility could fully load a vessel. This obstacle has been overcome in the past by ships being partially loaded at West Sacramento and then being topped off at either Samoa, California or Coos Bay, Oregon. This practice adds expense to the chips, but per Mr. Carlson is not necessarily a “deal breaker”.

2. Aside from the draft depth issue, a better understanding of the capabilities of the port facilities at both the Stockton and West Sacramento is needed. It is BECK’s understanding that in the past chips were exported from West Sacramento, but the status of the port and any remaining infrastructure is unknown. Regarding Stockton, Central Valley Ag reportedly has equipment at the port that can store, load, and unload chips, but the company has not yet handled those materials. As a point of reference, Roseburg Forest Products’ chip export terminal in Coos Bay, Oregon uses a pneumatic loading system to convey material from chip piles into a vessel. The pneumatic system ensures good compaction of the chips and provides a loading rate of 800,000 cubic feet per day. The loading tower at Coos Bay is stationary, thus the ship must be repositioned as each hold is filled. Additionally, the Coos Bay site includes 25 paved acres for chip storage, a mooring berth over 1,000 feet in length, a wharf 260 feet in length, and draft depth at the dock of 40 feet. The Coos Bay facility serves standard size chip hauling vessels, which can carry about 20,000 bone dry metric tons. Additional equipment is needed for weighing and unloading trucks and rail cars and for conveying unload material to storage piles. Given the unknown but limited “shelf-life” of the dead trees, a large capital investment in chip export terminal infrastructure may not provide the payback needed to fully amortize the required capital investment in port infrastructure.

3. If chip vessels were to be partially loaded in Stockton or West Sacramento and then topped off at Samoa, there are potential looming issues at Samoa as well. In recent years, vessels navigating to the Samoa Chip Export Facility have faced shoaling issues as winter storms fill in ship navigation channels. The U.S. Army Corps of Engineers has responded by expending dollars and resources on dredging to better accommodate the deep draft chip export vessels. The cost of dredging is high relative to the current amount of vessel traffic at the Samoa Chip Export Facility. Additional chip export activity at Samoa would provide further justification to the investment in dredging.

4. With respect to markets, Mr. Carlson indicated that Japanese buyers are interested in chips for energy production. This is apparently in response to a Feed-In-Tariff (FIT) scheme for renewables introduced in Japan in 2012. While much of the FIT derived demand for biomass comes from coal plants that will co-fire wood pellets, there are also several smaller biomass plants either under development or currently operating that will apparently use biomass purchased from foreign suppliers. For example, it was reported in late 2015 that Sumitomo Corporation was planning to build a 50 MW biomass plant in Sakata City in the Yamagata Prefecture and that fuel would be procured from both
domestic and imported biomass materials.10 Similarly, Nippon Steel and Sumitomo Metal Corporation announced expanded biomass usage for in-house power generation, including using wood chips for co-firing at a 330 MW unit in Oita Prefecture and a 149 MW unit in Iwate prefecture.11 Mr. Carlson stated that his foreign contacts indicated that a number of new Japanese biomass plants will be coming on line in 2017 through 2019. Thus, there appears to be a market for wood chips to produce power in Japan, but caution is needed since the market is dependent on continuation of Japan’s FIT policy, and it is likely that biomass suppliers in other parts of the world could supply material at a lower cost than U.S. producers.

LARGE BIOMASS POWER CONTRIBUTION TO DEAD TREE REMOVAL

Any evaluation of technologies to assist with tree mortality issues must include the potential contribution of existing biomass power and cogeneration facilities. Therefore, BECK interviewed Ms. Julee Malinowski-Ball, the Executive Director of the California Biomass Energy Alliance (CBEA) in Sacramento, who provided insight on the current and projected status of the industry. BECK also reviewed various relevant legislative documents and recent California Public Utilities Commission decisions and utility filings.

The Governor’s Emergency Proclamation recognizes the role of biomass power in addressing the tree mortality issue. Specifically, Item 8 of the Proclamation requested extensions of the contracts for bioenergy facilities. CPUC Resolution E-4770 was adopted on March 18, 2016. The resolution directed the three major investor owned utilities to procure a minimum of 50MW of bioenergy from new and existing facilities, with the focus being on existing facilities, utilizing 5 year extendable contracts. The existing Renewable Auction Mechanism (RAM) methodology was to be utilized, but bilateral contracts were also allowed. The procurement was tied firmly to the tree mortality issue by requiring an increasing amount of total fuel to be from identified high hazard zones, with 80% of all fuel being sourced from such zones beginning in 2019.

Solicitations were conducted by the three utilities, as well as bilateral contract discussions. The first tangible result was a "tolling agreement" between PG&E and Sierra Pacific Industries for up to 186 GWH/year of incremental energy from fuel supplied by PG&E that met the requirements of E-4770. It was approved by the CPUC on June 9, 2016.

The 2016 legislature, in SB 859, added a requirement for an additional 125 MW of short term bioenergy contracts, adding that publicly owned utilities (POU’s) with greater than 100,000 customers share in the 125 MW total requirement (total of 29MW). The CPUC again took up this requirement on an expedited basis and on October 13, 2016 approved Resolution E-4805.

The Resolution continues the use of the RAM process and allows any excess megawatts procured under Resolution E-4770 to count against the added 125 MW total. Five-year extendable contract options are again offered to existing facilities, and fuel requirements are a minimum of

---


60 percent from high hazard zones and a minimum of 80% from sustainable forest management activities by 2019.

The three large IOU's have now filed Advice Letters with the CPUC seeking approval of contracts with a total of 6 existing biomass power facilities for a total capacity of 154 MW and an annual delivery of 1,123.9 GWH annually. When this is combined with the previous Sierra Pacific Industries contract (186 GWH/YR) and the 29 MW POU allotment (estimated 215 GWH), this is a total procurement of 1,524.9 net GWH annually. Using a typical multiplier of 9,000 bone dry tons per GWH, this means that, under the terms of the contracts, the byproducts of sustainable forest management will total no less than 686,000 bone dry tons in 2017, 823,000 bone dry tons in 2018 and 1,100,000 bone dry tons in 2019 and beyond. Of this, beginning in 2019, at least 825,000 bone dry tons annually will be from Tier I and II designations. If other large biomass plants under existing long term contracts without these requirements also take hazard fuels, the numbers will be larger yet.

**MDI FOREST PRODUCTS**

BECK briefly interviewed Mr. Tony Simms of MDI Forest Products (MDI) of Emeryville, California. MDI specializes in exporting U.S. logs and lumber to various foreign countries. The company operates a log yard in the McClellan Business Park in Sacramento. Logs are accepted at the log yard, debarked, and eventually loaded into containers for export from the Port of Oakland.

Mr. Simms reported that their company is actively exporting logs and is seeking opportunities to expand their log exporting business. However, they are unable to obtain as many logs as their equipment could process and their markets would buy due to restrictions on exporting logs originating from state\(^\text{12}\) and federally owned lands. Because of this situation, Mr. Simms indicated that the company is also exploring the possibility of making pulp chips from whole logs and exporting those chips to offshore customers in Asia.

Oregon has faced similar issues regarding log exports. In 2013, Oregon Department of Forestry economist, Gary J. Lettman published a report\(^\text{13}\) summarizing his economic analysis of log exports in Oregon. Similarly, a U.S. Forest Service publication\(^\text{14}\) chronicles the history of log exports in the Pacific Northwest. Per both publications, the practice of log exports began in response to a massive windstorm that occurred on Columbus Day in 1962 that leveled over 11 billion board feet of timber in Oregon and Washington. Both states responded by immediately pursuing sales of salvaged logs to foreign buyers, primarily in Japan. Over time, China and Korea also became significant markets for log exports.

The practice of exporting logs, however, soon turned into a controversial issue because domestic producers claimed that log exports unfairly hurt their businesses. Something of a compromise was reached in 1968 when logs harvested from federal lands were prohibited from being exported. Similarly, logs harvested in Oregon from state and other public lands were banned

---

\(^{12}\) California Public Resources Code, Section 4650.1  
from being exported in 1990. Log exporting has always been allowed for logs harvested from tribally and privately owned lands.

The practice of exporting logs harvested from federally owned lands is currently allowed in Alaska provided certain conditions are met. Despite Alaska’s vast forests, the size of the forest products industry in the region is modest. The main reasons for that situation are Alaska’s long distance from markets and the relatively high cost of labor and supplies in Alaska. Therefore, the ability to export logs has been important in sustaining an infrastructure of logging contractors in the region, which, in turn, has supported a much higher level of timber harvesting than would be needed to supply Alaska’s conversion facilities (sawmills). Table A2.1 illustrates the historic level of log exports from Alaska’s two national forests (Tongass and Chugach). As shown in the table, the level of log exports has been consistent on an annual basis.

Table A2.1 – Alaska’s History of Log Exports 2005 to 2015

<table>
<thead>
<tr>
<th>Year</th>
<th>Cubic Meters</th>
<th>MBF (Scribner)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2005</td>
<td>967,094</td>
<td>138,156</td>
</tr>
<tr>
<td>2006</td>
<td>1,131,163</td>
<td>161,595</td>
</tr>
<tr>
<td>2007</td>
<td>895,079</td>
<td>127,868</td>
</tr>
<tr>
<td>2008</td>
<td>861,526</td>
<td>123,075</td>
</tr>
<tr>
<td>2009</td>
<td>928,041</td>
<td>132,577</td>
</tr>
<tr>
<td>2010</td>
<td>1,272,703</td>
<td>181,815</td>
</tr>
<tr>
<td>2011</td>
<td>1,249,746</td>
<td>178,535</td>
</tr>
<tr>
<td>2012</td>
<td>1,323,061</td>
<td>189,009</td>
</tr>
<tr>
<td>2013</td>
<td>1,254,557</td>
<td>179,222</td>
</tr>
<tr>
<td>2014</td>
<td>903,571</td>
<td>129,082</td>
</tr>
<tr>
<td>2015</td>
<td>730,887</td>
<td>104,412</td>
</tr>
</tbody>
</table>

ORIENTED STRAND BOARD (OSB)

OSB is a structural composite wood panel widely used in construction and industrial applications. Over 20 billion square feet (3/8” thickness basis) of OSB was consumed in the U.S. and Canada in 2015. The plants that manufacture OSB are large, industrial scale modern facilities that consume

---

15 Please note that the data in the table is based on U.S. International Trade Commission log export data, which is reported in cubic meters. BECK elected to use a conversion factor of 7 cubic meters per MBF of logs. Historically, however, a factor of 4.53 cubic meters per MBF has been used. Thus, the MBF volumes in the table may seem lower than other published sources. The factor of 7 cubic meters per MBF is believed to be more accurate. See additional info here: http://www.timbermeasure.com/CDA_2016/08-Daniels.pdf
very large volumes of wood fiber annually. If such a plant were developed in California, it could potentially consume dead trees as part of its raw material supply.

In 2015, The Beck Group completed a preliminary assessment regarding the feasibility of developing an OSB manufacturing plant in California. The key findings from the study were:

1. California represents one of the largest markets, accounting for an estimated 8 percent of all OSB consumed in North America. Despite California being such a large market, the closest OSB manufacturing plants are over 1,000 miles away in British Columbia and east Texas. Thus, a California based OSB plant would have a significant finished product transportation cost advantage over competing manufacturers.

2. The plant modeled in BECK’s feasibility analysis would consume approximately 675,000 green tons (U.S. short tons) of raw material annually. BECK estimated that as much as 1.373 million green tons of raw material could be available annually. The sources of supply could include pulpwood – small diameter trees harvested from forest thinning operations, topwood – the otherwise unutilized tops of trees harvested as sawlogs, and mill residuals – slabs, edgings, and trim-ends arising from the manufacture of lumber.

3. The capital investment for the plant modeled by BECK would be an estimated $166 million dollars.

4. More comprehensive analysis is needed in the areas of raw material availability and cost, capital costs, and regulatory and permitting issues.

Given those findings, BECK applied to the 2016 U.S. Forest Service Wood Innovation Grant program seeking funding to complete additional analysis. BECK was awarded the grant. One condition of receiving the grant was that BECK needed to identify an OSB industry partner to participate in the follow-up study. The industry partner’s role is to provide leadership and guidance in the completion of the study and be potentially interested in developing an OSB plant if warranted by the results of the study. BECK has secured an industry partner, and the study was recently started.

AIR BURNERS, INC.

BECK interviewed Mr. Norbert Fuhrmann, Vice President and Director of Sales for Air Burners, Inc. of Palm City, FL. Mr. Fuhrmann subsequently provided additional information and tools to allow BECK to conduct an initial generic evaluation of its innovative technology (PG Firebox) involving the combination of two proven opportunities.

Air Burners Inc. offers a technology involving a "firebox" in which wood is burned, coupled with an Organic Rankine Cycle (ORC) power generation system. It was emphasized that this technology is first a wood disposal tool and secondly for power generation. The firebox is a metal or refractory lined box which will accept whole tree pieces supplied by a front-end loader or grapple. The firebox is equipped with a forced combustion air system that assures a complete burn and relatively low emissions.

Over the firebox is a variable position "scoop" that diverts a portion of the exhaust gas through the hot water heat exchanger portion of the ORC system. The hot water output evaporates the ORC working fluid in a second heat exchanger, with the evaporated working fluid directed to an...
expander directly connected to a generator. A condenser cooled with water returns the working fluid to a liquid state prior to being re-evaporated.

The system can be produced in 3 sizes: 110 kilowatt (KW), 500 KW and 1 megawatt (MW). The 110 KW unit is designed to be portable, while the 500 KW and 1 MW units are designed to be sited at a fixed location, such as a log sort yard or landfill. The power generation system will supply the power for all auxiliary equipment (fans, pumps) with the remainder being sold to the utility, or a nearby business. The system is not self-starting, and must rely on a portable generator or grid power for startup.

One application touted by the manufacturer for the small unit (110 KW) is the company termed "electric forest" where the excess power is used to charge batteries that are used to power the electric mobile equipment involved in processing and delivering the trees for disposal. The scheme would avoid having to have a grid connection wherever the unit is sited.

Air Burners, Inc. supplies a spreadsheet to be used when evaluating a specific application. That spreadsheet has several application specific inputs that results in a calculated investment return. The spreadsheet is somewhat limited in that it does not include unit maintenance costs and such items as insurance, taxes, permits, cooling water, etc. and does not allow the input of sufficient siting and permitting costs for a typical California location.

The spreadsheet was run by BECK for two cases, a 110 KW portable installation and a 1 MW fixed installation. The spreadsheet deficiencies identified above were corrected with realistic numbers.

The results for the 110 KW installation were as follows:

- Operating Schedule – 5 days/week, 10 hours/day full load operation
- Net Electric Sales – 88 KW
- Electric Sales Price – $200/MWH (assumed maximum from BioMAT program)
- Total Capital Cost (incl. site development) – $850,000
- Annual Wood Consumption – 15,000 green tons
- Fuel Cost – $0 (but no tipping fee)
- Annual Operating Loss – $200,000 (with no capital allocation)
- Tipping Fee to obtain 10 year 15% Return on invested capital – $24/green ton

For the 1M Unit, the results were:

- Operating Schedule – 5 days/week, 10 hours/day full load operation
- Net Electric Sales – 954KW
- Electric Sales Price – $200/MWH
- Total Capital Cost (incl. site development) – $3 million
- Annual Wood Consumption – 17,500 green tons
- Fuel Cost – $0 (but no tipping fee)
- Annual Operating Loss – $0 (with no capital allocation)
The addition of power generation to a modified open trench burner application is clearly an innovative technology, and turns what would be a pure disposal technology into a least a partial utilization technology. The process is inefficient, as only a fraction of the heat from wood combustion is captured for power generation. As shown above, even with the highest prices that BECK projects from California’s BioMAT program for small facilities ($200/MWH), the technology cannot contribute to the cost of dead tree removal, but might lower the ultimate cost of disposal. The technology is substantially lower in capital cost than others in this size range, but the low efficiency means that for a larger long term fixed installation, other technologies may offer superior economics. In addition, there are questions regarding air quality permitting and water use that remain to be answered.

**RJJ RESOURCE MANAGEMENT CORPORATION**

BECK interviewed Mr. Dan Caven, Log Yard Manager for RJJ Resource Management Corporation (RJJ) of Richmond, California. Mr. Caven reported that RJJ has been actively involved in the export of sawlogs. The current process of exporting logs includes: logs being delivered to the company’s log yard in West Sacramento. In Sacramento, a ring-debarker is used to debark the logs prior to them being shipped by truck to RJJ’s log yard in Richmond, California. At Richmond, the logs are loaded into standard shipping containers. The containers are then delivered to the port where they are loaded onto ships.

The preferred small-end diameter of the logs exported by RJJ is between 8” to 18”. RJJ cannot accept any logs longer than 38’ 6” since the shipping containers are 40 feet long. Mr. Caven reported that the firm has been getting some salvage logs from PG&E clearing activities. Those logs, however, tend to be cut to relatively short lengths (e.g., 12, 16, and 20 foot lengths). The company accepts logs cut to these shorter lengths, but they are problematic for being able to fully utilize the volume available in the shipping containers.

The overwhelming majority of the logs are shipped to buyers in China. Approximately 75 percent of the logs shipped are ponderosa pine. The company also operates smaller, satellite log yards in Yosemite and Mariposa to accumulate log inventories so that export operations can continue through the winter months when there is very little logging activity. From January through October of 2016, the company has exported more than 6,000 containers of logs. Mr. Caven indicated that the company has the capacity and market to export more logs. However, like what was reported by MDI, given current restrictions on exporting logs from state or federal lands, neither firm has been able to secure larger supplies of logs to support expansion of their business. Like the opinions expressed by others in the log export business, RJJ is interested in expanding their log export business.

**SIERRA FOREST PRODUCTS**

BECK interviewed Mr. Kent Duysen, General Manager and part owner of Sierra Forest Products (SFP), Terra Bella, California. SFP is a softwood lumber sawmill that has been in business since 1968. It is the only industrial scale sawmill left in the Southern Sierra Nevada Mountain Range. The mill processes approximately 35 to 40 million board feet of logs (Scribner log scale) annually.
Per Mr. Duysen, the mill historically has received a log supply consisting of about 40 percent pine and 60 percent white fir. SFP has traditionally processed a significant portion of their logs into 1” nominal thickness¹⁶ select and common grade lumber in widths ranging from 4 to 12 inches. That type of lumber is used in a variety of applications, including paneling, siding, shelving, and furniture. However, in response to log supply and lumber market dynamics, the mill has begun producing 2” thick dimension lumber for use in structural building applications. This is a significant change in operating practices since it is not common for some pine species (e.g., ponderosa pine) to be processed into dimension lumber.

The switch to a focus on producing 2” thick lumber was driven by several factors. First, across the western U.S., a series of wildfires and insect and beetle attacks in recent years have translated into large volumes of logs (especially pine) that need to be salvaged. Those logs have entered the log market and many sawmills are producing larger than normal volumes of select and common grade lumber. This, in turn, has flooded lumber markets with excess supply and driven lumber prices down.

Second, the increase in tree mortality has changed the mill’s log supply species mix. Today, about 80 percent of the mill’s logs are pine and only 20 percent are white fir. The different species mix combined with the change in lumber product mix has resulted in the need for longer lumber drying schedules in the mill’s 5 dry kilns. In other words, thicker lumber takes longer to dry and pine takes longer to dry than white fir. This combination of factors, means that SFP’s overall lumber production capacity is now controlled by its kiln drying capacity rather than its sawmilling capacity. Mr. Duysen reported that several times this year, the sawmill had to suspend operations to allow the dry kilns to catch up to the sawmill’s lumber production. Despite the opportunity to expand kiln capacity, Mr. Duysen up to this point has not elected to do so. In total, these raw material supply and lumber market dynamics have created a difficult operating environment for his business.

Mr. Duysen said that a further complicating issue is the short “shelf-life” of dead trees. Per Mr. Duysen, trees salvaged from a fire and processed in the SFP sawmill 2 years after the fire had 30 to 35 percent defect in the logs. Defect is wood fiber that has deteriorated from fungus and insect activity to the point that it is no longer suitable for use as structural or appearance grade lumber.

Mr. Duysen also commented that, historically, his mill has always struggled to secure enough logs since most of the land around his mill is either a national forest or national park. An irony of the current situation is that while tree mortality has created an oversupply of logs, the simultaneous oversupply in lumber markets has hurt the mill’s financial performance due to low lumber demand and lumber prices.

A bright spot in SFP’s business is that the mill’s location in the Southern Sierra has translated into very strong markets for the mill’s by-products (sawdust, shavings, bark, and chips). The most important of these is using bark to make landscape material. Those markets have been and continue to be strong.

¹⁶ Nominal Thickness refers to a convention in the lumber industry in which the actual thickness of lumber is often slightly smaller than its nominal or “named” thickness. For example, a 2 x 4’s actual measurements are 1.5” thick by 3.5” wide.
APPENDIX 2 – INDUSTRY INTERVIEWS

Mr. Duysen also reported that in recent years, SFP has developed another landscape material market - colored wood chips. SFP works with a partner to color and sell the chips and they have been well received in the market. Therefore, Mr. Duysen has seriously considered installing whole-log chipping equipment in order process more dead trees and to be able to produce more colored chips for landscape material. However, after serious consideration and consultation with his partner and customers, he determined that there was not a large enough market to support higher colored landscape chip production levels.

Shavings from the operation are sold as animal bedding. Sawdust produced at the sawmill is separated by species and is used as a soil medium for young plants in nurseries and orchards.

Mr. Duysen also commented on log exports as a means of increasing utilization of dead trees. First, he identified a technical and logistical issue associated with transporting logs from the Sierra Range to port during hot summer months. He reported that loads of logs developed significant cracks during transport. Apparently, the very hot, dry air of the summer months coupled with moving the logs on the highway (which creates significant airflow) leads to very rapid drying and subsequent splitting (up to 2” wide).

Mr. Duysen also said that as a sawmiller, one of his main concerns about lifting log export restrictions for logs harvested from state or federal lands is that it would limit his sawmill’s log supply. However, Mr. Duysen said that he recognizes the need to utilize dead trees and he would, therefore, not necessarily be opposed to relaxing log export restrictions provided there was a detailed process in place by which only certain exports would be allowed. More specifically, he said a program by which logs were considered for export should include:

1. Initiation of exporting availability based on a state or federal agency declaring a specific region (e.g., county, watershed, national forest, etc.) to be in a “state of emergency” for a given period
2. Only logs harvested from the emergency zone would be available for export
3. Within the emergency zone, allowing log exports would be considered on a timber sale by timber sale basis
4. It must be demonstrated that there are no domestic purchasers of the logs
5. A person or group of reviewers (e.g., the U.S. Forest Service Regional Forester) would be assigned the task of reviewing all conditions required for granting export approval (e.g., state of emergency, timber sale within the emergency zone, no domestic purchasers, etc.)

SIERRA PACIFIC INDUSTRIES

BECK interviewed Mr. Cedric Twight, California Regulatory Affairs Manager, of Sierra Pacific Industries (SPI). SPI is based in Anderson, California and owns and manages nearly 1.9 million acres of timberland in California and Washington. SPI also operates many sawmills and biomass fueled power plants. The company is one of the largest lumber producers in the United States.

Mr. Twight indicated that California’s drought and associated beetle attacks have affected SPI’s business in several ways. First, the epidemic has killed trees on SPI’s lands. The areas hardest hit
are in Tuolumne, Calaveras, and Amador Counties. In addition, outbreaks are just starting to occur in El Dorado County. The company has responded aggressively to these outbreaks by having its foresters closely monitor SPI’s lands for signs of beetle attacks (e.g., bore holes and pitch tubes) on trees. When areas of such beetle outbreaks are discovered, company foresters identify the “epicenter” of the affected area. An extensive buffer zone is then delineated around the affected trees. Within the buffer zone, all trees are harvested. These steps are designed to prevent the beetles from spreading to nearby healthy trees. Mr. Twight reported that despite these efforts, the company frequently must revisit the affected areas and new areas because beetles continue entering SPI timberlands from trees located on adjoining landowner’s property.

The tree mortality epidemic has also affected SPI’s sawmills and biomass plants. Specifically, the Sonora Sawmill is processing 100 percent drought/beetle killed wood, which translates into an estimated annual log consumption of 90 million board feet of logs annually (Scribner log scale). The Chinese Camp Sawmill is processing 95 percent drought/beetle killed wood, which translates into an estimated annual log consumption of 27.5 million board feet of logs annually (Scribner log scale). The Lincoln Sawmill is also processing some drought/beetle killed wood, but also processing significant volumes of fire killed wood. The Lincoln sawmill consumes an estimated 195 million board feet of logs annually (Scribner log scale). All sawmills are operating at full two-shift capacity given constraints in the amount of downtime needed for mill maintenance, kiln drying capacity, and the ability of the market to absorb heavy volumes of blue-stained lumber.

Regarding the company’s biomass power plants, the company recently completed a bilateral negotiation of the terms of its power sales contract with Pacific Gas & Electric. The key change in the renegotiation is that the company can operate its biomass power plants more hours (i.e., sell more power to PG&E) than originally specified in their power sales contract, provided a certain portion of the fuel used to fire those plants is drought/beetle killed salvage material from California forests.

Regarding SPI developing completely new facilities and new products, Mr. Twight said that the company is constantly evaluating new opportunities. A current focus area is investigating and developing new, higher-value markets for selling the sawmilling by-products (e.g., chips, sawdust, shavings, and bark) produced by existing facilities.

Mr. Twight also stated that any efforts at new SPI business development would be dependent on: 1) the U.S. Forest Service and other public landowners committing to a long-term expansion of the volume of timber harvested at a sustainable harvest level; and 2) SPI’s ability to secure that new supply under long-term contracts. This is because SPI’s current operations (sawmills and biomass power) are scaled to match the sustainable harvest of SPI’s own timberlands and the available logs supplied from other industrial timberland owners, non-industrial owners and the USFS. The USFS provides the lowest volume of logs (approximately 10 percent) that SPI uses in its sawmilling facilities. Therefore, raw material to supply any new business development would have to come from sources other than SPI’s own holdings.

Mr. Twight also offered a recommendation about national forest management policy. SPI believes that the U.S. Forest Service could better respond to incidents such as wildfire and the current tree mortality issue if such events were declared a “state of emergency”, which would in turn allow the U.S. Forest Service to respond to such events under different rules. More
specifically, the state of emergency status would provide (within limits) a measure of relief from the National Environmental Policy Act (NEPA) process that many believe is a serious constraint on national forest’s ability to respond to fire and drought emergencies. The NEPA process provides a mechanism for legal challenges that cause projects to be delayed until they become uneconomical to operate. This leaves the USFS in the unenviable position of trying to treat fuels, hazard trees and replant the fire area without any revenue to support those efforts, which results in a detriment to the environment because most of those projects are not completed.

Mr. Twight explained that SPI’s research and monitoring of fire salvaging has demonstrated that fire salvage operations immediately conducted after a fire can significantly reduce sediment flow. Immediate fire salvage will allow the USFS to sell fire killed trees at a higher value and thus offset the significant restoration costs associated with catastrophic wildfires. Mr. Twight stated that there is scientific evidence to support responsible and timely fire salvage, but salvaging operations are often thwarted by litigation of restoration projects. Mr. Twight also suggested that SPI would support the concept that once an incident has been declared a state of emergency it would remain in that status through any subsequent timber harvesting, slash disposal and replanting efforts so that all those activities can be carried out in a timely manner. Mr. Twight said that a quick response is critical in preserving the value and utility of trees affected by wildfire, drought, and disease.

Finally, Mr. Twight mentioned that there is a compelling case to be made for more active forest management on national forests. One of the main benefits he cited was the stimulation of rural economies by directly creating jobs at processing facilities, indirectly creating new jobs harvesting trees and transporting logs, and induced jobs providing all the goods and services that would support new, large businesses in rural areas. He also mentioned that there is a correlation between higher levels of active forest management and reduced levels of wildfire. If true, it would lead to significant firefighting cost savings for the local, state, and federal agencies. It would also mean reduced greenhouse gas emissions associated with wildfire and insect mortality. Another benefit he cited is that healthy forests contribute to providing high quality water and a secure supply of water.

**SIERRA RESOURCE MANAGEMENT**

BECK interviewed Mr. Mike Albrecht, owner of Sierra Resource Management, a forestry and logging company based in Jamestown, California. Mr. Albrecht said that he has been involved in California’s forest products industry for more than 40 years, including a position as director of fuel procurement at Ultrapower and several other biomass fueled power plants. Mr. Albrecht said that during his career in California’s forest products industry he has been involved in planning and discussions about several new, California-based forest products businesses, including wood pellet manufacturing, wood briquette manufacturing, cellulosic ethanol, and wood shavings.

During that time, very few of the prospective businesses ever materialized. The reasons he offered for nearly all of the businesses not becoming a reality were two-fold. First, the markets for the products produced by the businesses were shaky. As examples, he offered that markets for wood pellets and briquettes in California were discouraged by overly restrictive air quality regulations in some regions, which prevented homeowners from burning wood pellets or briquettes for home heating. Second, Mr. Albrecht said that the prospective businesses needed
to demonstrate to prospective financiers that they had a secure, long-term supply of raw material. In every case this meant securing a long-term supply from publicly owned sources such as the U.S. Forest Service. None of the project developers Mr. Albrecht worked with could secure such contracts, which lead to none of the prospective businesses being able to move beyond planning to development and operations.

Despite the long history of frustrating attempts at new forest products business development, Mr. Albrecht stated that he continues to work toward new ways of increasing utilization of material from national forests. He is hopeful that his recent work with other members of collaborative groups in Tuolumne County will result in a landscape level management plan that has widespread support among the public, the agency, industry, and others and will allow the U.S. Forest Service to carry out its forest management program without the constant threat of appeals and litigation. He recommends that the U.S. Forest Service develop and replicate a model in which a series of 25,000 to 50,000 acre long-term stewardship contracts are awarded to contractors who could then go about the business of active forest management, including salvaging and utilizing dead trees.

**SMALL SCALE BIOMASS POWER/CHP UNDER THE BIOMAT PROGRAM**

A potential outlet for woody material arising from the tree mortality issue is small, community scale biomass power and CHP projects encouraged by California’s SB 1122. To obtain a status of this program, BECK interviewed Ms. Angie Lottes, Biomass Program Coordinator, The Watershed Research & Training Center, Hayfork, CA. In addition, BECK consulted various recent legislation and CPUC decisions regarding this program.

SB 1122 (Rubio, 2013) placed a requirement on California Investor Owned Utilities (IOU’s) to purchase mandated amounts of electricity from small (3 MW or less) biomass applications. Included in that mandate was the requirement to purchase 50 MW of electricity from the byproducts of sustainable forest management.

The legislation required the CPUC to implement the legislation and a final order was approved on December 18, 2014. The CPUC enlisted the California Department of Forestry & Fire Protection (CALFIRE) to draft the working definition of Sustainable Forest Management (SFM) required by the legislation. The CPUC determined that 47 of the 50MW requirement fall on Pacific Gas & Electric (PG&E) since that is where the forest resource is located, with only 2.5 MW allocated to Southern California Edison (SCE) and 0.5 MW to San Diego Gas & Electric (SDG&E).

The CALFIRE report to the CPUC identified 4 types of fuel that they determined met the intent of SB1122 as being byproducts of SFM. The four are:

1. Fuels from fire threat reduction projects
2. Fuels from fire safe clearance activities
3. Fuels from infrastructure clearance projects
4. Fuels from other sustainable forest management
The legislation indicates that 80% or more of fuel be from one of these categories and that recordkeeping/reporting be done annually to provide verification.

The December 18, 2014 CPUC decision (D-14) codifies much of the above and lays out the following program for implementing the 50 MW sustainable forest management portion of SB 1122.

- $127.72/MWH project levelized starting price, with statewide price pool
- Minimum of 3 projects in initial queue to allow price change modification to begin. Goes to 5 projects in queue once first 1 MW accepts contract price
- Program terminates 60 months after first offering
- Project must be in service territory of one of IOU's
- CPUC staff to review maximum price if rises to $197/MWH

Upon completion of the initial queue, the IOU's hold the first bimonthly subscription of 6 MW of PPA's. If there are no takers at the starting price, a series of bimonthly price increases will take place until a project of at least 1MW accepts the offering price. The price can also go down per the same schedule if the 6 MW is fully subscribed. If projects of this size can accept prices in the $180-200/MWH range, as speculated by BECK and others, it would be 12 months after the initial queue is filled with 3 projects before an acceptable price is reached.

5.2.4 Current Status

The BioMAT program has now been operating for nearly a year and there is, to BECK's knowledge, only one project in the utility queue, leaving the price at the initial starting price of $127.72/MWH – insufficient to allow a PPA to be selected. There are several projects (to be discussed below) in active early stage development, but these have stalled short of the queue when substantial utility interconnection deposits were required.

5.2.5 Subsequent Changes

The original SB 1122 language has now been supplemented in 2016 by SB 840, AB 1923 and the Governor's Emergency Drought Proclamation. The intent of the above actions was to remedy some of the issues constraining projects and to expand the project options.

SB 840 and the Governor's Proclamation, which were just implemented by CPUC Decision on October 27, 2016, accomplishes three key items for the BioMAT program:

1. Adds that all fuel originating from CALFIRE High Hazard Zones 1 & 2 (HHZ 1&2) qualifies as products of sustainable forest management for purposes of Category 3 BioMAT projects.
2. Allows projects to temporarily drop off utility interconnection queue after completing a System Impact Study (SIS), but before posting large deposits, and still qualify for the BioMAT queue.
3. Accelerates the price changes under the BioMAT program by holding monthly instead of bimonthly auctions.
AB 1923, which is effective on January 1, 2017 and has not yet been formally addressed by the CPUC, would further increase options for BioMAT projects by:

1. Allowing projects of up to 5 MW nameplate capacity to qualify for the BioMAT program so long as no more than 3 MW is contracted under a BioMAT contract.
2. Allow existing transmission interconnections to be used by BioMAT projects as opposed to a previous requirement that all program interconnections be at distribution voltage.

Despite only one project being in the queue, BECK has identified a total of 12 projects in various stages of development in response to the BioMAT program, though there may be others for which information has not surfaced publicly. Of the 12, two are in the Coast Range in Mendocino and Humboldt counties, and the remaining ten are in the Sierras, stretching from Shasta County in the North to Mariposa County in the South. Everything would interconnect to PG&E. These 12 projects would consume 60% of the 50MW allocation for such projects. In total, the projects would consume an estimated 240,000 bone dry tons (BDT) of fuel annually. If all of the 50 MW could be contracted for within the mandated 5-year life of the BioMAT program, this annual fuel consumption could increase to about 400,000 BDT annually.

The impact of these plants could be significantly greater if coupled with other forest products activities on the same site. Further investigation has shown that of the 12 projects in development, 10–11 are on the sites of existing or dismantled sawmills. These sawmill sites are typically much larger in size than required by the BioMAT project and are already industrially zoned. In addition, the sites typically have access to water and have been served previously with substantial high voltage electrical service.

With the program changes mandated by SB 840, AB 1923 and the Governor's Emergency Proclamation, it is expected that at least 2 additional projects will be added to the program queue by February, 2017. These additions mean that the first price increase under BioMAT would occur on April 1, 2017. With the monthly program offerings now required, BECK estimates that by late in the third quarter of 2017, prices will be at levels (estimated at $180 – 200/MWH) that will allow BioMAT PPA's to be signed. By this time other projects should likely have joined the queue, thereby allowing the program to meet the mandated 5 projects in the queue to keep the price adjustment mechanism functioning after the first 1 MW has been contracted.

To fully utilize the 50 MW allocation under the legislation, 5–7 additional projects could be developed. With the changes from SB 840 and AB1923, this program hopefully will become more attractive to existing industries. The ideal BioMAT project would have a cluster of forest products businesses on a single site, with a large inflow of “high hazard” fuel, each business adding value to the resource. Unfortunately for the current tree mortality issue, it will be late 2019 before the first facilities under this program come on line given an expected 2+ year permit/design/construction/startup schedule.
APPENDIX 2 – INDUSTRY INTERVIEWS

SOPER-WHEELER COMPANY

BECK interviewed Paul Violett, Vice President of Soper-Wheeler, Inc. of Strawberry Valley, California. The company owns and manages nearly 100,000 acres of timberland. The company harvests and sells between 25 and 35 million board feet of logs (Scribner) annually.

Mr. Violett reported that their company has been affected by the drought and beetle outbreak in several ways. First, in terms of timber management, the company actively salvages any areas affected by drought/beetle killed trees. In the past, the volume of salvaged timber has been small on an annual basis, and it was relatively easy to find markets for those logs. One relatively common market was what Mr. Violett referred to as a salvage purchase order from either of two companies that export logs from the Sacramento and Oakland areas to foreign markets. More recently, however, it has not been as easy to sell the salvage logs because the market is flooded with such material.

Second, the company sought to develop a market for chips produced from logging slash associated with the harvest of its timber. These efforts were supported by a 2016 Wood Innovation Grant from the U.S. Forest Service and included the purchase of a grinder modified with special knives and screening equipment to produce clean chips and the purchase of a chip van trailer with a walking floor to deliver and unload landscape chips. Mr. Violett reported that prior to purchasing the equipment their research had indicated as many as 35 landscaping supply companies operating in their region. Despite their planning, the market for landscape material has not developed as well as Soper Wheeler had hoped. The main reason cited for the poor performance is that dwindling biomass markets (e.g., the closure of many biomass power plants) has caused others in the forest products industry to also pursue the landscape market. Some of the others pursuing this market are better positioned to serve landscape customers because of economies of scale and a different cost structure for producing their landscape material.

TIMBER PRODUCTS COMPANY

BECK interviewed Mr. Jim Foster, fiber procurement manager for Timber Products Company’s (TPC) particleboard plant in Martell, California. TPC’s particleboard plant is the only such plant in California. BECK estimates that when the plant is operating at full capacity it can produce about 140 million square feet of particleboard annually (3/4” thickness basis). That full production capacity translates into an estimated raw material usage of about 200,000 bone dry tons. Mr. Foster reported that the plant is currently operating 24 hours per day, 5 days per week. Thus, the plant is operating at about 70 percent of its full capacity.

Sawdust and planer shavings from sawmills are the typical raw material supply for particleboard plants throughout North America. However, beginning in late 2014, Mr. Foster reported that TPC began accepting raw material for the Martell particleboard plant in whole log form. The process involves the company accepting logs greater than 5” in diameter on the small end and no greater than 28” in diameter and in lengths between 8 and 40 feet. Logs are received at the TPC log yard, stored, and then chipped. The chips are then fed into TPC’s normal manufacturing process (e.g., sizing, screening, blending, and forming).

Mr. Foster reported about several somewhat unique circumstances associated with TPC’s decision to begin procuring logs as a source of supply. First, a number of years ago the
APPENDIX 2 – INDUSTRY INTERVIEWS

The particleboard plant eliminated all raw material dryers at the plant because of very restrictive air quality permitting requirements. This decision means that the plant only purchases raw material that is already dry, such as kiln-dried lumber planer shavings from sawmills. It also means that the plant needs to allow incoming logs to dry prior to chipping. Mr. Foster said the drying process takes up to a year, depending on the season.

Second, Mr. Foster said that given the company’s history of purchasing mill residuals, they have little infrastructure in place for handling logs (e.g., trucks, loaders, chippers, etc.) Therefore, the company has elected to rely heavily on contractors to support the effort to procure whole logs. This includes using trucking contractors to deliver logs and a chipping contractor to process the logs into chips. Up to this point the typical procedure has been for logs to accumulate in the log yard until dry. Then, about once per month a chipping contractor brings his equipment into the yard and spends about a week processing the logs into chips.

Third, particleboard manufacturing requires clean wood fiber (i.e., no bark mixed in). Fortunately for TPC, the logs procured as part of this new effort have largely already lost nearly all their bark. Thus, the chipping process results in clean wood fiber suitable for use in particleboard manufacturing.

Fourth, Mr. Foster reported that a problematic aspect of the log procurement initiative is that much of the material received is derived from clearing trees in high hazard zones around homes, roads, and power lines. Thus, it is relatively common that the trees are taken down by arborists in short lengths from the top down. That practice is opposed to a typical logging operation in which the entire tree is felled in one cut at the base of the tree. The higher prevalence of short lengths creates material handling difficulties for transporting and storing the logs. Shorter logs also decrease the productivity of chipping operations. Mr. Foster said that TPC purchases the logs for basically the cost of transporting the material.

Mr. Foster reported that the log procurement initiative currently supplies about 10 to 12 percent of TPC’s total raw material requirement. He also reported that there is opportunity for vastly increasing the supply from this source. However, given the reliance on sourcing dry fiber from sawmills, TPC is very cautious about cutting off its current suppliers of mill residues since the log supply source has only a limited shelf life. TPC would like to continue utilizing logs as part of its supply recipe beyond the current tree mortality issue. A primary reason for this is that TPC views utilizing dead or fire killed trees to sequester carbon long-term as opposed to the dead trees releasing carbon as they degrade or burn in a wildfire.

BECK also interviewed Mr. Chris Chase, Timber Manager at Timber Products Company. In addition to the particleboard plant in Martell, California, Timber Products operates a veneer plant in Yreka, California and owns and manages 115,000 acres of timberland. Mr. Chase said that Timber Products has completed two biomass cogeneration feasibility studies related to their Yreka veneer plant. He said the company was interested in a biomass cogeneration plant at that location because it would allow the veneer produced at Yreka to be dried at Yreka instead of the current practice which is shipping the veneer north to one of the company’s other plants in Medford and Grants Pass, Oregon. Drying veneer in Yreka would eliminate the need to truck material whose weight is 50 percent water. Drying in Yreka would also stop the veneer from going to a plant where the boilers are fired by natural gas – another fossil fuel. In addition, Mr.
Chase said a cogeneration plant would allow the company to burn up to 100,000 bone dry tons of logging slash and mill residuals under the controlled conditions of a boiler rather than the uncontrolled burning of slash piles.

Despite the company’s sustained interest in developing a cogeneration plant, such a project has not moved forward. Mr. Chase said a major reason for this is very restrictive regulations related to air quality permitting. Thus, he recommended potential policy changes in air quality permitting, which could consider broader considerations such as how the cogeneration plant would reduce diesel emissions from trucks, natural gas use at a sister plant, and open burning of logging slash.

**WOOD SAVINGS IN PORTERVILLE, CA**

BECK interviewed Mr. Bob Brewster who has been working on the development of a facility in Porterville, California that would convert logs into wood shavings. The wood shavings would be bagged and sold as animal bedding. Mr. Brewster reports that there are good markets for this type of material in Southern California. The plant would consume up to 40,000 green tons of logs per year. Mr. Brewster has experience in this type of business. In the past, he built and operated a similar facility near Jamestown, California. Most the bagged shavings produced by that plant were sold to markets in California. Several years ago, he sold the business to American Wood Fibers.

Regarding the prospective plant in Porterville, Mr. Brewster stated that he has completed nearly all the required planning and due diligence for the prospective business, including securing a site; obtaining firm quotes for the required equipment; and developing layout drawings for the equipment, buildings, etc. He also said that local officials have been very supportive of the project. Mr. Brewster indicated that since he would be processing dead trees, no burner and dryer would be needed at the facility, which presumably would ease the permitting process.

Mr. Brewster stated that the only thing holding him back from beginning to construct the plant is that he needs a long-term timber supply contract to obtain financing. He said he needs a minimum 5-year contract, but a 10-year contract would be preferable. Per Mr. Brewster, the region around Porterville is very heavy to federal ownership including the Sequoia National Forest and Sequoia National Park. Therefore, he has focused his efforts on discussions with the U.S. Forest Service. Despite his efforts and the efforts of U.S. Forest Service personnel, there has been little progress toward reaching a supply agreement. Mr. Brewster believes the myriad of environmental regulations and analysis required for planning a timber sale and a recent large wildfire in the region, which diverted the U.S. Forest Service’s attention and resources, are the two main contributing factors in the delay in reaching a supply agreement.

Mr. Brewster also mentioned that the Tulare County right-of-way along roads has been recently broadened to include a distance of 150’ from the centerline. Dead trees within that zone can be felled and could potentially be a source of raw material for his prospective business. The same is true for dead trees in high hazard zones around villages and communities. Thus, there could potentially be a supply of material from these sources.

Mr. Brewster also offered several other observations about factors holding back the development of projects, including:
1. A change in the U.S. Forest Service annual grant program, which switched the focus to funding planning and engineering and away from using grant money to purchase equipment.

2. That, in his opinion, the area around Porterville has limited availability of contractors for logging and hauling raw material.

Regarding the U.S. Forest Service annual grant program, Mr. Brewster suggested that CALFIRE might initiate a state-funded grant or zero/low interest loan program. Mr. Brewster’s vision for such a program is that funds offered on a competitive basis and which could be used in a variety of ways (not just planning and engineering) would spur business development and utilization of dead trees.

Finally, Mr. Brewster noted that the site he has secured for the prospective wood shavings plant is large enough that it could easily support more than one business. If another business were interested in co-locating at the site it would allow sharing of costs for things like equipment for loading and unloading trucks, utilities, other site related expenditures (lease/purchase), and synergies related to raw material utilization. For example, Mr. Brewster noted that if a small sawmill co-located at the site, his operation would be able to utilize slabs, edgings, and other trim from the sawmill in the shavings manufacturing process.
<table>
<thead>
<tr>
<th>Technology</th>
<th>Scoring Key</th>
<th>Technology Score</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Firewood - bundles</td>
<td>0 to 6</td>
<td>3</td>
<td>Market/Regulatory constraint because of air quality</td>
</tr>
<tr>
<td>Low Cap/Simple Product Mix</td>
<td>0 to 6</td>
<td>3</td>
<td>Needs low cost logs for feasibility</td>
</tr>
<tr>
<td>Firewood - bulk</td>
<td>0 to 6</td>
<td>3</td>
<td>Market/Regulatory constraint because of air quality</td>
</tr>
<tr>
<td>Decorative Bark</td>
<td>0 to 6</td>
<td>3</td>
<td>Likely needs to be add on to another business</td>
</tr>
<tr>
<td>Decorative Chips</td>
<td>0 to 6</td>
<td>3</td>
<td>Market uncertainty</td>
</tr>
<tr>
<td>Semi-Mobile Sawmill (New Saw)</td>
<td>0 to 6</td>
<td>3</td>
<td>Scale is small</td>
</tr>
<tr>
<td>Extractives (essential oils)</td>
<td>0 to 6</td>
<td>3</td>
<td>Requires change in log export rules</td>
</tr>
<tr>
<td>Animal Bedding</td>
<td>0 to 6</td>
<td>3</td>
<td>Likely only viable in the Coast region</td>
</tr>
<tr>
<td>Log Exports</td>
<td>0 to 6</td>
<td>3</td>
<td>Offset of fossil fueled heat customer</td>
</tr>
<tr>
<td>Mulch &amp; Soil Amendment</td>
<td>0 to 6</td>
<td>3</td>
<td>Scale is small</td>
</tr>
<tr>
<td>Biofilter media</td>
<td>0 to 6</td>
<td>3</td>
<td>Assumes wood muncher and lathe to create veneer</td>
</tr>
<tr>
<td>Whole Log Chips for P&amp;P/Energy</td>
<td>0 to 6</td>
<td>3</td>
<td>Market uncertainty</td>
</tr>
<tr>
<td>Small Biomass CHP</td>
<td>0 to 6</td>
<td>3</td>
<td>Market uncertainty</td>
</tr>
<tr>
<td>Post and Pole</td>
<td>0 to 6</td>
<td>3</td>
<td>Assumptions wood muncher and lathe to create veneer</td>
</tr>
<tr>
<td>Erosion Control Mulch</td>
<td>0 to 6</td>
<td>3</td>
<td>Market uncertainty</td>
</tr>
<tr>
<td>Easihide</td>
<td>0 to 6</td>
<td>3</td>
<td>Limited annual volume utilized</td>
</tr>
<tr>
<td>Air curtain burner - no power gen.</td>
<td>0 to 6</td>
<td>3</td>
<td>This evaluation for JMW &amp; smaller only</td>
</tr>
<tr>
<td>Small Biomass Power</td>
<td>0 to 6</td>
<td>3</td>
<td>Secure supply of timber required; Good market in So. CA.</td>
</tr>
<tr>
<td>Large Scale Biomass Power</td>
<td>0 to 6</td>
<td>3</td>
<td>Market constraint due to air quality</td>
</tr>
<tr>
<td>Large Scale Sawmill</td>
<td>0 to 6</td>
<td>3</td>
<td>Market too small to project</td>
</tr>
<tr>
<td>Fuel Bricks/Logs</td>
<td>0 to 6</td>
<td>3</td>
<td>Limited ability to utilize ponderosa pine</td>
</tr>
<tr>
<td>Gluam</td>
<td>0 to 6</td>
<td>3</td>
<td>Market uncertainty and lack of port infrastructure</td>
</tr>
<tr>
<td>Wood Pellets</td>
<td>0 to 6</td>
<td>3</td>
<td>Long project development lead time</td>
</tr>
<tr>
<td>MDF</td>
<td>0 to 6</td>
<td>3</td>
<td>Species limitations; could possibly utilize incense cedar</td>
</tr>
<tr>
<td>Shingles</td>
<td>0 to 6</td>
<td>3</td>
<td>Not dependent on tree species and can utilize a high percentage of pondersa pine</td>
</tr>
</tbody>
</table>

**Technology Score:**
- 1-2 = Not viable
- 3 = Viable
- 4-6 = Highly viable
- 7-9 = Extremely viable
- 10 = Fully viable

**Scoring Key:**
- 0 = Not viable
- 1 = Questionable
- 2 = Viable
- 3 = Highly viable
- 4 = Extremely viable
- 5 = Fully viable
- 6 = Not dependent on tree species and can utilize a high percentage of pondersa pine
- 7 = Highly viable
- 8 = Extremely viable
- 9 = Fully viable
- 10 = Fully viable

**Remarks:**
- Market/Regulatory constraint because of air quality
- Needs low cost logs for feasibility
- Likely needs to be add on to another business
- Scale is small
- Requires change in log export rules
- Likely only viable in the Coast region
- Offset of fossil fueled heat customer
- Scale is small
- Assumes wood muncher and lathe to create veneer
- Limited annual volume utilized
- This evaluation for JMW & smaller only
- Secure supply of timber required; Good market in So. CA.
- Market constraint due to air quality
- Market too small to project
- Species limitations; could possibly utilize incense cedar

**Technology Score:**
- 1-2 = Not viable
- 3 = Viable
- 4-6 = Highly viable
- 7-9 = Extremely viable
- 10 = Fully viable

**Remarks:**
- Market/Regulatory constraint because of air quality
- Needs low cost logs for feasibility
- Likely needs to be add on to another business
- Scale is small
- Requires change in log export rules
- Likely only viable in the Coast region
- Offset of fossil fueled heat customer
- Scale is small
- Assumes wood muncher and lathe to create veneer
- Limited annual volume utilized
- This evaluation for JMW & smaller only
- Secure supply of timber required; Good market in So. CA.
- Market constraint due to air quality
- Market too small to project
- Species limitations; could possibly utilize incense cedar

**Technology Score:**
- 1-2 = Not viable
- 3 = Viable
- 4-6 = Highly viable
- 7-9 = Extremely viable
- 10 = Fully viable

**Remarks:**
- Market/Regulatory constraint because of air quality
- Needs low cost logs for feasibility
- Likely needs to be add on to another business
- Scale is small
- Requires change in log export rules
- Likely only viable in the Coast region
- Offset of fossil fueled heat customer
- Scale is small
- Assumes wood muncher and lathe to create veneer
- Limited annual volume utilized
- This evaluation for JMW & smaller only
- Secure supply of timber required; Good market in So. CA.
- Market constraint due to air quality
- Market too small to project
- Species limitations; could possibly utilize incense cedar
Appendix 3 continued – Dead Tree Utilization Opportunity Screening Matrix

| Technology                              | Technology Supplier/Developer must be able to offer commercial warranties of performance, environmental compliance, and completion, and must be able to bond such warranty through commercial sources. | The Technology proposed must have been demonstrated in a commercial setting, at commercial scale, for at least two years. | Technology is capable of being financed through normal commercial channels, with debt/equity ratios in line with other Opportunities of similar risk. | The business/technology is receiving, through government mandate, special tax credits, production, or other support, and is capable of demonstrating that it is capable of generating positive cash flow. | The technology/business is not dependent on tree species and can utilize a high percentage of ponderosa pine. | The technology/business is replicable on multiple sites. | The business is mobile such that it can be moved to multiple sites. | The total capital investment in the technology is less than $1,000,000. | Raw Material and Regulatory Constraint Specific to California. | If this technology is implemented or expanded in CA it will have a measurable impact on the utilization of dead/dying trees. | The level of capital investment in the business/technology is such that the project has a payback of 4 years or less using financial modeling, industry comparables. | The business/technology could become fully operational in less than 1 year from initiation of planning to commissioning, particularly on sites where an existing business is operational. | Technology Score | Remarks |
|----------------------------------------|-------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------|
| Scoring Key                            | 0 to 3                                                                                           | 0 to 3                                                                                           | 0 to 3                                                                                           | 0 to 3                                                                                           | 0 to 3                                                                                           | 0 to 3                                                                                           | 0 to 3                                                                                           | 0 to 3                                                                                           | 0 to 3                                                                                           | 0 to 3                                                                                           | 0 to 3                                                                                           | 0 to 3                                                                                           | 0 to 3                                                                                           | 0 to 3                                                                                           | 0 to 3                                                                                           |
| Small Gasification/IC Engine Chp       | 1                                                                                               | 0                                                                                               | 0                                                                                               | 0                                                                                               | 0                                                                                               | 0                                                                                               | 0                                                                                               | 4                                                                                               | 6                                                                                               | 4                                                                                               | 6                                                                                               | 4                                                                                               | 5                                                                                               | 0                                                                                               | 41                                                                                               | Offset of fossil fueled heat customer |
| Scriber - structural and flooring      | 3                                                                                               | 3                                                                                               | 3                                                                                               | 3                                                                                               | 3                                                                                               | 3                                                                                               | 3                                                                                               | 3                                                                                               | 3                                                                                               | 3                                                                                               | 3                                                                                               | 3                                                                                               | 3                                                                                               | 3                                                                                               | 39                                                                                               | Species limitations (ponderosa pine) |
| Small Gasification/IC Engine           | 1                                                                                               | 0                                                                                               | 0                                                                                               | 0                                                                                               | 0                                                                                               | 0                                                                                               | 0                                                                                               | 0                                                                                               | 0                                                                                               | 0                                                                                               | 0                                                                                               | 0                                                                                               | 0                                                                                               | 0                                                                                               | 40                                                                                               | Biochar possible byproduct |
| CLT                                    | 3                                                                                               | 3                                                                                               | 3                                                                                               | 3                                                                                               | 3                                                                                               | 3                                                                                               | 3                                                                                               | 3                                                                                               | 3                                                                                               | 3                                                                                               | 3                                                                                               | 3                                                                                               | 3                                                                                               | 3                                                                                               | 39                                                                                               | Long development lead time; current capacity > market |
| Particleboard                          | 3                                                                                               | 3                                                                                               | 3                                                                                               | 3                                                                                               | 3                                                                                               | 3                                                                                               | 3                                                                                               | 3                                                                                               | 3                                                                                               | 3                                                                                               | 3                                                                                               | 3                                                                                               | 3                                                                                               | 3                                                                                               | 39                                                                                               | EVA/TCR/Bio/Avor/Cell/OMD/ 
| Large Scale Biomass Power              | 1                                                                                               | 3                                                                                               | 3                                                                                               | 3                                                                                               | 3                                                                                               | 3                                                                                               | 3                                                                                               | 3                                                                                               | 3                                                                                               | 3                                                                                               | 3                                                                                               | 3                                                                                               | 3                                                                                               | 3                                                                                               | 39                                                                                               | Evaluates w/o carbon capture/sequestration. Includes BioRAM |
| Air curtain burner with power gen.     | 3                                                                                               | 3                                                                                               | 3                                                                                               | 3                                                                                               | 3                                                                                               | 3                                                                                               | 3                                                                                               | 3                                                                                               | 3                                                                                               | 3                                                                                               | 3                                                                                               | 3                                                                                               | 3                                                                                               | 3                                                                                               | 38                                                                                               | High cap ex relative to revenue |
| Fasor Mill                             | 3                                                                                               | 3                                                                                               | 3                                                                                               | 3                                                                                               | 3                                                                                               | 3                                                                                               | 3                                                                                               | 3                                                                                               | 3                                                                                               | 3                                                                                               | 3                                                                                               | 3                                                                                               | 3                                                                                               | 3                                                                                               | 37                                                                                               | Requires treating of boards if utilizing ponderosa pine |
| Wood Plastic Composite                 | 3                                                                                               | 3                                                                                               | 3                                                                                               | 3                                                                                               | 3                                                                                               | 3                                                                                               | 3                                                                                               | 3                                                                                               | 3                                                                                               | 3                                                                                               | 3                                                                                               | 3                                                                                               | 3                                                                                               | 3                                                                                               | 37                                                                                               | Market uncertainty |
| Pulp and Paper                         | 3                                                                                               | 3                                                                                               | 3                                                                                               | 3                                                                                               | 3                                                                                               | 3                                                                                               | 3                                                                                               | 3                                                                                               | 3                                                                                               | 3                                                                                               | 3                                                                                               | 3                                                                                               | 3                                                                                               | 3                                                                                               | 37                                                                                               | Difficult regulatory environment in California |
| Activated carbon                       | 3                                                                                               | 3                                                                                               | 3                                                                                               | 3                                                                                               | 3                                                                                               | 3                                                                                               | 3                                                                                               | 3                                                                                               | 3                                                                                               | 3                                                                                               | 3                                                                                               | 3                                                                                               | 3                                                                                               | 3                                                                                               | 36                                                                                               | Only 1 current manufacturer (Weyerhaeuser) |
| Pyrolysis                              | 0                                                                                               | 0                                                                                               | 0                                                                                               | 0                                                                                               | 0                                                                                               | 0                                                                                               | 0                                                                                               | 0                                                                                               | 0                                                                                               | 0                                                                                               | 0                                                                                               | 0                                                                                               | 0                                                                                               | 0                                                                                               | 37                                                                                               | May not meet quality spec’s |
| Paraffin                               | 3                                                                                               | 3                                                                                               | 3                                                                                               | 3                                                                                               | 3                                                                                               | 3                                                                                               | 3                                                                                               | 3                                                                                               | 3                                                                                               | 3                                                                                               | 3                                                                                               | 3                                                                                               | 3                                                                                               | 3                                                                                               | 36                                                                                               | Requires sustained high oil prices, refinery modifications |
| Veneer - LVL                           | 3                                                                                               | 3                                                                                               | 3                                                                                               | 3                                                                                               | 3                                                                                               | 3                                                                                               | 3                                                                                               | 3                                                                                               | 3                                                                                               | 3                                                                                               | 3                                                                                               | 3                                                                                               | 3                                                                                               | 3                                                                                               | 35                                                                                               | Market upside, but species limitation |
| Hardboard                              | 3                                                                                               | 3                                                                                               | 3                                                                                               | 3                                                                                               | 3                                                                                               | 3                                                                                               | 3                                                                                               | 3                                                                                               | 3                                                                                               | 3                                                                                               | 3                                                                                               | 3                                                                                               | 3                                                                                               | 3                                                                                               | 35                                                                                               | Long project lead time. Potential market upside |
| i-joists                               | 3                                                                                               | 3                                                                                               | 3                                                                                               | 3                                                                                               | 3                                                                                               | 3                                                                                               | 3                                                                                               | 3                                                                                               | 3                                                                                               | 3                                                                                               | 3                                                                                               | 3                                                                                               | 3                                                                                               | 3                                                                                               | 34                                                                                               | Value added to LVL and/or OSB production |
| OSB                                    | 3                                                                                               | 3                                                                                               | 3                                                                                               | 3                                                                                               | 3                                                                                               | 3                                                                                               | 3                                                                                               | 3                                                                                               | 3                                                                                               | 3                                                                                               | 3                                                                                               | 3                                                                                               | 3                                                                                               | 3                                                                                               | 30                                                                                               | Potential regulatory difficulty; secure supply? |
| Charcoal                               | 3                                                                                               | 3                                                                                               | 3                                                                                               | 3                                                                                               | 3                                                                                               | 3                                                                                               | 3                                                                                               | 3                                                                                               | 3                                                                                               | 3                                                                                               | 3                                                                                               | 3                                                                                               | 3                                                                                               | 3                                                                                               | 30                                                                                               | Market uncertainty |
| Torrefied Wood Pellets                 | 0                                                                                               | 1                                                                                               | 3                                                                                               | 3                                                                                               | 3                                                                                               | 3                                                                                               | 3                                                                                               | 3                                                                                               | 3                                                                                               | 3                                                                                               | 3                                                                                               | 3                                                                                               | 3                                                                                               | 3                                                                                               | 27                                                                                               | No proven market |
| Plywood                                | 3                                                                                               | 3                                                                                               | 3                                                                                               | 3                                                                                               | 3                                                                                               | 3                                                                                               | 3                                                                                               | 3                                                                                               | 3                                                                                               | 3                                                                                               | 3                                                                                               | 3                                                                                               | 3                                                                                               | 3                                                                                               | 26                                                                                               | Secure raw material? Regulatory issues because of glues |
| Cellulosic Ethanol                     | 0                                                                                               | 0                                                                                               | 0                                                                                               | 0                                                                                               | 0                                                                                               | 0                                                                                               | 0                                                                                               | 0                                                                                               | 0                                                                                               | 0                                                                                               | 0                                                                                               | 0                                                                                               | 0                                                                                               | 0                                                                                               | 24                                                                                               | Not proven commercially |
| Nano-Cellulose                         | 0                                                                                               | 0                                                                                               | 0                                                                                               | 0                                                                                               | 0                                                                                               | 1                                                                                               | 1                                                                                               | 1                                                                                               | 1                                                                                               | 1                                                                                               | 0                                                                                               | 1                                                                                               | 1                                                                                               | 1                                                                                               | 17                                                                                               | Not proven commercially |