BIOMASS in the SIERRA NEVADA

A Case for Healthy Forests and Rural Economies

November 2019

SIERRA BUSINESS COUNCIL

A Message from Sierra Business Council

This paper is not an argument for a new kind of coal.

It is a thoughtful and scientifically supported proposition for a way to reinvest in rural economies and counties that have been disproportionately affected by some of the state's biggest climate impacts to date. Wildfire, drought, tree mortality, distressed watersheds – these are all symptoms of our changing climate. These events, large and small, long and brief, affect our economies and our homes, both urban and rural. They affect how and where we live, play, and breathe. This paper attempts to provide a clear-eyed, realistic look at the challenges that our forested Sierra Nevada communities face, the threat posed by massive and destructive wildfires, and an acknowledgment that while biomass cannot solve all of these problems, it should be pursued as part of the solution.

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TABLE OF CONTENTS

EXECUTIVE SUMMARY

California's forests are in dire straits due to a number of stressors, including a century-plus of fire suppression practices that have led to overcrowded forests, extended drought conditions throughout the state, and a pine beetle scourge that together have killed at least 147 million trees throughout the state of California since 2010, the majority of which are in the Sierra Nevada mountain range.[1] In part as a result of these stressors and the growing impacts of climate change, including warmer conditions and seasonal weather patterns swinging increasingly between extreme precipitation and extended dry periods, overcrowded forests pose a massive wildfire threat.

Fire is a necessary component of a healthy Sierra Nevada forest. The systematic suppression of any and all fire events over the past 100 years has resulted in Sierra Nevada forests that are overgrown and dense; vastly different from the fire-adapted forests that covered the landscape over 100 years ago, many of which were actively maintained by tribal populations.[2] Unlike 100 years ago, hundreds of thousands of Californians now live in the Sierra wildland urban interface (WUI) -- urbanized regions adjacent to high fire hazard zones -- meaning the risks and costs associated with wildfire have changed. With the advent of an unprecedented fire season in 2018 that sent fire suppression and emergency response costs soaring to the tune of $947.4 million and insurance losses exceeding $24 billion,[3] and a severe season projected for 2019[4] that prompted Governor Newsom to declare a state of emergency to prepare vulnerable communities for the oncoming fire season[5], Sierra Nevada forests are threatening to become a massive liability to the state of California and its many residents.

Complicating matters is the staggering cost of forest management, estimated by some to be in the billions of dollars per year to support the recommended pace and scale of treatment needed to restore a more natural fire regime and achieve more ecologically sustainable and resilient forests across the California's landscape. Managed wildfires and prescribed burning[6] are important tools for forest restoration, but their effectiveness is limited in areas where human development has become increasingly woven into what was once a wild landscape. We cannot simply reintroduce fire, and burn our way to a healthier forest; it will require a combined effort of prescribed burns, mechanical thinning, and systematic restoration. Fortunately, within the problem lies a part of the solution: forest biomass utilization.

Biomass utilization is the use of residual solid material generated by various agricultural or forest activities to create value-added products, such as biomass energy and innovative wood products. In the case of forest biomass energy, excess material from forest management treatments, such as dead and damaged trees not suitable for wildlife habitat or low-value small-diameter trees and brush left over from thinning[7] or other forest health activities, are combusted in a controlled facility to reduce emissions and create electricity. Co-sited production of innovative wood products present opportunities for the development of mass timber products, nanotechnology, and small diameter timber products to make biomass economically viable.

In its heyday in the early 1990s, California's bioenergy industry was the largest and most diverse in the world,[8] thanks in part to the federal Public Utilities Regulatory Policy Act (PURPA, 1978)[9], that stimulated the growth of biomass and other renewable energy sources in the U.S. due to the relatively high cost of other energy sources at the time. In California, biomass was considered an important means of achieving the state's mandated waste reduction goals because it diverted material that otherwise would have been openly burned in piles or disposed of in landfills, and instead put that material to use for beneficial purposes, including creating electricity.

FURTHER READING

Biomass energy is a vast and complex topic, and this report does not attempt to analyze the full carbon lifecycle of various biomass feedstocks, nor the total greenhouse gas emissions impact of a single biomass facility and its supply chain, much less the industry as a whole. There should be further conversations around the carbon footprint of added-value wood products and additional goods that use engineered wood or mass timber. For further insight into these issues, we recommend the following:

Literature Review and Sensitivity Analysis of Biopower Life-Cycle Assessments and Greenhouse Gas Emission. Electric Power Research Institute, 2013.

Comparative Life Cycle Assessments: Carbon Neutrality and Wood Biomass Energy. Roger A. Sedjo, 2013.

Recommendations to Expand Wood Products Markets in California. SB 859 Wood Products Working Group, 2017.

Improving California's Forest and Watershed Management. Legislative Analyst's Office, 2018.

Identifying Market Interests and Opportunities for Sierra Nevada Sustainable Forestry Materials. Sandra Lupien, MPP & Joshua Harrison, 2019

Circa 2000, deregulation of the electric utility industry in California returned the system to a cost-based framework in which non-market values (non-electricity-related co-benefits) – e.g. waste reduction or resource diversity – were no longer considered after an initial transition period.[10] Because biomass became a higher-cost resource, the industry declined as a major source of electrical production in California.

By once again recognizing, valuing, and monetizing the co-benefits of forest biomass energy, state and local governments and private landowners can help finance necessary improvements to forest health, incentivize ecological forestry practices, and reduce the risk of large, damaging wildfires.

Using forest biomass to create electricity or other products provides not only a financial mechanism to help offset the cost of forest treatment, but also offers a range of environmental, social, and economic benefits such as renewable energy production, net reductions in greenhouse gas (GHG) emissions, increased water quality and yield, net improvements to air quality, rural job creation, improved public health and productivity, and increased sustainability for forested communities and the rest of the state. In assessing the benefits of biomass utilization, we must consider all of the potential costs, avoided costs, and benefits as we did prior to deregulation. Not the least of these is renewable forest biomass energy, one of many wildfire and climate change resilience strategies necessary to meet state goals regarding forest health and wildfire risk reduction.

In this paper we detail the current condition of the Sierra Nevada, one of the state's primary forested areas, identify how the judicious removal and sustainable use of excess forest material can help defray necessary forest treatment costs, and how bioenergy processing as one means of disposal can help address the forest fuel problem while providing additional benefits to local communities and urban areas that rely on natural resources from the Sierra.

ENVIRONMENTAL JUSTICE and BIOMASS

Historically, some biomass energy production has had an outsized impact on structurally disenfranchised (disadvantaged) communities. Environmental and air quality advocates point to pollution and particulate emitting facilities where impacts are overlooked or disregarded. Some of the most prominent cited examples are in California's central valley burning agricultural waste.

Biomass energy production is not a 'one size fits all solution', and we are not advocating for the carte blanche expansion of biomass energy state and nation-wide. Siting and location must be considered within specific communities and air quality basins to address environmental justice concerns.

SBC's expertise lies in the communities of the Sierra Nevada, and we know their social, environmental and economic challenges intimately. The language in this report is very specific—we are focused on forest biomass as one part of the solution to California's overwhelming forest management challenge, and the co-benefits biomass utilization could provide to some of the communities that are bearing the brunt of a changing climate.

What is Biomass?

Because biomass is organic material that comes from plants, forest biomass is recognized as a renewable energy source in the state of California.[11] Types of biomass can include excess material generated from timber operations, forest health treatments, agriculture, and construction, and the material can be used for ancillary purposes like value-added wood product manufacturing or biomass energy generation. Solid biomass can be burned directly to produce heat and turn a turbine or warm a boiler, converted into biogas or biofuels, such as ethanol and biodiesel, or used to create additional useful products, such as wood chips, animal bedding, landscaping material, or mass timber products like cross-laminated timber or oriented strand board.[12] The focus of this report is biomass energy, also referred to as bioenergy, as a renewable energy source that makes judicious use of excess forest material from thinning or other forest management activities that would otherwise be disposed of in landfills, open-burned in piles, or left to decompose.


(left) A pile of forest thinnings from the Sagehen Forest Shady Rest Fuel Break. (right) Chipped forest material at Loyalton Biomass Facility. Photos courtesy of Simone Cordery-Cotter

With an urgent need to increase the pace and scale of ecological forest restoration and fuel mitigation[13], biomass energy operations utilizing excess forest material pose an opportunity to prepare the landscape for reintroducing prescribed fire and help offset the cost of those and other restoration projects, which can be expensive and time-consuming. For the purposes of this report, the term biomass refers to the surplus and typically otherwise non-merchantable woody by-products of forest health and fuel reduction projects, such as excess wood chips, small diameter tree trunks,[14] and dead trees and brush that are not left on the forest floor as habitat. While there are other market-based, socio-ecologically responsible uses for biomass including wood products manufacturing and agricultural applications, this paper focuses primarily on biomass energy solutions.

Almost every biomass facility in the Sierra Nevada region uses woody biomass as the plant's primary feedstock. (This in contrast to biomass plants located in the San Joaquin Valley, that primarily utilize non-marketable agricultural byproducts, such as shells, crop trimmings, etc.) This is due to the ready availability of woody biomass feedstock from nearby tree mortality zones and/or fuel mitigation projects, many of which focus on removing small-diameter trees and brush from the forest that would otherwise be unmarketable material in need of disposal by the timber industry. Depending on the facility location, and surrounding land ownership, along with forest density, biomass facilities can make use of biomass anywhere from a 20-mile to 100-mile radius while still keeping the economics of chipping and transporting relatively competitive with other renewable energy sources.[15,16] Removal of feedstock from beyond an established perimeter increases shipping costs, GHG emissions from trucking, and reduces the cost-effectiveness of the feedstock, making it less competitive for power purchase agreements.[17] The key is to keep forest biomass energy facilities local and scalable to the landscapes and communities they serve.

Local biomass energy industries based in forested Sierra Nevada communities have the potential to help finance climate-resilient forests, protect key watersheds, reduce particulate emissions from open burning and wildfire, increase local grid reliability, and reduce landfill waste. As a renewable energy source, biomass energy utilization can help the state meet its renewable energy requirements.[18]

DEFINING THE NEED: Ecological Restoration of Sierra Nevada Forests

There is a clear and immediate need for accelerated forest management in the Sierra Nevada, both to protect live trees and to address the growing tree mortality issue. As both an example and a symptom, the estimated 147 million dead trees in the Sierra Nevada present a major public health hazard in the form of wildfire intensity risk, are a significant source of greenhouse gas emissions, and contribute to unhealthy forest conditions that jeopardize the water quality and water supply of the Sierra Nevada watershed that provides over 60% of California's developed water supply.[19] This massive tree-die off is attributable to many factors, including decades of fire suppression, the most recent five-year drought in California, pest invasions, and climate change.[20]

In order to combat the overcrowded conditions and increasing dead tree mass in California's mixed conifer forests, forest managers at the state and federal level utilize a number of tools. These include mechanical and hand thinning (actively removing excess vegetation from the forest using machinery and hand tools) followed by pile burning as well as prescribed fire or controlled burns. According to the California Forest Climate Action Team's Forest Carbon Plan, an increase in the pace and scale of forest restoration activity in the Sierra, including mechanical thinning in areas near where people live (also known as the wildland-urban interface, or WUI) and thinning, prescribed burns, and managed fires where conditions allow in the forest interior, is badly needed to return the forest to an ecologically resilient state. The overall goal is a heterogeneous forest structure dominated by large-circumference trees.[21] Restored forests have been shown to be more resilient to climate change, sequester (absorb and store) more carbon, are more biologically diverse, and are more resilient to wildfire[22] – benefits that cannot be overstated as the globe creeps toward a 2 degree Celsius temperature increase.[23]

CALIFORNIA'S FIRE LANDSCAPES

It's important to differentiate between the various landscapes that burn in California when we discuss fire. In a state that rises from sea level to above 14,000 feet at points in the Sierra Nevada, and is home to Mediterranean and desert climates, landscapes span everything from lush coastal forests to high desert. The shrub-covered coastal slopes and oak woodlands of southern and central California, also known as chaparral, are characterized by infrequent fire regimes (30-50+ years) that burn at high intensity and regenerate quickly. Fire events in chaparral landscapes are becoming more common due to human encroachment in natural areas. The 2017 Thomas Fire in Ventura and Santa Barbara counties is a characteristic example of a chaparral fire, the spread of which was aggravated by strong Santa Ana winds gusting up to 60 miles per hour. The role fire plays in the chaparral landscape versus California's mountainous mixed conifer forests differs greatly, thus it is important to differentiate between forest and vegetation management strategies for the two ecological regions.

The Forest Carbon Plan estimates that by 2030, the pace of forest restoration and fuels treatment on state, private, and federally-owned land needs to more than triple to a whopping 1 million acres per year to return California forests to a healthy, ecologically resilient state as net carbon sinks.[24] Data shows that California's forests are becoming net carbon emitters rather than sinks, due to land use conversion, changing climate conditions, and wildfire.[25] Conversion of California forests from net carbon sinks to net carbon emission sources poses a threat to achieving California's emission reduction goals and poses potential to create a negative feedback loop, exacerbating existing climate change effects.

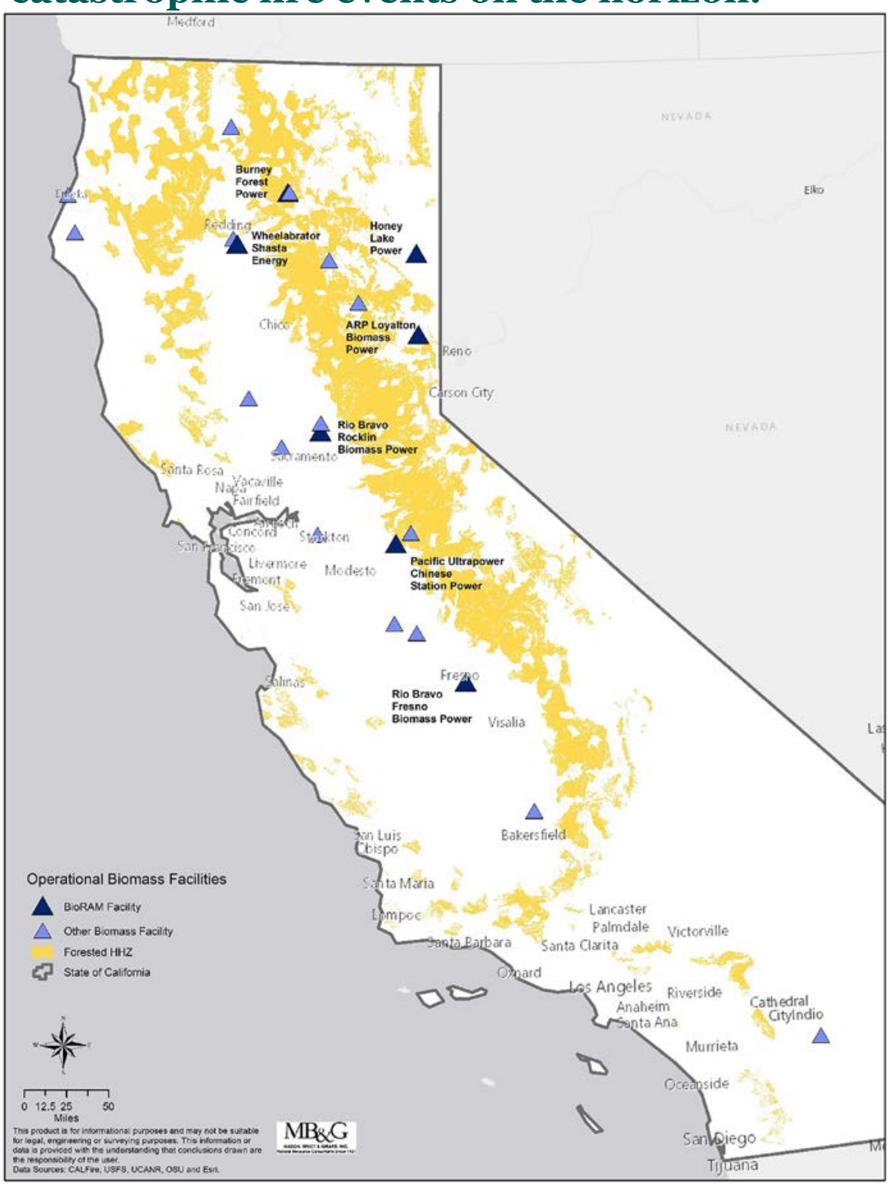
Ecological restoration of Sierra Nevada forests will help mitigate future catastrophic wildfire, improve regional climate resilience, ensure the quality and quantity of water supply for millions of Californians, sequester carbon, and preserve wildlife habitat, among other benefits.

Ecologically restored Sierra Nevada forests are a huge asset to the state of California. Restored forests that have been subject to prescribed fire regimes and mechanical thinning produce more water for downstream users, store more carbon, and are more fire- and climate change-resilient. Researchers have found that over an 18-year period starting in 1990, thinned forests saved 3.7 billion gallons of water annually in California's Kings River Basin and 17 billion gallons of water annually in the American River Basin.[26] In a region that provides 60% of the state's developed water supply, watershed improvements are benefits that cannot be overlooked, especially as climate change-related extreme heat days, drought periods, and overall warmer temperatures strain California's water systems.

Restored forests also store more carbon than other landscapes – the Sierra Nevada region as a whole stores half of the state's above-ground carbon,[27] and has been identified as a key player in achieving state carbon reduction goals.[28] Unfortunately, over the past two years due to tree mortality, wildfires, and other disturbances, Sierra Nevada forests have emitted more carbon annually than they have stored, and are projected to decline further later in the century.[29] As we look forward into a warming world, climate-resilient forests that can remain carbon sinks even in the face of disturbances will be key to maintaining the state's water and air quality.

A glaring barrier to achieving this goal is the high cost of forest management: the Forest Carbon Plan's recommended 1 million acres of restoration activity per year could cost the state, federal land agencies, and private land owners anywhere from $750 to $4,400 per acre according to some sources.[30,31] Forest treatment costs per acre can vary widely, depending on the methods used, technology employed, and whether or not the process produces merchantable timber in the form of sawlogs. Judicious and sustainable market-based uses of excess forest biomass for energy and value-added wood products can help offset that cost, allowing for more treatment, reduced net emissions, and air quality benefits that help the state advance closer to meeting restoration targets set by peer-reviewed and stakeholder-informed reports, such as the Forest Carbon Plan, the Natural and Working Lands Climate Change Draft Action Plan, and the 2019 "Wildfires and Climate Change: California's Energy Future" report from Governor Newsom's Strike Force.

Much of the urgency around forest management stems from increased wildfire risk. In the past three years, California has seen increasingly deadly wildfire seasons culminating in the single most expensive natural disaster of 2018 that took the lives of 85 people: the Camp Fire in Butte County that virtually destroyed the town of Paradise.[32] The evidence points to even more catastrophic fire events on the horizon.



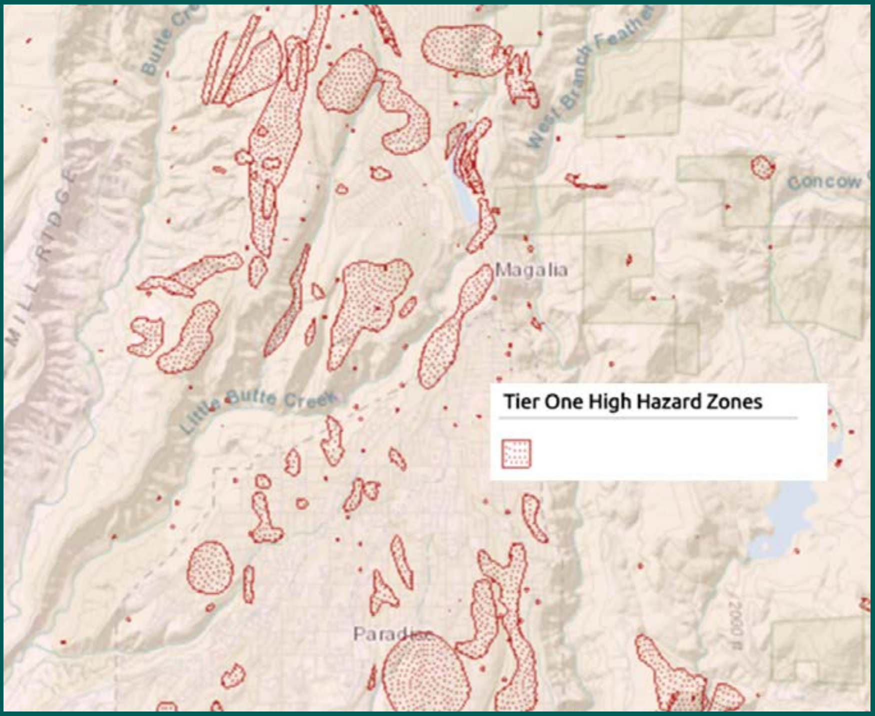
CalFIRE works with the Forest Management Task Force to identify areas of the state where dead and dying trees pose a hazard to local communities, infrastructure, and natural areas. These areas are broken into two tiers: Tier 1 – where high tree mortality directly coincides with critical infrastructure (including utility lines) and poses a threat to communities, and Tier 2 – watershed areas that have significant community and natural resource assets in need of protection. These zones are high priority areas for forest restoration activities, and current state legislation requires BioRAM[33] biomass plants to procure certain percentages of their feedstock from these High Hazard Zones (HHZs).[34] A June 2019 study prepared for the High Hazard Fuel Study Committee identified 42 million bone-dry tons (BDT) of potential biomass fuel on 3.6 million HHZ acres (Tiers 1 and 2) within a 50-mile radius of BioRAM plants, indicating an abundance of qualifying biomass in areas that have been identified as hazardous to communities and watersheds.[35] Note that this is just biomass from High Hazard Zones within a 50 mile haul distance of a BioRAM plant – the same report identified 248 million BDT of forest residue biomass on 13.1 million acres of High Hazard Zones overall. That 42 million BDT of forest residue biomass, mostly in the form of dead trees and essentially the lowest hanging fruit for bioenergy production, currently poses a massive public health hazard, whether it fuels California's next megafire or disrupts communities on a smaller scale, by falling on people, cars, roads, and other infrastructure. This is biomass that unquestionably needs to be removed, leaving only the discussion about what to do with the staggering 42 million BDT. If diverted to a bioenergy facility instead of a landfill, that amount of biomass currently represents 6% of the state's overall electricity generation capacity, roughly the total energy needs of a metropolitan area the size and population of San Francisco.[36] Forest management that would remove this tonnage takes into account existing California forest management practices and BioRAM contract stipulations, which explicitly prohibit clearcutting on public lands. The bottom line is that this material needs to be removed from the forest, and it is merely a question of how to pay for that removal, and where to put the material.

Despite the overwhelming arguments for taking swift and concentrated action to restore Sierra forests, there are many challenges. For example, prescribed fire and pile burns, a necessary part of the solution to achieve scale in removing excess forest biomass, require close monitoring and can only take place in areas where conditions allow and during

LIVING in the HAZARD ZONE

There is considerable risk when high-priority areas are not treated in a timely manner, as demonstrated by the 2018 Camp Fire. The community of Paradise was covered in Tier 1 hazard zones, but only one area in the northern part of Magalia was subject to concentrated forest-thinning activity. The Butte County Fire Safe Council Executive Director, Calli-Jane DeAnda, said in a November 2018 interview that forest management probably spared the Pine Ridge Elementary School in Magalia after crews cleared vegetation and trimmed 11 acres of trees near the campus.

"I think it's very likely that the school would have burned," said DeAnda when asked what would have happened without the trimming. The effort was achieved in part thanks to $1 million of federal and state grants invested in forest thinning and brush removal.[149]



Map Courtesy of CalFIRE's Fire and Resource Assessment Program, accessed October 4, 2019.

limited times of the year due to air quality and public safety concerns. Depending on the combination of hand thinning, mechanical thinning, pile burning, and prescribed burning used, treatments can be quite costly, making it difficult or impossible for state and federal land agencies, as well as private land owners, to pay for sustained treatments.[37] Scaled up to meet the Forest Carbon Plan's goals of 1 million acres per year on federal, private, and state-owned land in the state of California, this would cost $1.1 billion to $4 billion annually. Public funding without a market-based mechanism cannot meet this need, leaving forests in an unhealthy and dangerous state, while legislators and residents struggle with the daunting task ahead.

The simple truth is that there isn't enough state and federal money being made available for pre-fire forest thinning and restoration on the scale that needs to occur, even given the combined budgets of CalFIRE and the USDA Forest Service, because so much is held in reserve for fire suppression. This is where biomass utilization, through private and public investment coupled with market development and value added wood products, can help offset the cost of these necessary pre-fire efforts, while making California's forests safer and healthier. Preemptive wildfire mitigation will also reduce fire suppression costs in the long run.

Treatment Type	Cost Range per acre[38,39]	Considerations
Mastication (material chipped by machine and left on the forest floor)	$450-$1800	Machinery needs to be able to easily access the forest via road.
Hand thinning + pile burn	$1000-$4000	
Chip/harvest with mechanical thinning equipment and haul	$1500-$4400	Costs can be offset by trucking chips to biomass facilities and/or selling merchantable timber.[40]
Prescribed fire	$300-$1800	Requires that forest has already been thinned from below, either through mastication or hand thinning. This cost would be in addition to either mastication or hand thinning.

STATE FUNDING

State Forestry Budget, FY 2017-2018[41]	Non-Federal Lands Projected Averaged Costs 500,000 acres per year[42]	Anticipated Annual CA State Budget Shortfall
$220 million	$542 million - $2 billion	-$322 million - $1.78 billion

It should be noted that these figures do not include indirect costs such as planning and permitting, and the goal of these is to demonstrate the volume of need for additional resources. These figures are not policy or budget recommendations, simply an illustration of necessity to bring more resources beyond public funding to bear on this complex problem. Forest treatment itself is complex and influenced by multiple factors, and professional foresters and land managers in California stress the importance of evaluating these costs in the context of the specific nature and scale of the landscapes that require treatment.[43]

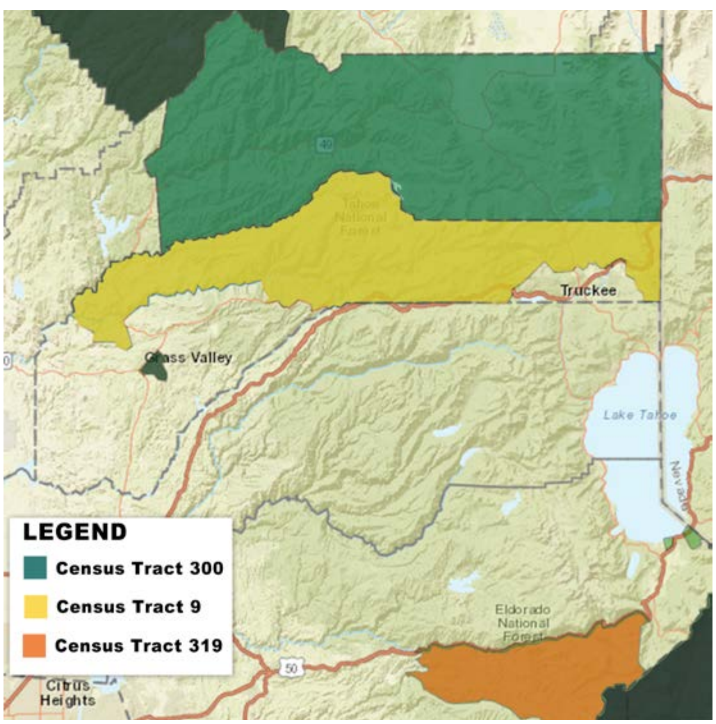
CO-BENEFITS and THE COST OF INACTION

Localized forest biomass energy has a host of social and economic benefits beyond the environmental net benefits of avoided pile-burning and wildfire emissions (See Appendix A for emissions comparison), more sustainable long-term carbon storage, healthier habitat, and more abundant water supplies. Compared to the costs of inaction, investment in biomass solutions offers a holistic and feasible alternative.

Local Economic Benefits

Biomass energy facilities offer high-paying, long-term employment opportunities for energy professionals in communities that typically lack a local industry that promises year-round employment. Natural resource communities, in the wake of the decline of the timber and mineral-extraction industries, are becoming increasingly reliant on tourism and recreation to draw outside investment and visitation, as demonstrated by growing employment numbers in the visitation and hospitality sectors, correlated with declining employment numbers in goods-producing industries including mining and timber harvesting.[44] While it is positive to see any type of environmental industry growth in rural, natural-resource communities, those communities are also susceptible to boom and bust cycles, especially when recreation and tourism are influenced by issues such as seasonal water and snow shortages or air quality impacts from wildfire. Research into the 2008 Economic Recession and its impacts on rural economies in the American West has also demonstrated that natural resource-based communities are more vulnerable to economic downturns when compared to areas less reliant on tourism, supporting the case for diversified economies beyond recreation and tourism.[45]

Existing and proposed biomass energy facilities in the Sierra Nevada are also ripe for Federal Opportunity Zone[46] investments, inviting millions of dollars' worth of private capital investments in various facilities, which promotes much-needed long-term investment and economic resilience that contributes to community employment across all sectors. For example, the re-opening of the Loyalton Biomass facility in April 2018 resulted in 21 full-time jobs in a community of 720 people. The ripple effect resulted in 120 jobs created in a county of 3,000 people, and there are community discussions around re-opening a medical facility in the town as a result. This is significant in a community that once boasted a population of 1,400 and lost stores, schools, and a hospital upon the plant's 2001 closure.[47] If that ripple effect can be replicated, and capitalized on in other Sierra Nevada communities, the potential impact would be significant.



<The State Integrated Opportunity Zone Map shows three large, rural opportunity zones in and near Placer County that could potentially serve as sites for future biomass energy facilities. Those zones are Census Tract 9 in Nevada County, Census Tract 100 in Sierra County, and Census Tract 319 in El Dorado County.

Downstream Economic and Environmental Benefits

The environmental benefits of biomass are not limited to positive impacts on local communities. Removal of excess forest mass is a critical tool to help create healthier watersheds and potentially more water yield for downstream communities. For example, studies have demonstrated that thinning 500,000 to 600,000 acres of forest can increase average water yield by 100,000 acre-feet.[48] A 2015 study from The Nature Conservancy estimated that northern Sierra Nevada watershed yields would increase as a result of forest thinning projects, with the largest water increase from the Feather watershed – an increase of 285,000 acre-feet over the course of 20 years.[49] An economic analysis of these benefits in the same report suggests that even small increases in water yield could have a marked effect on producing added hydropower in downstream facilities. The Nature Conservancy's benefit-cost ratio (BCR) analysis demonstrated that hydropower benefits have the potential to offset anywhere between 17 and 60% of the cost of forest restoration, assuming a watershed has downstream hydropower and can sustainably accommodate a threefold increase in the pace and scale of forest thinning (compared to observed activities between 2002 and 2012).[50] Not only do forest thinning activities make forests more resilient to wildfire, they can also increase the ability of forests to sustain climate-adapted source watersheds for both local and downstream communities' water supplies.

Biomass offers another environmental benefit as an alternative waste stream for green waste that would otherwise occupy space in landfills. California Senate Bill 1383 (2016) requires a 75% reduction in organic waste dumped in landfills by 2025, yet the projected pace and scale of forest restoration would produce massive amounts of green waste in the form of biomass that would directly inhibit achievement of that goal and contribute significantly to methane emissions from landfills.[51] Biomass entering municipal waste streams can be expensive and place stress on existing infrastructure. If sanitary districts, landfill operators, and municipal waste managers have a market that allows for the incentivized diversion of waste from vegetation management projects to biomass facilities instead of landfills, there's a path to create a dedicated waste stream that contributes to local employment and more sustainable waste practices while meeting state waste reduction goals. This is already in practice in Nevada County – the Eastern Regional Landfill just outside of Truckee diverts 8,000 – 9,000 tons of green waste per year to the American Renewable Power biomass plant in Loyalton, 37 miles north.[52]

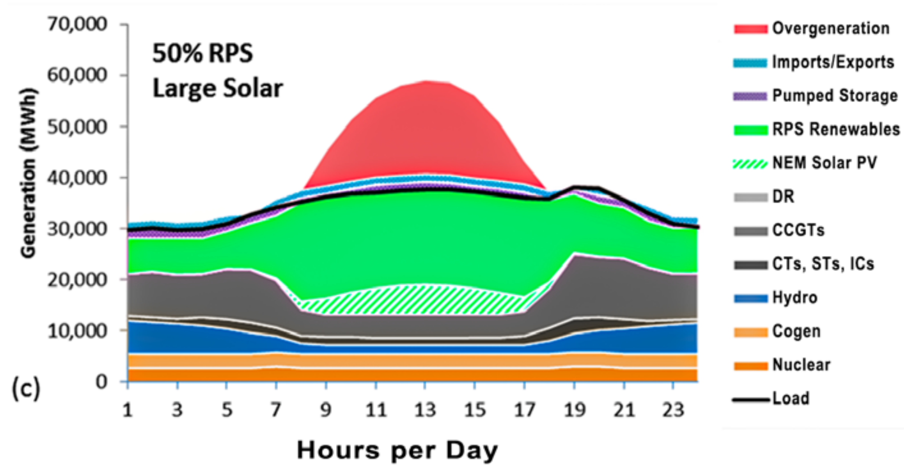
Loyalton Biomass Facility By the Numbers

- 21 jobs created
- Average Salary: $48,000
- 40% above median income wages
- Projected impact of entire ReGen Campus: 350 community & facility jobs

Baseload Energy Generation and Community Energy Resilience

An advantage of biomass when compared to other renewable forms of energy such as wind and solar is that it can be generated on demand (also known as a "baseload" or "dispatchable"), similar to fossil fuel energy generation. Solar and wind are weather and sun-dependent, meaning they are not dispatchable energy sources, and in order to meet the total estimated generation demand, energy providers need to compensate for when the wind is not blowing, or the sun is not shining in certain areas by building extra generation into the system. With a baseload power source, or dispatchable source like biomass, the need for storage and solar overbuild is reduced, and biomass rounds out the demand when wind and solar cannot meet energy needs. When all of that extra generation capacity is operating (ie the sun is shining and the wind is blowing everywhere), you have over-generation, which can overload and stress energy grids. According to the

CPUC, wind and solar cost an average of $0.05/kwh and $0.03/kwh respectively in 2018, while natural gas costs hovered around an average of $0.10/kwh, comparable to biomass at $0.11/kwh.[53] The cost of bioenergy worldwide has not fallen as steadily as wind and photovoltaic (solar) in the last seven years, with the localized cost of bioenergy [54] fluctuating very little from a high of $0.08 USD/kwh to a low of $0.06 USD/kwh, mostly due to capital costs, according to the International Renewable Energy Association.



>Graph demonstrating Large Solar Scenario Over-generation over the course of a day in April 2030. Courtesy of the Energy Information Administration.

Analysis shows that despite these perceived higher costs, incorporation of biomass into the renewables energy mix could actually reduce projected utility rates relative to other Renewable Portfolio Standards scenarios. A 2014 study conducted by Energy + Environmental Economics for California's investor-owned utilities examined the financial impact of a diverse renewables mix (a mix less heavily reliant on solar and more inclusive of biomass, hydro, and geothermal) versus a heavily solar-dominated generation portfolio.[55] The study demonstrated that as the state's renewable portfolio grows, utilities will need to start curtailing solar generation in order to provide reliable service and avoid over-generation, sometimes to the tune of 65% curtailment.[56] The cost of curtailing that solar over-generation is projected to result in a utility rate increase of up to 23%. However, a more diverse renewable portfolio shows a "substantially lower rate impact than the more heavily solar-dominated cases, primarily because the diverse portfolio results in less over-generation."[57] A 2015 report from the CPUC further illustrated these points, making the case for flexible grid capacity to meet usage ramping (large, quick increases in energy usage), and suggesting that dispatchable, or "on-demand," biomass could be part of the solution.[58]

Biomass energy can help provide electrical grid resilience by adding diversity to the state's portfolio of renewable energy sources, a key component of both emergency preparedness and decarbonization, while keeping costs low.

Wind and solar are subject to weather variability that does not track with energy usage patterns, and power lines bringing non-localized energy to communities may be subject to extreme weather risks or proactive de-energization due to wildfire risk. To counterbalance these drawbacks, local, scalable biomass energy facilities can serve as a baseload, decentralized energy source.[59]

Local communities have already experienced the benefits of local renewable baseline power generation from biomass facilities. When the Camp Fire broke out in Paradise in November of 2018, it downed the only transmission line that provided power to Lassen Municipal Utility District customers more than 100 miles away in Susanville and the surrounding area.[60] LMUD operators were able to plug into the biomass-powered Honey Lake Power facility, and provide power to Susanville's homes and businesses for almost three weeks while the transmission line was restored.

The possibility of extended power outages from public safety power shutoffs or actual fire events is a major concern, both for the directly affected communities and those downstream. When the 2013 Rim Fire blew up outside of Yosemite National Park, then-Governor Brown first declared a state of emergency in the directly affected communities of Tuolumne County, followed the very next day by a similar declaration for the city and county of San Francisco due to the imminent threat of fire wiping out water and power distribution lines.[61] Costs associated with power outages can be heavy. For example, the Great Blackout on September 8, 2011, in San Diego County racked up between $97 and $118 million in economic losses in just 12 hours, based on conservative estimates.[62] More recently, an initial calculation regarding the October 2019 Pacific Gas & Electric Public Safety Power Shutoff event in northern California by Michael Wara of Stanford University's Woods Institute estimates the financial impact of that blackout at some $65 million for residential customers and up to $2.5 billion for small commercial and industrial customers, assuming 800,000 customers out of power for 48 hours.[63]

Additionally, using biomass energy for sectors that are more difficult to transition to carbon-free sources (manufacturing in particular) could contribute to decarbonization and overall carbon neutrality in the long-term.[64]

THE COST OF INACTION

As insurmountable as the financial figures of forest management sound, the cost of inaction is far higher – especially in terms of the potential for loss of life. The fiscal year of 2017-2018 was record-setting -- the state of California saw $947.4 million just in fire suppression costs.[65] That does not include the estimated $12.5 billion of insured losses from the Camp Fire alone, in addition to the human cost of the more than 14,000 homes destroyed and the 85 people who were killed in the blaze.[66,67]

California's megafires also have rippling, undeniable consequences throughout the state's insurance markets, most of which are still playing out as homeowners in the Sierra Nevada lose their insurance and are not offered reasonable alternatives. Average fire insurance premiums, if homeowners can still access fire insurance programs, range from $1,800 to $5,000 per year, sometimes higher.[68] Homeowners in wildfire-prone areas report being unable to find fire insurance policies after being informed by insurance carriers that their policy is being canceled,[69] and a recent report from the Commission on Catastrophic Wildfire Cost and Recovery found that homeowners in the wildland urban interface (WUI) pay 50% more for insurance than other California residents.[70] Insurance companies report slowly withdrawing from the California markets in an effort to remain profitable, or in some cases, solvent.[71] For some, it's too late – Merced Property & Casualty Co. of Atwater was declared insolvent in December of 2018, after collapsing under $64 million in potential liabilities in the wake of the Camp Fire.[72] Desperate homeowners are left with the barebones California FAIR Plan as an insurer of last resort, and there are concerns about how long such a program can remain in existence since it is covering all the higher-risk policies that other companies have turned down.[73]

According to California's 4th Climate Assessment Sierra Nevada Regional Report, immediate action is needed to prepare Sierra Nevada forests and communities to be resilient in the face of rising climate change costs.[74] Models of future conditions under a business-as-usual scenario predict increased frequency and severity of wildfire and drought stress, and lower carbon storage capacity in Sierra Nevada forests.[75]

Uncertainty in precipitation and weather event modeling indicates a likelihood of more variable and unpredictable precipitation events, both in terms of timing and volume. Declining snowpack threatens to disrupt the entire watershed system and the downstream communities that rely on year-round Sierra Nevada water supplies. And finally, under these conditions, wildfire insurance costs are expected to rise by 18% by 2055 in areas with the highest risk – encompassing most communities in the Sierra.[76]

Across the entire state, rising population numbers and warming temperatures threaten to strain the state's energy systems: climate-related costs to natural gas and electricity systems are estimated to cost $510 million and $650 million respectively on an annual basis by midcentury, while wildfire costs to the electrical grid are estimated at $47 million annually by midcentury.[77] With no adaptation measures taken, harvested timber values are expected to decline as much as 8% by 2100, potentially costing the state $3 billion by midcentury and $8 billion by 2080.[78]

Water system impacts could be just as severe, with downstream flooding impacts and decreased water quality and quantity.[79] There is a 50% probability of a mega-flood event occurring before 2060, which could cost the state $42 billion; and even with perfect foresight and adaptive measures, water shortage costs to the state could reach $1 billion annually.[80] Unhealthy forests impact everything, from the scale and behavior of wildfires, to the state's watershed reliability and water supply, to the landscape's ability to absorb and disperse major precipitation events.

The numbers are clear: the cost of inaction is far too high.

When faced with the scale of need in our forests, and the untenable losses that will occur if the work is not done, California must find a way to increase the pace and scale of forest treatment. Public funding, alone, that simply pays for vegetation management and leaves tons of biomass in the forest, cannot close the gap. Even with 2019's state budget allocations for forest management, there still exists a substantial funding gap that will only grow wider as the problem worsens and federal forest management budgets are threatened by proposed cuts.[81,82] Collectively, we must find a way to help finance landscape-level forest restoration projects by encouraging private investment and private capital, and that can only be done through creating market-based solutions for the woody material resulting from forest treatments – such as biomass energy.[83]

Critics of biomass claim that the revival of the biomass industry will lead to clearcutting of the very forests the effort is attempting to preserve – an action that, first, is not at all what this paper argues and, second, is not actually legally feasible for BioRAM plants, due to SB 859 that explicitly states fuels cannot come from clearcutting efforts.[84] A reinvigorated biomass industry – one that is supported by sound policy and recognizes and values the social, economic, and environmental net benefits of biomass and links restoration and forest management plans – is a critical piece of the puzzle when it comes to creating a viable, market-driven solution to remove excess forest biomass and restore our forests to an ecologically resilient state. Energy and other wood products are in essence byproducts of a process that is increasingly necessary to achieve critical forest health and fire risk reduction goals.

SOLUTIONS

It's estimated that there are so many dead trees from the tree mortality crisis in the Sierra Nevada, that it would take 100 years for the available mill and biomass infrastructure in California to process all of the dead material.[85] While we are not suggesting that the biomass industry alone can solve the problem, we do have an opportunity – through judicious and sustainable use of excess forest biomass – to contribute to its solution.

It's important to reiterate that this whitepaper is not arguing that biomass energy is the only climate change solution, nor that trees should be cut simply to provide energy, nor that all forest treatment material should be removed from the forest. Instead, this paper acknowledges that our forests are in poor shape and that biomass utilization for energy and other value-added wood products can provide critical funding in the short-term to address long-term forest health needs while also providing valuable investment, economic development, jobs, and other co-benefits to rural communities and the state overall. The forest management work needs to happen, and biomass energy utilization offers a sustainable way to help finance that work while offering a host of co-benefits that other forest treatment alternatives would not.

Challenges to expanding biomass energy in California include the time it takes to site or restart facilities, regulatory uncertainty affecting long-term investment strategies, the work associated with assessing and assuring sufficient sustainable material for processing in each facility at a reasonable price, and securing long-term power purchase agreements with energy providers – all of which affect the not-insignificant capital costs involved in building or reinvesting in facilities.

To help address these challenges, Sierra Nevada communities and the state of California need to take some, if not all, of the following steps to provide a path for scalable forest biomass energy utilization, value-added wood product market development, and to enact a broad-based support for the wood product industry as one part of ecological forest restoration efforts.

To that end, we're proposing the following set of recommendations:

Increase public investment that recognizes the co-benefits of forest biomass under our current situation.

- Value the co-benefits. Revisit AB 1890, the legislation that deregulated California's electricity production back in 1994, which – while it recognized the many co-benefits of biomass energy – only provided price support through the Renewable Transition Fund (RTF) during a deregulation transition period that ended in 2001. As part of AB 1890, the state was supposed to consider long-term policies for valuing co-benefits and shifting certain biomass energy production costs to those beneficiaries; but the Legislature never fully took up the issue.[86] Inherent co-benefits of biomass utilization such as watershed improvement, forest restoration, reduced fire risk, green waste diversion, and grid resilience need to be quantified and reflected in energy and product pricing.

- Incentivize and streamline resilient ecological outcomes in funded projects. Encourage appropriate large-landscape forest planning processes to achieve ecological restoration objectives. These large-landscape processes may cover multiple jurisdictions. In cases where forestry plans have been adopted and incorporated into state and federal forest planning documents, allow and encourage the development of programmatic NEPA/CEQA documents that would allow individual projects within the covered geography and activities to be adopted through a streamlined administrative process.

Increase private investment to augment public dollars and improve the financial viability of biomass as a tool to address forest health.

- Incentivize private investment. Create financial incentives, a more certain and streamlined permitting process to make long term investments more appealing, and favorable market conditions for private investment in existing biomass energy generation facilities. Addressing the recommendations above will create a sound economic case for investing in biomass facilities up and down the Sierra. This can be galvanized by the utilization of existing Federal Opportunity Zones near vulnerable forested communities that would encourage private investment opportunities and create social and environmental co-benefits.
- Quantify available feedstock. Assess feedstock available for biomass utilization in relationship to sustainable forest restoration and resilience objectives. In other words, assess feedstock in the context of the overarching goal of ecological restoration – not energy output potential. This would also set the stage for concentrated private investment – if the market potential is quantified, investors are more likely to see a return.

Protect existing facilities to maintain current capacity to accept excess forest material.

At full capacity, the Loyalton Biomass Facility alone has the potential to help finance the treatment of 12,288 acres per year, assuming 12 BDT available per acre. If that overall landscape required treatment every 20 years, Loyalton could support ongoing ecological forest restoration on 245,760 acres of forest land. There are currently 10 established biomass facilities in the Sierra Nevada, eight of which are currently operating.[87] Four of those active facilities are qualified as BioRAM facilities, meaning that they have power purchase agreements with investor-owned utilities, and a state-mandated percentage of their fuel needs to come from High Hazard Zones. It's notable that not all of the Sierra Nevada facilities are even operating at their full generation capacity.[88] Just between the BioRAM facilities, it's estimated that they could consume 1.8 million bone dry tons (BDT) of forest biomass from High Hazard Zones, annually. For scale, the 2019 CPUC inventory estimated that there are potentially 248 million BDT of biomass just in the High Hazard Zones.[89]

- Reform BioRAM power purchase agreements (PPA). Reform requirements of BioRAM 1 and BioRAM 2 to ensure that the facilities with contracts are able to meet the feedstock requirements. Currently BioRAM 1 contract facilities are able to pay more for fuel loads than BioRAM 2 facilities, due to PPA energy prices. This results in certain plants beating out other plants in acquiring qualifying feedstock, even when plants that pay less are located closer to areas where forest biomass is chipped and removed. This results in lopsided supply and demand dynamics and subsidizes market inequalities between facilities, leaving some forested areas adjacent to biomass plants without a viable market mechanism for removing forest biomass. Many co-benefits, such as reduced GHG emissions and increased local employment, are lost or diminished if material is transported across longer distances to other facilities or if excess material is left to decompose on the roadside. A higher purchase price for feedstock will also dis-incentivize open-pile burning, making for better air quality and less fire risk.
- Expand the definition of qualifying fuels. To increase the amount of biomass feedstock available for utilization and to reduce transportation costs, the definition of qualifying fuel for BioRAM facilities should be expanded. In addition to current definitions, adding those zones identified as moderate, high, and very high risk on the Fire and Resource Assessment Program map to qualifying HHZ fuel would positively impact the economics of removing that material from the forest to biomass plants. The definition could also be expanded by including waste material from qualifying fire prevention thinning projects. This change would also assist local governments and other small landowners not located in HHZs currently struggling in their fire prevention efforts to remove fuel, as well as reduce competition for qualifying fuel and reduce fuel prices. It's important to note that the impetus for this expansion is to accelerate ecological forestry and increase carbon capture, meaning that the removal of large green trees would not be included in this definition, and the focus would remain on dead material and ladder fuels.

THE ECONOMICS OF BIOMASS

One of the main reasons biomass energy doesn't pencil out economically is because the cost of the fuel (removal from the forest, chipping, processing, and transporting) – without accounting for the many co-benefits – outweighs the income from charging for the energy generated. However, if there are additional buyers for woody material onsite, co-located with the biomass facility, those economics shift, because other wood products, such as cross-laminated timber, post and pole, wood extracts, and other wood-based manufacturing are higher value, thus able to offer more economic incentive for non-commercially merchantable timber pulled out of High Hazard Zones.

Essentially, between the co-located manufacturing processes and biomass energy generation, transportation costs for forest residuals are offset more readily. The biomass plant, especially a combined heat and power plant (CHP) like Loyalton, provides waste heat and steam for manufacturing processes, while also providing affordable renewable energy onsite. It resembles a more modern version of timber companies co-locating biomass plants to power sawmills, with two key differences: 1) biomass fuel is drawn specifically from forest restoration activities and High Hazard Zone fuel removal (not clearcutting), and 2) renewable energy is produced in a closed loop.

Expand biomass facilities through renovation/reoperation of shuttered plants, co-location of other wood products businesses, and in some cases construction of new facilities – all in the service of making forest treatment more economically viable by providing outlets for the material.

Given a region-wide effort to reinvest in existing shuttered and under-utilized biomass plants, which would require statewide policy changes to address their economic feasibility and a concerted effort to site symbiotic wood manufacturing facilities, it would be possible to treat 193,000 forested acres per year, starting with some of the region's most vulnerable communities.[90] That translates into almost 20% of the goals established by the California Forest Carbon Plan, or 3.9 million acres over the course of 20 years, given allowance for rotational thinning practices.

Further inroads could be made if investments were directed at restarting shuttered plants that were once a vibrant part of rural forest communities, as well as siting additional small- to mid-size facilities to reduce the cost of processing and transporting forest biomass. The current infrastructure for processing the target amount of biomass and wood products does not exist on the needed scale in the state of California, but with the right policies in place for sustainable biomass revitalization and expansion, state and local jurisdictions could help close the gap between the current capacity and where the state needs to be to meet its ecological forest restoration, renewable energy generation, and net GHG and other emission reduction goals.

- Invest in transportation and infrastructure. Support implementation and improvement of biomass energy infrastructure, such as efficient and renewable biomass removal and transport equipment that minimizes ecological impact and improves CHP (combined heat and power) technology, as well as focusing on workforce development for local forested communities.
- Support wood product manufacturing in state protocols. Support market development and adoption of mass timber products, such as cross-laminated timber, oriented strand board, and oriented strand panels, by incentivizing or requiring their use in California markets via the Building Code, and funding research and pilot projects for identifying innovative new wood product uses and subsequent GHG impacts. Biomass energy can be economically viable when a bioenergy facility is co-sited with a mill or other manufacturing facility, due to bioenergy's production of valuable byproducts like waste heat and steam, energy, and biochar and ash for manufacturing operations.

The alternative is to allow the dead tree biomass and excess live material to remain in the forest – standing, where it falls, or in slash piles -- where decomposition emits carbon and dead trees and excess fuel feed wildfires. Wildfires in particular can negate years of efforts to reduce greenhouse gas emissions across sectors, and pump dangerous levels of particulate emissions into the atmosphere, smothering entire parts of the state for days or weeks at a time. (For a more detailed analysis on alternative emissions scenarios, please see Appendix A.) Biomass utilization has to be a part of the solution as California grapples with this critical issue.[91]

CONCLUSION

This is not an argument for a new kind of coal.

This is a discussion around and justification for increasing public and private investment in biomass in service of making forest treatment more economically viable by providing local outlets for the material and reaping economic, social, and environmental co-benefits at the same time.

The scale of destruction witnessed in the wake of the Camp Fire in the fall of 2018 was a watershed moment, a canary in the coal mine as the state of California was thrust abruptly into an age of new normal. The loss of life was unprecedented and sobering. It was the embodiment of a vulnerable community's worst fears – infrastructure failing, neglected forests fueling voracious flames, and a community caught in the maelstrom, despite having an evacuation plan and emergency protocols in place. There are many other communities like Paradise in the Sierra Nevada, surrounded by forests that are groaning under the weight of a century of unchecked growth and millions of dead and dying trees. The resources to invest in hazard mitigation and forest management are already stretched thin between multiple agencies, and there is a swelling demand for proactive management. For example, in fiscal year 2017-18, upon issuing an RFP for forestry management grants, CalFIRE received 72 project applications requesting four times the total funding available in the program that year.

The need has outpaced the available resources.

The state and local jurisdictions cannot shoulder the entire financial burden of managing all of the publicly owned lands in the Sierra, and private landowners are finding their resources equally strained under the combined costs of rising fire insurance costs and maintenance of defensible spaces. The sheer accumulation of forest biomass in the Sierra Nevada needs the state's attention. It is a problem of such a magnitude that it demands a combination of private and public funding, economic and environmental interests, and swift, decisive action if we are to collectively restore the state's most significant carbon sink while maintaining the safety of wildland communities. Biomass utilization is only one arrow in the quiver, but it is significant enough, and misunderstood enough, to justify a thoughtful plea for consideration. This is that argument – that when biomass utilization is strategically combined with forest restoration and hazard mitigation goals, and biomass energy is co-sited with other wood manufacturing processes that can use renewable energy and its byproducts, it can be a force for economic revitalization, environmental stewardship, social justice, and a better California, for all.

WOOD PRODUCTS

Mass timber products have been in use in European markets for decades and are slowly gaining popularity in North America. Mass timber provides builders with design flexibility and cost-effective prefabrication, as well as offering superior fire resistance and seismic performance when compared to masonry and concrete-constructed buildings.[150] Currently the majority of mass timber utilized in the United States is imported. This paper makes no attempt to expand further on the GHG lifecycle of those products and their carbon impact of supply and manufacture. That particular subject is ripe for exploration in a similar publication, but not a focus of this particular piece.

BIOMASS CONCERNS AND FAQs

Biomass is not a one-size-fits-all solution; it must be considered in the unique context of the place in which it may be utilized. This section more closely examines the various controversies, frequently asked questions, and concerns surrounding biomass use.

CONCERN: Biomass incineration is a source of air and carbon pollution, at a time when we most need to reduce particulate and GHG emissions.

In the past, biomass plants located in the San Joaquin Valley of California have been criticized for excessive air pollution and violations of air quality standards. In 2011, for example, two biomass facilities in El Nido and Chowchilla were fined by the Federal EPA and local air quality district for emitting air pollutants including nitrogen oxides, sulfur dioxide, and carbon monoxide in excess of permit limits.[92] These facilities had not upgraded their pollution control equipment to adequately capture emissions. Another biomass facility was forced to pay a $145,000 settlement in 2013 due to failure to operate and maintain emission monitoring equipment.[93] In areas identified by the federal Environmental Protection Agency as having some of the worst air quality in the nation due to highway traffic and agricultural machinery, these concerns are valid. Affected communities and policymakers are concerned about not only the impact that the actual facility will have on the surrounding air quality, but also the impact of freight trucking that is necessary to bring in and process feedstocks.[94]

In the face of these challenges, it's important to point out that biomass facilities are subject to strict air quality control from local air quality districts and permit requirements, and are required to reduce emissions of criteria air pollutants, similar to coal-fired power plant regulations.[95] Reductions are made possible by pollution capture devices, and biomass plants are subject to the same strict air pollution controls as other power generation and industrial facilities.[96] Forest biomass in particular tends to be one of the cleaner feedstocks, rather than biomass facilities that combust construction waste or some agricultural byproducts. At American Renewable Power's Loyalton facility, combustion is controlled via a dust collector, char section remover, and then a fan with an electrostatic precipitator – this means that 98% of the produced particulate matter goes into an ash bunker and is sold as an agricultural product for soil enrichment.[97]

It's also vital to bring wildfire, and how it impacts the entire state, into this discussion as we discuss emission alternatives. Butte County's Camp Fire in November of 2018 produced an estimated 3.6 million metric tons of CO2 and equivalent greenhouse gases.[98] Over the course of three weeks, the 2013 Rim Fire put out a total of 167,410 tons of PM2.5 pollutants during its active burn period, peaking just over 10,000 tons on two separate days.[99,100] The smoke plume alone brought some of the worst air quality that the Bay Area has seen in almost 20 years and stayed there for several days. The streets of San Francisco and the surrounding area, home to 7.15 million people, resembled those of a ghost town as residents retreated indoors from air quality that registered in the "very unhealthy" zone,[101] and the estimated public health impact, in terms of dollars, clocked in around $600 million.[102] It's estimated that if the burn area of the Rim Fire had been treated with prescribed burns and other forestry management practices such as thinning, the emissions would have been reduced by 48%.[103]

The state's aggressive GHG emission reduction goals are meaningless when they are either partially or fully negated by increasingly devastating wildfires. Not only did the Camp Fire produce the same amount of GHG emissions as a week of California auto emissions, it burned so intensely through homes and automobiles that post-fire researchers have discovered toxic cocktails of cancer-causing chemicals in the rural water supply system that will take $300 million and two years to mitigate and restore.[104]

The Bay Area is not alone in being impacted by air quality concerns. Yosemite's 2013 Rim Fire burned 257,000 acres and produced the same amount of CO2e (carbon dioxide equivalent) emissions as 2.57 million cars.[105] Even a month after burning, when the Rim Fire was 80% contained, residents of the San Joaquin Valley experienced such dismal air quality that school children were kept inside during recess and sports practice. Communities 75 miles away in Nevada were affected by an Air Quality Index of 167 – well into the 'unhealthy' end of the federally-determined spectrum.[106] Even small businesses are not immune to degraded air quality and the associated drop in tourism. During the 2018 Ferguson Fire, which hit during peak visitation months of July and August, parts of Yosemite National Park were closed, while the financial consequences reverberated throughout the community.[107] Hotels shuttered while guiding and backpacking outfits refunded trips as the brief tourist season was shortened, resulting in an estimated 9% drop in total tourism numbers. In terms of dollars, it was a loss of $1.6 million in park entry fees alone, and an estimated $18 - $40 million hit in local labor income for the surrounding gateway communities.[108]

To cite the failings of a select few biomass plants while ignoring the larger issue at hand for the safety and well-being of thousands of California residents is not only myopic, but negligent.

CONCERN: To feed an ongoing biomass operation requires continually thinning or clearcutting forests. Tree thinning will not continue indefinitely at current levels – the concern is that biomass incineration will drive forest management, rather than the other way around.

Under the current legal structure, part of the process for proposing a new biomass energy facility, or the conversion of a former timber mill into a biomass energy plant, entails conducting a fuel feasibility study. This involves evaluating the density of surrounding forests, their ownership status (private or public, state or federal), and accounting for any additional possible waste streams that can be diverted. For example, the Loyalton Biomass Plant makes use of wooden shipping pallets from a nearby Tesla manufacturing facility. Honey Lake Power Facility diverts green waste, such as branch clippings, pine needles, and old Christmas trees from the Eastern Regional Landfill on Highway 89.

Depending on forest density, topography, estimated treatment/retreatment intervals and volumes, and past history of forest management, fuel feasibility studies can project both a high and a low estimate for biomass availability. This in turn informs the total capacity of the facility – for example, Loyalton Biomass Plant is a 20 MW facility adjacent to several Fire Hazard Severity Zones, according to CAL FIRE.[109] In contrast, smaller plants such as the proposed Mariposa Biomass Project, are scaled down with consideration to surrounding fuels availability. It's in the facility's economic interests to keep transportation distances down, while also reducing fuel costs and GHG emissions associated with trucking.

Forest management and treatment intervals, how often an area of forest needs to be treated either by thinning or prescribed burning, and the volume of material created in each subsequent treatment, can vary drastically based on place, as well as the predominant tree species, and precipitation patterns. For example, red fir ecosystems in Yosemite National Park remain fire-resilient for up to 15 years after a controlled burn treatment. Several mechanically thinned stands in Lassen National Forest were able to withstand the Cone Fire of 2002 – the treatment had been completed 5 years earlier and proved to still be effective.[110] Many feasibility reports assume a treatment return interval of 20 years to accurately forecast biomass availability.[111]

It is deliberate that the focus of this paper is on biomass and the role it has to play in the forest management of Sierra Nevada forests as an economic mechanism to finance what has historically been a vastly underfunded priority. The current state of neglect we find our forests in only illustrates the need for an ongoing funding mechanism to encourage stewardship and help offset the cost of the Forest Carbon Plan that aspires to treat forests on the scale of a million acres per year.[112]

CONCERN: Biomass is not carbon-neutral, and burning wood products releases CO2 immediately into the atmosphere, faster than it would be released through natural decay on the forest floor.

Energy production activities are classified as carbon-neutral if the process produces no net increase in greenhouse gas (GHG) emissions on a life-cycle basis.[113] The crux of the argument revolves around the determination of ‘life-cycle’ for biomass energy, which can vary based on the type and age of the biomass that is used to generate energy, and is complicated by the fact that there exists no commonly accepted definition for a carbon-neutral activity in the bioenergy industry.[114]

In Europe the calculation is based in part on the “best use of available resources.” -- “Branches, bark and other sawmill residues have produced the energy for driers, heating, and in some cases, local electricity generation. Within the framework of sustainable forest management, this can be seen as making the best use of available resources, where the fuel is from materials for which there is no higher value use (the ‘cascade’ principle; EC, 2014). Such a forest, managed sustainably to maintain a stable or increasing carbon stock, can be characterized as producing no net release of carbon and thus ‘carbon neutral’.”[115]

As it relates to other material sources, as trees grow, they sequester carbon. Upon combustion, that carbon is released into the atmosphere in the form of carbon dioxide. This CO2 release, commonly referred to as biogenic CO2, results in emissions related to the natural carbon cycle. Fossil fuel combustion, burning of coal or natural gas or petroleum, is referred to as non-biogenic CO2 – in other words, carbon that has been locked up in the ground for millions of years.[116] These two cycles are distinguished by the Intergovernmental Panel on Climate Change as the fast domain (atmospheric, oceanic, vegetative, and soil carbon transfer) and the slow domain, where turnover times exceed 10,000 years. Fossil fuel combustion moves carbon from the slow domain to the fast domain, while biomass energy maintains carbon equilibrium within the fast domain.[117]

A primary concern of forest biomass critics is that in order to meet the feedstock needs of biomass facilities, large, old growth forests that sequester the most carbon will be at greatest risk of being ‘clear cut,’ resulting in carbon-positive activity that increases carbon in the atmosphere.[118] However, the California Environmental Quality Act (CEQA) and the Z’Berg-Nejedly Forest Practice Act of 1973, codified as Sections 4511-4630.2 of the Public Resources Code[119], still apply to feedstock harvested on public land for biomass utilization.[120] Because of this, clearcutting and other unsustainable forestry practices would not occur as a means of providing feedstock to biomass facilities. Current BioRAM feedstock regulations also explicitly prohibit clear-cutting practices as a means of garnering fuel, requiring that at least 80 percent of the feedstock of a BioRAM facility be a byproduct of sustainable forestry management and is not from lands that have been clear cut.[121]

CONCERN: Biomass combustion is dirtier than coal.

The overall emissions factor for biomass per unit of energy is less than that of various coal types: 195 lbs of carbon dioxide per million British Thermal units for biomass, while coal ranges from 205.2-217.0 lbs/MMBtu.[122] That being said, when discussing how ‘dirty’ an energy source is, particulate matter, criteria air pollutants, and hazardous air pollutants are typically the culprits in question.

Coal powered electricity plants account for 86% of NOx emissions and 83% of fine particulate emissions within the United States’ power sector.[123] In 2011, coal generated 43.5% of electricity in the power sector, while biomass and other renewable energy sources like geothermal, wind, solar, and waste generated 4.2%. In contrast, coal was responsible for 97.7% of sulfur dioxide, 85.7% of NOx, 83% of PM2.5, and 86.3% of PM10. The only biomass emissions that even registered on the scale were less than 1% for PM2.5 (0.9%), PM10 (0.9%) and NOx (0.5%).[124] Pollution capture has also improved dramatically at biomass plants over the last decade given technology advancements. As demonstrated earlier, in ARP’s Loyalton facility, combustion is controlled via the amount of air allowed into the combustion chamber, resulting in high burning temperatures. The emissions go through a dust collector, char section remover, and then a fan with an electrostatic precipitator – this means that 98% of the produced particulate matter goes into an ash bunker and is sold as an agricultural product for soil enrichment.[125]

A benefit of biomass energy is that combustion is controlled and subject to air quality controls, whereas pile burning and large, damaging wildfires that have become bigger and more devastating throughout the state in past years can emit massive amounts of greenhouse gases and particulate emissions in a very short period of time. For example, it’s estimated the 2018 Camp Fire in California’s Butte County released 3.6 million metric tons of CO2 - slightly more than the total amount of CO2 emitted by California’s private transportation sector in a week.[126] Widely considered the largest wildfire in Sierra history, the 2013 Rim Fire released 11.4 million metric tons of CO2, equivalent to almost three times the emissions emitted by the City of San Francisco over the course of a year.[127]

Not only do large intense wildfires fueled by overcrowded forests endanger human life and release dangerous pollutants on a massive scale, they can also reduce the overall carbon storage capacity of a forest, resulting in long-term degeneration of carbon sequestration capacity.[128] Studies conducted within the state of California point out that untreated and overcrowded forests burning at high intensity actually shift the forest from becoming a net carbon sink to a net carbon emitter.[129] This is due to the fact that exceptionally dense forests can fuel higher-temperature fires, which in turn kill larger trees that store the most carbon, and convert previously forested landscapes into grassland and brush.

The effects of the wildfire are then multiplied – not only are large growth, carbon-storing trees killed, the returning landscape stores about 10% of what a restored forest landscape would have been able to sequester.[130]

If forests are managed properly and extra biomass is removed, a biomass energy facility can create a market for the biomass that is considered unmarketable for commercial timber operations, which typically includes brush, insect-damaged timber, and small diameter trees that would otherwise be left to rot or burn in the forest.

CONCERN: Biomass is an expensive method of generating electricity, and unnecessary when we have other renewable energy generation, including solar, wind, and hydroelectric.

Pricing of electricity, especially renewables, is a complex challenge in the face of a changing legislative landscape that varies wildly in terms of tax credits, incentives, and other financial subsidies. The U.S. Energy Information Administration, an independent federal agency that focuses on the analysis and distribution of information to inform policymaking, cites two measures as the most accurate for determining energy cost: Levelized Cost of Electricity (LCOE) and Levelized Avoided Cost (LACE).[131] Levelized Cost of Electricity is a convenient summary metric of the overall competitiveness of different generating technologies and is listed as the per-megawatt hour cost of building and operating a generation plant over an assumed operating life. This metric takes current (2018) subsidies, tax credits and incentives into account. Levelized Avoided Cost is far more complex to calculate – it examines the cost of generating electricity without a new generation project. For example, this calculation can be used to examine the money-saving potential of a renewable installation that is designed to replace a fossil fuel generation project. There are a number of cost recovery period assumptions and weighted capital costs that go into these calculations, and can be explored in further detail here [eia.gov]. Below are the LCOE values for various forms of fossil fuel and renewable energy, expressed in 2017 dollars per megawatthour ($/MWh).[132]

Plant Type	Total LCOE (incl. tax credits)
Conventional Natural Gas (combined cycle)	50.1
Wind (onshore)	48.0
Wind (offshore)	117.1
Solar	49.9
Hydroelectric	61.7
Biomass	95.3

At first glance, biomass would appear to be more expensive than onshore wind, solar, and hydroelectric. However, there remains the important distinction between dispatchable and non-dispatchable technologies. Dispatchable technologies can be incorporated into the grid as needed, whereas technologies such as wind, solar, and hydroelectric, are considered non-dispatchable technologies due to their intermittent generation nature.[133] Wind and solar are fully dependent on the weather to operate, while hydroelectric can vary based on seasonal water flows and reservoir capacities. Biomass energy is a dispatchable technology, which means it can rise to the occasion as a baseload generation source, similar to how fossil fuels, such as natural gas, operate currently. The only other renewable that comes close to biomass as a likely competitor is geothermal, which has yet to be brought widely into the fold.

CONCERN: Biomass does not create a significant number of jobs.

Across the Sierra there are a number of towns like North Fork and Loyalton that experienced major economic hardships upon the closing of timber mills that previously supported a thriving community. Loyalton's mill reduced operations in 2000 and shut down completely in 2010, laying off workers at an alarming rate in a town that had only 853 residents in the 2000 census.[134,135] The mill reopened in 2018 under the ownership of American Renewable Power, adding 21 jobs back into the small town. In being re-branded as the Resource Regen Campus, the 212-acre site is aiming to bring in other green tech and added-value wood product companies, promising access to low-cost heat and steam, a gigabit fiber connection, and access to sewer-wastewater discharge infrastructure, ideal for light and heavy manufacturing activities in a town originally built upon and now sorely in need of industry.

Biomass also offers a sustainable economic mechanism for funding forestry and natural resource management jobs, outside of the recreation economy. In counties like Sierra County where Loyalton is located and where 65% of forested land is owned by the federal government, demand by a biomass facility for small-diameter wood and brush can provide a financing mechanism for encouraging sustainable forest thinning, which results in wildfire mitigation, healthier watersheds, and the creation of supply-chain management jobs. A thriving biomass industry can employ forestry workers, truck drivers, and plant operators. This can in turn help towns like Loyalton revive their grocery store, bank, and other markers of a flourishing community.

The claim that 21 jobs is not 'significant' to a population of less than 800 people is a special type of privilege.

Forestry and clean power jobs are significantly higher paying and more reliable as long-term employment, especially when compared to the recreation and hospitality sector jobs that have replaced many of the viable jobs in natural-resource dependent communities through the Sierra.

APPENDIX A - Bioenergy Utilization in The Sierra: Emission Comparison

A century of fire suppression, a five-year drought, and over 147 million dead or dying trees have created overcrowded and unhealthy forests that are susceptible to catastrophic wildfire. In the Sierra Nevada region, five separate wildfires between 2013 and 2019 have burned 100,000 acres or more with unusually large swaths of land burning at high severity[136.] These fires generate extremely high amounts of greenhouse gas (GHG) and particulate emissions. For example, CO2e emissions from the 2013 Rim Fire in Tuolumne County were equivalent to the annual emissions of 2.57 million vehicles[137.]

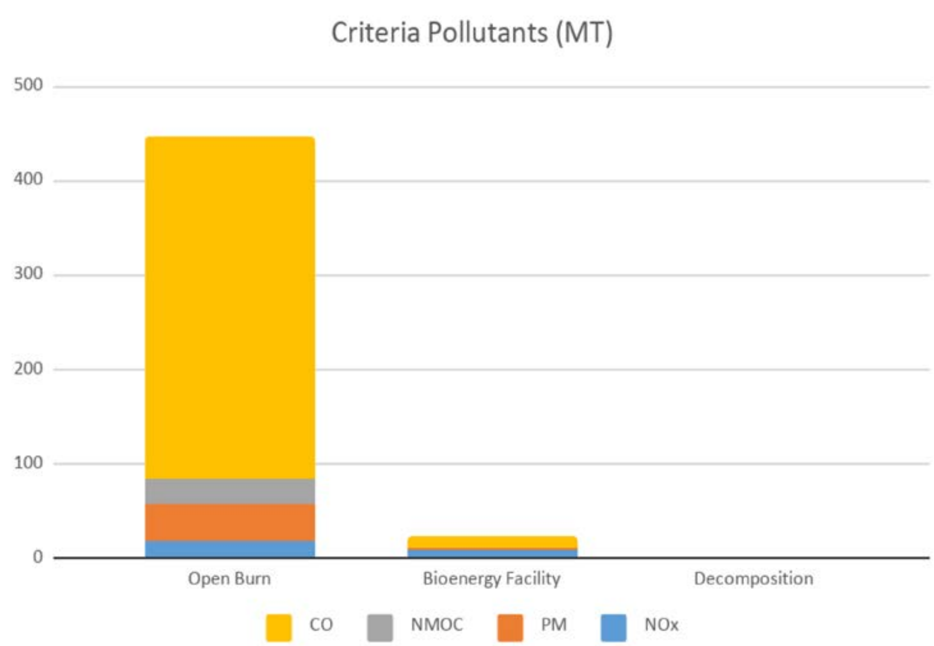
Removing overstocked fuel from California forests is essential to protecting public safety, reducing GHG and particulate emissions, improving forest health and habitat, and reversing the troubling trend of Sierra forests acting as a net carbon source, rather than a net carbon sink.

Three scenarios exist for removing excess biomass (thinned materials):

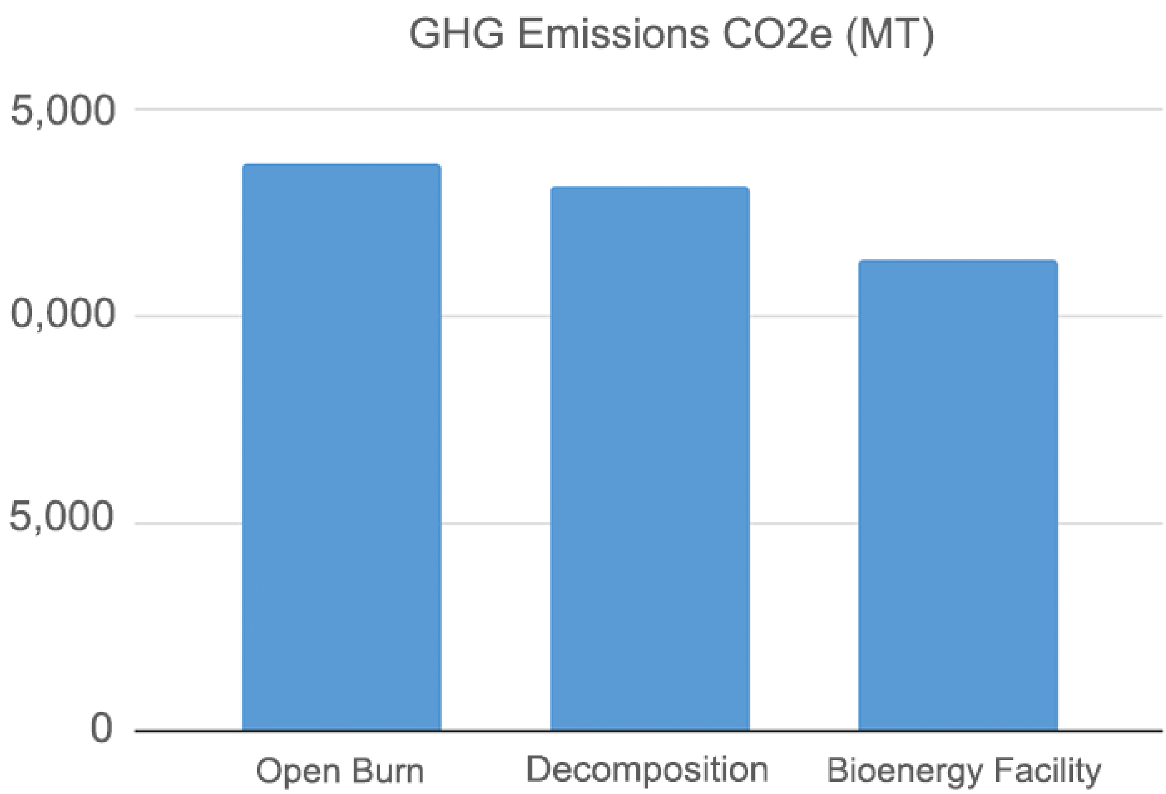
1. Fire (wildfire, prescribed fire, or pile burning)
2. Removal (excess biomass is used for energy production, commercial timber, or other wood products)
3. Decomposition (either naturally or by chipping on-site)

The purpose of this handout is to provide an overview of the emissions associated with each scenario using pile burning for the “fire” scenario, bioenergy as the “removal” scenario, and decomposition of chipped material for the “decomposition” scenario.

A 2011 third-party peer-reviewed study[138] compared criteria air pollutant emissions from transport and utilization of 6,096 bone-dry metric tons of mixed conifer slash in the Sierra Nevada in a bioenergy facility compared with pile burning the same amount of slash. Decomposition emissions in this scenario are solely from chipping and were not investigated as part of the above-referenced study. Here are the findings:



The chart below shows the GHG emissions (CO2e) for each scenario. The bioenergy facility scenario includes emissions from processing, transporting, and burning biomass for energy. The decomposition scenario includes GHG emissions from processing biomass and then leaving it to decay. The amount of GHG emissions from fossil fuel combustion that would otherwise be displaced by the bioenergy facility are included in the totals for open burning and decomposition scenario.



Data used for open burn and bioenergy facility emissions calculations sourced from: Bruce Springsteen , Tom Christofk , Steve Eubanks , Tad Mason , Chris Clavin & Brett Storey (2011) Emission Reductions from Woody Biomass Waste for Energy as an Alternative to Open Burning, Journal of the Air & Waste Management Association, 61:1, 63-68, DOI: 10.3155/1047-3289.61.1.63
Decomposition emission factor sourced from: Placer County Air Pollution Control District. (2013). *Biomass Waste for Energy Project Reporting Protocol*. Retrieved from https://www.placer.ca.gov/DocumentCenter/View/2100/01-2013-Biomass-Waste-for-Energy-Project-Reporting-Protocol-PDF

Bioenergy facilities capture co-benefits not realized through open burning and decomposition, including:

- Baseload, year-round renewable energy generation
- Reliable energy generation during disaster events when connection to transmission lines is impossible
- Economic development and private investment in rural areas
- Job creation
- Reducing wildfire risk in nearby communities
- Local tax revenue

Of the three options for excess biomass, utilization in a bioenergy facility is the most beneficial because it is controlled, captures important co-benefits, significantly reduces criteria pollutants compared with open burning, and is comparable with decomposition in CO2e emissions. In addition, a thriving Sierra bioenergy industry will help offset the cost of forest restoration which decreases wildfire risk. Emissions from bioenergy facilities are more predictable and lower than wildfire, open-pile burning, or decomposition.

APPENDIX B – BioRAM Plants & Operating Biomass Facilities

Forest Service | Berkeley UNIVERSITY OF CALIFORNIA

Scan the QR code to view an interactive version of this map at http://tinyurl.com/qdlbqk6

CALIFORNIA BIORAM & BIOMAT FACILITIES
SUITABLE NATIONAL FOREST SYSTEM (NFS) LANDS

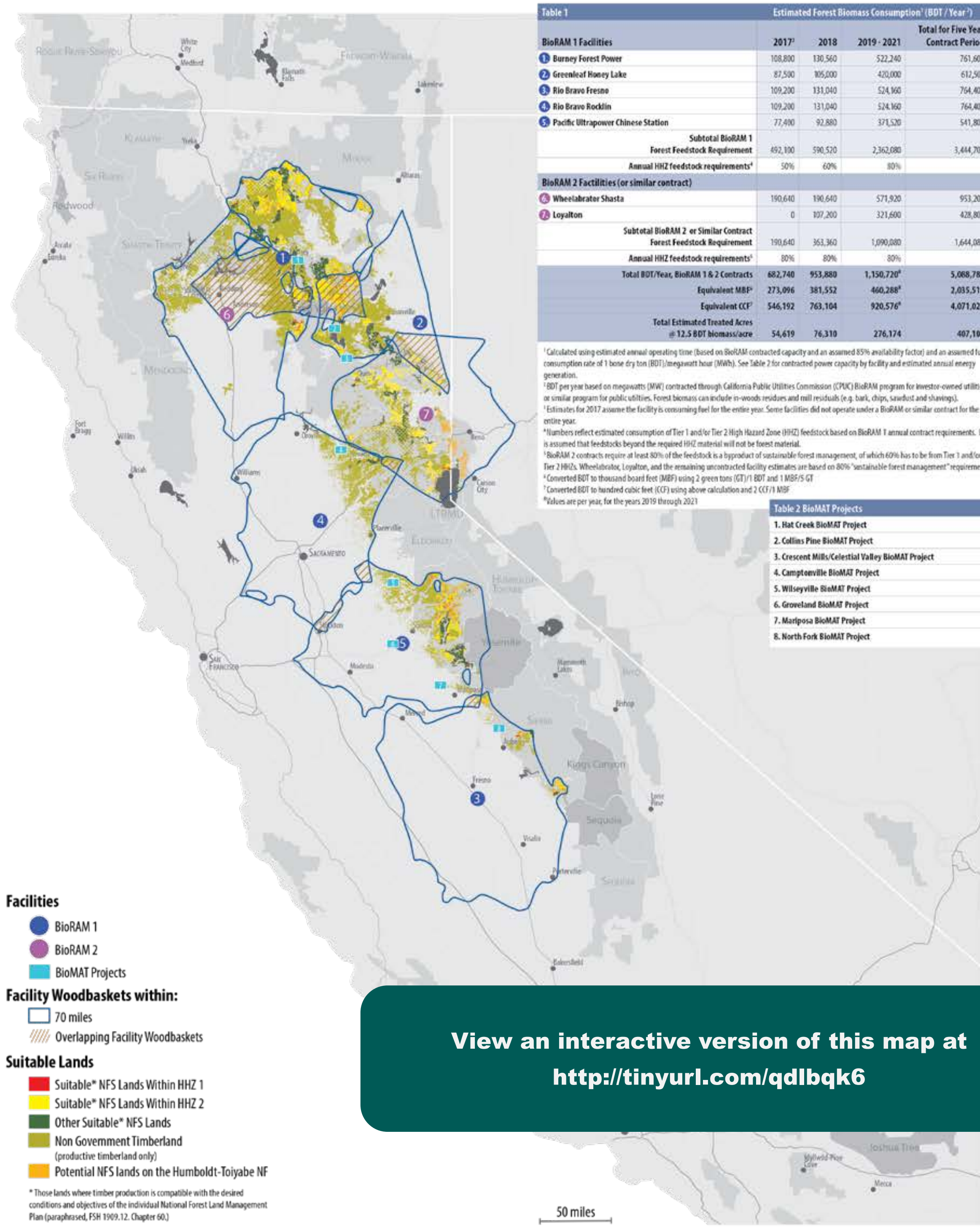


Table 1 — Estimated Forest Biomass Consumption[1] (BDT / Year[2])

BioRAM 1 Facilities	2017[3]	2018	2019 - 2021	Total for Five Year Contract Period
1 Burney Forest Power	108,800	130,560	522,240	761,600
2 Greenleaf Honey Lake	87,500	105,000	420,000	612,500
3 Rio Bravo Fresno	109,200	131,040	524,160	764,400
4 Rio Bravo Rocklin	109,200	131,040	524,160	764,400
5 Pacific Ultrapower Chinese Station	77,400	92,880	371,520	541,800
Subtotal BioRAM 1 Forest Feedstock Requirement	492,100	590,520	2,362,080	3,444,700
Annual HHZ feedstock requirements[4]	50%	60%	80%	
BioRAM 2 Factilities (or similar contract)				
6 Wheelabrater Shasta	190,640	190,640	571,920	953,200
7 Loyalton	0	107,200	321,600	428,800
Subtotal BioRAM 2 or Similar Contract Forest Feedstock Requirement	190,640	363,360	1,090,080	1,644,080
Annual HHZ feedstock requirements[5]	80%	80%	80%	
Total BDT/Year, BioRAM 1 & 2 Contracts	**682,740**	**953,880**	**1,150,720[8]**	**5,088,780**
Equivalent MBF[6]	**273,096**	**381,552**	**460,288[8]**	**2,035,512**
Equivalent CCF[7]	**546,192**	**763,104**	**920,576[8]**	**4,071,024**
Total Estimated Treated Acres @ 12.5 BDT biomass/acre	**54,619**	**76,310**	**276,174**	**407,102**

[1] Calculated using estimated annual operating time (based on BioRAM contracted capacity and an assumed 85% availability factor) and an assumed fuel consumption rate of 1 bone dry ton (BDT)/megawatt hour (MWh). See Table 2 for contracted power capacity by facility and estimated annual energy generation.
[2] BDT per year based on megawatts (MW) contracted through California Public Utilities Commission (CPUC) BioRAM program for investor-owned utilities or similar program for public utilities. Forest biomass can include in-woods residues and mill residuals (e.g. bark, chips, sawdust and shavings).
[3] Estimates for 2017 assume the facility is consuming fuel for the entire year. Some facilities did not operate under a BioRAM or similar contract for the entire year.
[4] Numbers reflect estimated consumption of Tier 1 and/or Tier 2 High Hazard Zone (HHZ) feedstock based on BioRAM 1 annual contract requirements. It is assumed that feedstocks beyond the required HHZ material will not be forest material.
[5] BioRAM 2 contracts require at least 80% of the feedstock is a byproduct of sustainable forest management, of which 60% has to be from Tier 1 and/or Tier 2 HHZs. Wheelabrator, Loyalton, and the remaining uncontracted facility estimates are based on 80% "sustainable forest management" requirement.
[6] Converted BDT to thousand board feet (MBF) using 2 green tons (GT)/1 BDT and 1 MBF/5 GT
[7] Converted BDT to hundred cubic feet (CCF) using above calculation and 2 CCF/1 MBF
[8] Values are per year, for the years 2019 through 2021

Table 2 BioMAT Projects
1. Hat Creek BioMAT Project
2. Collins Pine BioMAT Project
3. Crescent Mills/Celestial Valley BioMAT Project
4. Camptonville BioMAT Project
5. Wilseyville BioMAT Project
6. Groveland BioMAT Project
7. Mariposa BioMAT Project
8. North Fork BioMAT Project

View an interactive version of this map at http://tinyurl.com/qdlbqk6

APPENDIX C – Different Bioenergy Production Types

A range of biomass-to-energy technologies have been used in industrial and residential scenarios in the United States, most of which are summarized below. While thermal conversion is the primary method for direct energy production, other byproducts can be produced through various technologies such as biofuels and paper manufacturing. Both the United States and California Environmental Protection Agencies and local air quality management districts enforce strict air quality control technologies on waste-to-energy plants, which clean or remove toxic substances or particulate matter before they are exposed to the surrounding environment.

THERMAL CONVERSION | Thermal conversion of biomass to energy makes use of forest slash and green waste that would otherwise be diverted into landfills, burned in open piles, or left to decompose in the forest or field. Almost every biomass facility in the Sierra Nevada uses woody biomass as the plant's primary feedstock. This is due to the ready availability of woody biomass feedstock from nearby fuel mitigation projects, many of which focus on removing small diameter trees and brush from the forest that would otherwise be unmarketable products for the timber industry to dispose of. Research shows that biomass is cost-effective when feedstock is pulled from a 100-mile radius (Sierra Club Biomass Guidelines) - removal of feedstock from beyond that perimeter increases shipping costs and reduces the cost effectiveness of the feedstock.

DIRECT FIRING AND CO-FIRING | In order to be used in a direct-fire or co-firing biomass energy plant, chipped wood matter is dehydrated through a heat-intensive drying process called torrefaction, which reduces the weight of the wood by 20% and makes it more cost-effective to transport. The resulting briquettes can be burned either directly or through co-firing with a fossil fuel such as coal. Direct burning produces steam, which powers a turbine connected to an electricity-producing generator. Many biomass facilities make use of the waste heat from the electricity-generation process to heat buildings or for manufacturing processes. This combined power and heat process (CHP) results in an increase of 80% energy efficiency, up from the traditional 20% efficiency of older biomass facilities.

PYROLYSIS | Pyrolysis is the process of heating biomass to 200° to 300° C (390° to 570° F) while excluding oxygen from the heating chamber. Without oxygen, the biomass does not combust, and is instead chemically altered into the byproducts pyrolysis oil, syngas, and biochar. All of these can be used for energy. Biochar has additional useful applications in agriculture, including soil nutrient enrichment and carbon sequestration.

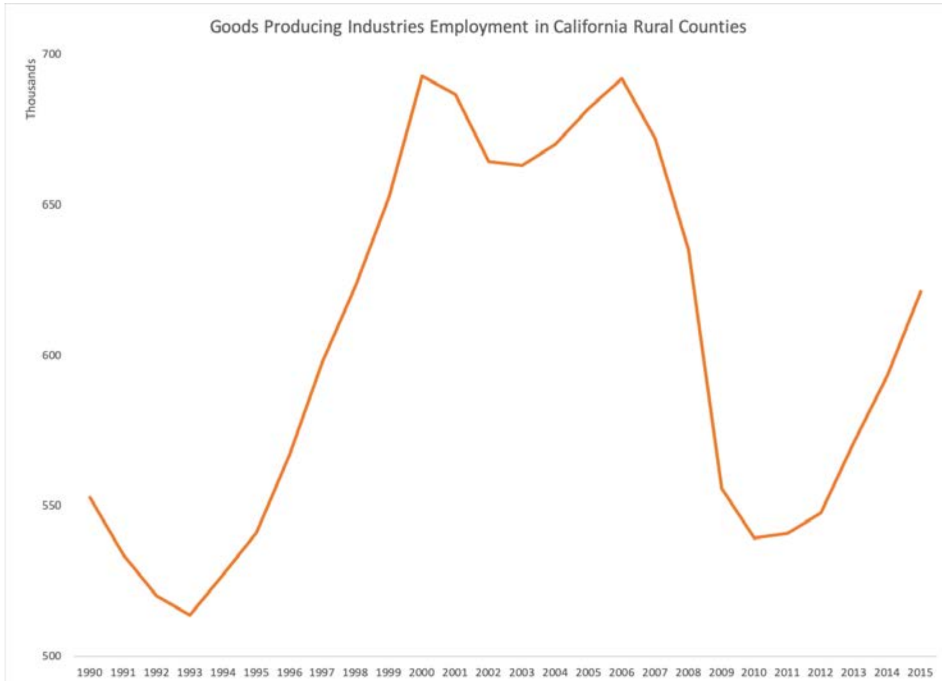
GASIFICATION | During gasification, biomass is heated to more than 700° C (1,300° F) with some controlled oxygen. The byproducts of this process are syngas and slag. Slag is a liquid substance that can be hardened into shingles, cement, or asphalt.

ANAEROBIC DECOMPOSITION | Anaerobic decomposition is the process of bacteria breaking down organic matter without exposure to oxygen, which naturally occurs in landfills. It can also be implemented in a controlled environment, and is sometimes used on ranches and livestock farms using livestock waste. The main byproduct of this process is methane, which can also be used for energy.

APPENDIX D – Organizations Active in California Biomass

NAME	MISSION	WEBSITE
The Bioenergy Association of California (BAC)	BAC was established in 2013 to promote sustainable bioenergy development. Members include private companies, public agencies, local governments, investors, consultants, nonprofits, individuals and others interested in promoting community-scale bioenergy generation. BAC focuses on policy advocacy, public education and outreach, research, and industry best practices.	http://www.bioenergyca.org/
RFS Power Coalition	RFS Power Coalition is a group of biomass energy providers and stakeholders who are protesting the failure of the federal Environmental Protection Agency to process electricity-generating biomass applications under the Renewable Fuels Standard of 2007.	Rfspower.com
CA Forest Biomass Working Group	The ad-hoc California Forest Biomass Working Group (CA Forest BWG) is composed of a variety of forest biomass utilization interests across California. They meet to discuss wood energy policy, project opportunities and barriers, technology progress, funding opportunities and other relevant topics.	https://ucanr.edu/sites/swet/Biomass_Working_Group/
Calforests – California Forestry Association	The California Forestry Association (Calforests) is the statewide trade association that consists of forest owners, forest products producers and forestry professionals committed to sustainable forestry and responsible stewardship of our renewable natural resources through environmentally sound policies and conservation practices. The forest sector is a significant contributor to our state's environmental and economic well-being.	http://calforests.org/
Alpine Biomass Collaborative	The Alpine Biomass Committee (ABC) is a new collaborative formed in June 2016 that is focused on unifying partners, promoting forest and watershed health and supporting sustainable economic development throughout Alpine County. 95% of the county is federal land, including four National Forests (Stanislaus, Humboldt-Toiyabe, El Dorado and Lake Tahoe Basin Management Unit).	https://alpinebiomass-committee.wordpress.com
California Biomass Energy Alliance (CBEA)	The California Biomass Energy Alliance was created almost 20 years ago with a charter to promote biomass energy as a means to reach the environmental and economic goals of California. On behalf of its members, we have worked tirelessly as the sole advocate of the solid fuel biomass power industry through California's energy crisis, the introduction and implementation of renewable standard and waste reduction mandates though to today's carbon constrained proceedings ruled by AB 32's greenhouse gas emissions reduction requirements.	http://www.calbiomass.org/

APPENDIX E – Conversion of High Paying Manufacturing Jobs to Tourism-Based Jobs in Rural California Counties



APPENDIX F - Glossary of Terms

ADDED VALUE WOOD PRODUCTS: these can include engineered mass timber and wood-based composite panel products used in building construction, retrofits, and remodeling, wood processed for use in other industries and applications, including wood cellulosic nanotechnology applications and biochar (charcoal made for uses other than fuel, such as soil amendments and filtration)

BIOMASS UTILIZATION: the use of residual solid material generated by various agricultural or forest activities to create value-added products, such as biomass energy.

BIOMASS: excess biological material that can be used for energy production, heat production, or as raw material for industrial processes or value-added product manufacturing

CARBON LIFE CYCLE ANALYSIS: Under the Environmental Protection Agency's Renewable Fuel Standard, a carbon life cycle, sometimes referred to as fuel cycle or well-to-wheel analysis, is used to assess the overall greenhouse gas (GHG) impacts of a fuel, including each stage of its production and use[139]

CO-BENEFITS (ALSO KNOWN AS NON-MARKET VALUES): positive effects that arise indirectly from strategies directed at solving one specific problem.[140] For example, forest management efforts have an end goal of reducing wildfire hazard and improving forest health, but indirect positive outcomes from these efforts can include job creation, improved recreation access, and energy production from forest waste.

CO2E: Carbon dioxide equivalent or CO2e means the number of metric tons of CO2 emissions with the same global warming potential as one metric ton of another greenhouse gas, as defined by the U.S. Environmental Protection Agency

ECOLOGICAL FORESTRY: a combination of strategic thinning, prescribed fire, and managed wildfire

ECOLOGICALLY RESILIENT FORESTS: majority tree-covered landscapes, actively maintained so they are less prone to large, severe wildfires and drought and to decrease likelihood of large tree mortality events from insect and disease outbreaks, especially in the face of climate change

ENGINEERED WOOD OR MASS TIMBER: structural components that have been fabricated. Engineered wood is manufactured by bonding together wood strands, veneers, lumber or other forms of wood fiber to produce a larger and integral composite unit that is stronger and stiffer than the sum of its parts.[141]

FOREST BIOMASS ENERGY: the renewable energy generated from processing forest biomass

FOREST BIOMASS: excess material removed from forested areas (for the purposes of this paper, forest biomass refers to montane and subalpine forests characterized by a majority of coniferous tree types)

FOREST MANAGEMENT: the process of planning and implementing practices for the stewardship and use of forests and other wooded land to meet specific environmental, economic, social, and cultural objectives.[142]

GREENHOUSE GASES: gases such as carbon dioxide, methane, nitrous oxide, and fluorinated gases, that trap heat in the Earth's atmosphere and cause climate change.[143]

HAZARD VS. RISK: "Hazard" is based on the physical conditions that give a likelihood that an area will burn over a 30 to 50-year period without considering modifications such as fuel reduction efforts. "Risk" is the potential damage a fire can do to the area under existing conditions, including any modifications such as defensible space, irrigation and sprinklers, and ignition resistant building construction which can reduce fire risk. Risk considers the susceptibility of what is being protected.[144]

HIGH HAZARD ZONES: High hazard zones are areas of the state representing a high risk for wildfire and falling trees, resulting from severe drought conditions and bark beetle infestation. As of March 1, 2019, Tier 2 High Hazard Zones have been revised to include the perimeter of any wildland fire since 2012 (the beginning of the drought). The High Hazard Zone definitions are:

> Tier 1 High Hazard Zones are areas where tree mortality, caused by drought, coincides with critical infrastructure, including but not limited to roads, utilities, and public schools. They represent a direct threat to public safety and identify areas to be prioritized for hazardous tree removal. These zones are identified pursuant to the Governor's State of Emergency Executive Order in 2015.
>
> Tier 2 High Hazard Zones are areas defined by: 1) watersheds (HUC12, average 24,000 acres) that have significant tree mortality combined with community and natural resource assets; or 2) the perimeter of any wildland fire since 2012 (the beginning of the drought). Work at the Tier 2 level addresses the immediate threat of falling trees and fire risk, and supports broader forest health and landscape level fire planning issues. They represent areas to be prioritized for hazard mitigation as well as forest health restoration. These zones are identified pursuant to the Governor's State of Emergency Executive Order in 2015.
> *Definitions courtesy of California's Tree Mortality Task Force.*

PRESCRIBED BURNS: a forest management tactic where a forest management agency (state or federal) deliberately ignites a predetermined area of forest with low intensity and monitored fire to control ladder fuel growth. Prescribed fire is a fire that has been deliberately set, while a controlled burn is an unintentionally caused fire that is allowed to burn within the parameters determined by forest managers and fire protection personnel.

RENEWABLE ENERGY: Renewable energy is energy from sources that are naturally replenishing but flow-limited; renewable resources are virtually inexhaustible in duration but limited in the amount of energy that is available per unit of time.[145]

SMALL-DIAMETER TREES: The USDA Forest Service in conjunction with the Forest Products Laboratory loosely defines 'small diameter and underutilized (SDU) material' as timber that is left in the forest because it is not economical to remove. Depending on the tree species and varying characteristics of the timber, 'small diameter' can range anywhere from 4 to 16 inches DBH (diameter at breast height). Small diameter and underutilized (SDU) material also include the dense understory in forests that serves as ladder fuel and contributes to crown fires.[146]

STRUCTURALLY DISENFRANCHISED COMMUNITIES: primarily know to California law as 'disadvantaged communities' or 'DACs', these are areas throughout California which most suffer from a combination of economic, health, and environmental burdens. These burdens include poverty, high unemployment, air and water pollution, presence of hazardous wastes as well as high incidence of asthma and heart disease. The term 'structurally disenfranchised' recognizes the agency that these communities have to improve their outlooks, without shame.

THINNING: the removal of forest overgrowth from a stand of trees to reduce competition, reduce wildfire risk, and maintain a healthy forest. Mechanical thinning is done by large harvesting machines, while hand thinning is done by people, either with power tools or hand tools. It is the opposite of the timber industry's tactic of high-grading – removing large circumference, high value trees and leaving smaller diameter trees.[147]

WILDLAND URBAN INTERFACE (WUI): the area where houses meet or intermingle with undeveloped wildland vegetation. The WUI is a focal area for human-environment conflicts, such as the destruction of homes by wildfires, habitat fragmentation, and biodiversity decline.[148]

APPENDIX G - Levelized Cost of Electricity Methodology

This appendix is a summary of the methodology used by the U.S. Energy Information Administration to calculate the Levelized Cost of Electricity, and the Levelized Avoided Cost of New Generation Resources. For a complete analysis, and data set for 2018, please refer to U.S. EIA 2018 Report, titled Levelized Cost and Levelized Avoided Cost of New Generation Resources in the Annual Energy Outlook 2018. It can be found online at:
https://www.eia.gov/outlooks/archive/aeo18/pdf/electricity_generation.pdf
If this link is not functioning, please contact Sierra Business Council at 530.582.4800 for a digital copy of the report.

LEVELIZED COST OF ELECTRICITY (LCOE)

Levelized cost of electricity (LCOE) is often cited as a convenient summary measure of the overall competiveness of different generating technologies. It represents the per-megawatthour cost (in discounted real dollars) of building and operating a generating plant over an assumed financial life and duty cycle. Key inputs to calculating LCOE include capital costs, fuel costs, fixed and variable operations and maintenance (O&M) costs, financing costs, and an assumed utilization rate for each plant type. The importance of these factors varies among the technologies. For technologies such as solar and wind generation that have no fuel costs and relatively small variable O&M costs, LCOE changes in rough proportion to the estimated capital cost of generation capacity. For technologies with significant fuel cost, both fuel cost and overnight cost estimates significantly affect LCOE. The availability of various incentives, including state or federal tax credits, can also affect the calculation of LCOE. As with any projection, there is uncertainty about all of these factors, and their values can vary regionally and temporally as technologies evolve and as fuel prices change.

LEVELIZED AVOIDED COST OF ELECTRICITY (LACE)

Conceptually, an alternative assessment of economic competitiveness between generation technologies can be gained by considering the avoided cost, a measure of what it would cost the grid to generate the electricity that would be displaced by a new generation project. Avoided cost, which provides a proxy measure for the annual economic value of a candidate project, may be summed over its financial life and converted to a level annualized value that is divided by average annual output of the project to develop its levelized avoided cost of electricity (LACE). The LACE value may then be compared with the LCOE value to provide an indication of whether or not the project's value exceeds its cost when multiple technologies are available to meet load. Using both the LCOE and LACE in combination provides a better assessment of economic competitiveness than either measure separately.

ENDNOTES

1 (Gomes and McLean 2019) It's important to note that this figure does not include fire-killed trees – as of publishing date, there does not exist a comprehensive data set on fire-induced tree mortality for the state.

2 (Forest Climate Action Team 2018)

3 (Lin, Should California buy disaster insurance? 2019)

4 National Interagency Fire Center 2019)

5 (Gudel 2019)

6 Prescribed fire is a fire that has been deliberately set, while a controlled burn is an unintentionally caused fire that is allowed to burn within the parameters determined by forest managers and fire protection personnel.

7 Thinning is the removal of forest overgrowth from a stand of trees to reduce competition, reduce wildfire risk, and maintain a healthy forest. Mechanical thinning is done by large harvesting machines, while hand thinning is done by people, either with power tools or hand tools. It is the opposite of the timber industry's tactic of high-grading – removing large circumference, high value trees and leaving smaller diameter trees. (Tang, et al. 2005)

8 (Morris 2000)

9 The federal Public Utilities Regulatory Policy Act (PURPA) was passed in 1978 and mandated that electric utility companies buy privately produced power at their "avoided cost" of generation. The combination of high avoided cost rates relative to other energy sources and federal investment in renewable energy helped the biomass industry grow in California to meet the state's growing demand. (Morris 2000)

10 (Morris 2000)

11 (California Energy Commission 2017)

12 It is a common misconception that cross-laminated timber or oriented strand board require larger diameter trees. CLT in Canada and Europe is manufactured primarily using small diameter timber, and North American manufacturing processes are following suit as the material gains popularity. (Mohammad, et al. 2012)

13 (The Nature Conservancy 2019)

14 The USDA Forest Service in conjunction with the Forest Products Laboratory loosely defines 'small diameter and underutilized (SDU) material' as timber that is left in the forest because it is not economical to remove. Depending on the tree species and varying characteristics of the timber, 'small diameter' can range anywhere from 4 to 16 inches DBH (diameter at breast height). Small diameter and underutilized (SDU) material also include the dense understory in forests that serves as ladder fuel and contributes to crown fires. Small diameter is intended, in this context, to refer to timber and biomass materials where the cost of removal from the forest falls below market value and is therefore not cost effective. (USDA Forest Service, Forest Products Laboratory 2001)

15 (TSS Consultants 2014)

16 (Storey 2011)

17 (TSS Consultants 2008)

18 (California Energy Commission 2017)

19 (Sierra Nevada Conservancy 2019)

20 (US Department of Agriculture California Climate Hub 2017)

21 Forest Climate Action Team 2018)

22 (Dore, et al. 2012)

23 (Sierra Nevada Conservancy 2019)

24 (Forest Climate Action Team 2018)

25 (Sleeter, et al. 2019)

26 (National Science Foundation 2018)

27 (Sierra Nevada Conservancy 2019)

28 (California Air Resources Board 2019)

29 (Lalonde, et al. 2018), (Sleeter, et al. 2019)

30 (Forest Climate Action Team 2018)

31 (Tompkins 2020)

32 (Fuller 2018)

33 BioRAM stands for the Biofuel Renewable Auction Mechanism program of the state of California, an extension of the Renewable Auction Mechanism program. Participating utilities use the program to procure renewable energy (including bioenergy) from eligible facilities in order to meet their state-mandated renewable portfolio standards.

34 (Mason, Bruce & Girard, Inc., The Beck Group June 13, 2019)

35 (Mason, Bruce & Girard, Inc., The Beck Group June 13, 2019)

36 Calculation assumes 8,500 BDT per 1 MWh, and 1 MWh = 1,000 households, average of 3 people per household. 42 million BDT in inventory over 20 years / 8,500 BDT = 4,941 MWh (approx.) * 1,000 households = 4,941,176 households over 20 years. 4,941,176 households / 20 years = 247,058 households per year x 3 people per average household = 741,176 people, roughly the population of the city of San Francisco (Stokes (USDA), Deneke (USDA) and Stewart (Department of Interior) 2004). This claim is purely for illustrative purposes to highlight the sheer amount of available biomass even after commercial timber harvesting operations and sustainable harvesting practices are accounted for, and should not be viewed as a claim of sustained biomass energy production over time. Calculations have also not been adjusted for future climate change impacts, which could drastically increase tree mortality.

37 (De Lasaux and Kocher 2006)

38 Cost ranges estimated and aggregated across several sources, normalized in terms of 2020 US dollars based on inflation rates. (Tompkins 2020) (Hartsough, et al. 2008) (Steve Holl Consulting 2007)

39 (Steve Holl Consulting 2007)

40 Sawlogs harvested on federal land cannot exceed 30" in diameter at breast height. Typically, merchantable sawlogs would include timber ranging from 10 or 11 inches in diameter at breast height up to 30" dbh. Any material under that 10" or 11" dbh minimum could be chipped and transported to a biomass facility, where prices are calculated per bone dry ton or green ton, depending on fuel moisture content. (Tompkins 2020) (Turner 2019)

41 (Ehlers 2018) – Fiscal year 2017-18 CalFIRE was appropriated $195 million in Greenhouse Gas Reduction Funds (GGRF) for forest health and fire prevention activities, as well as $20 million for the agency's Urban and Community Forestry Program. $91.5 million of that $195 million was earmarked specifically for forest health, with the remainder dedicated to fire prevention. The same year, California Conservation Corps was granted $5 million for forest health and urban forestry activities. Upon issuing an RFP for forestry management grants, CalFIRE received 72 project applications, totaling $330 million worth of forestry work, for a grant program that had just $91.5 million worth of funding.

42 Non-federal land only at 500,000 acres per year (recommended by the Forest Carbon Plan). This estimate was provided by CalFIRE and is an aspirational goal based on the consideration of ecological need and predictions of capacity to implement treatments. This acreage is currently more than what CalFIRE considers operationally feasible and should be considered a target to work toward. It is considered achievable pending increased resources and expanded markets for woody materials. (Forest Climate Action Team 2018, 3) Costs are averaged over primary methods of treatment on the low end and high end of ranges, all in 2020 USD. Average costs per acre are calculated by treatment methods (mastication plus prescribed fire, hand thinning plus pile burn, and chip/harvest plus haul). These numbers are primarily for illustrative purposes in the Sierra Nevada – prices per acre of treatment vary broadly based on topography, labor prices, operator availability, and available technologies. These price estimates do not include offsets from timber sales of sawlogs and biomass chip sales. (Tompkins 2020) (Steve Holl Consulting 2007)

43 (Tompkins 2020), (Moghaddas 2020)

44 For more data analysis and sources, please see Appendix E.

45 (Chia-Yun Tsai 2015)

46 Opportunity Zones are designated low-income census tracts that are eligible for tax-incentivized investments made possible through the 2018 U.S. Investing in Opportunities Act. Projects that qualify for investment should encourage growth in these communities and can include a wide range of efforts from creating living wage jobs to building resilient communities.

47 (Turner 2019)

48 (Downing 2015)

49 (Podolak, et al. 2015)

50 (Podolak, et al. 2015)

51 (Cimini 2019)

52 (Turner 2019)

53 It's important to note that these average costs represent levelized cost of energy, which represents the installed capital costs (including construction costs, financing costs, tax credits, and other related taxes or subsidies) converted to a level stream of payments over the plant's assumed financial lifetime. Source: U.S. Energy Information Administration, www.eia.gov (Sukunta 2018)

54 (IRENA 2018)

55 Large Solar Scenario meets a 50% RPS in 2030 by relying mostly on large, utility-scale solar PV resources, in keeping with current procurement trends. (Energy + Environmental Economics 2014, 4)

56 (Energy + Environmental Economics 2014)

57 (Energy + Environmental Economics 2014)

58 (Martinot and Younghein 2015)

59 (Walton 2018)

60 (Williams 2018)

61 (Edmund G. Brown Jr., Governor Brown Declares State of Emergency for the City and County of San Francisco 2013) (Edmund G. Brown Jr., Governor Brown Declares State of Emergency in Tuolumne County 2013)

62 (Miles, Gallagher and Huxford 2013)

63 (Wara 2019)

64 (Jenkins, Luke and Thernstrom 2018)

65 (CalFIRE 2018)

66 (Munich Re 2019)

67 (Butte County Sheriff & Coroner 2019)

68 (Habegger 2019)

69 (Kasler and Sabalow, 'Sticker shock' for California wildfire areas: Insurance rates doubled, policies dropped 2019)

70 (Peterman, et al. 2019)

71 (Kasler and Sabalow, 'Sticker shock' for California wildfire areas: Insurance rates doubled, policies dropped 2019)

72 (Kasler and Sabalow, 'Sticker shock' for California wildfire areas: Insurance rates doubled, policies dropped 2019)

73 (California Fair Access to Insurance Requirements 2015)

74 (Dettinger 2018)

75 (Liang, Hurteau and Westerling 2018)

76 (Bedsworth 2018)

77 (Bedsworth 2018)

78 (Bedsworth 2018)

79 (Reich, et al. 2018)

80 (Bedsworth 2018)

81 (Kasler, Gov. Newsom wants to prevent CA wildfires. But he won't commit funding for 'hardening' homes 2019)

82 (American Forests 2018)

83 For the purposes of this report, the scope will remain focused on biomass energy production in the Sierra Nevada, and not expand on added value wood products, due to the economic and social co-benefits outlined in this report. (SB 859 Wood Products Working Group 2017)

84 SB 859, signed by Governor Jerry Brown and enacted on September 14, 2016, requires that 80% of the feedstock for a BioRAM eligible facility on an annual basis must be a by-product of sustainable forestry management, which includes removal of trees from High Hazard Zones and not from lands that have been clear cut. (Mason, Bruce & Girard, Inc., The Beck Group June 13, 2019)

85 (The Beck Group 2017), pg 2.

86 (Morris 2000)

87 (UC Berkeley Woody Biomass Utilization Group 2019)

88 Operational MW capacity fluctuates with availability of forest biomass and other fuel, so this research paper is not able to determine just how many MW are being generated versus total capacity.

89 (Mason, Bruce & Girard, Inc., The Beck Group June 13, 2019)

90 This is a rough calculation, given the cumulative total MW capacity of all idle and operational biomass facilities in the Sierra Nevada as of August 2019, and does not include proposed projects. The methodology of this calculation hinges on the assumption that forest thinning projects are pulling roughly 12 BDT (bone dry tons) of forest biomass per acre; a figure that can vary widely given tree mortality, watershed health, and tree type and age on a forested acre in the Sierra Nevada. The average value of 12 BDT per treated acre is courtesy of an interview with Jim Turner with American Renewable Power and Loyalton Biomass Power in Sierra County given his treatment experience.

91 (SB 859 Wood Products Working Group 2017)

92 (Sun-Star Staff 2011)

93 (Ardito 2013)

94 (Romero 2019)

95 (California Air Resources Board 2013)

96 (California Air Resources Board 2013)

97 (Turner 2019)

98 (Alexander 2018)

99 (Long, Tarnay and North 2018)

100 (Navarro 2016)

101 (Li 2018)

102 (Long, Tarnay and North 2018)

103 (Long, Tarnay and North 2018)

104 (Bizjak 2019)

105 (Garcia, et al. 2017)

106 (Goodale 2013)

107 (Calfas 2018)

108 (Siler 2018)

109 (CAL FIRE 2007)

110 (Agee and Skinner 2005)

111 (TSS Consultants 2014)

112 (Forest Climate Action Team 2018)

113 (Bracmort 2016), R. Miner, "Biomass Carbon Neutrality in the Context of Forest-based Fuels and Products," U.S. Department of Agriculture (USDA) Bioelectricity and GHG Workshop, Washington, DC, November 15, 2010

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115 (Norton, et al. 2019)

116 (IEA Bioenergy 2019)

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122 (U.S. Environmental Protection Agency 2014)

123 (Massetti, et al. 2017)

124 (Massetti, et al. 2017)

125 (Turner 2019)

126 (Alexander 2018)

127 (Arrington 2018)

128 (Sierra Nevada Conservancy 2019)

129 (Gonzalez, et al. 2015)

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139 (U.S. Environmental Protection Agency 2016)

140 (Smith and Woodward 2014)

141 (Russelburg 2005)

142 (Food and Agriculture Organization of the United Nations 2019)

143 (U.S. Environmental Protection Agency 2019)

144 (Office of the State Fire Marshal 2007)

145 (U.S. Energy Information Administration 2019)

146 (USDA Forest Service, Forest Products Laboratory 2001)

147 (Tang, et al. 2005)

148 (Radeloff, et al. 2005)

149 (Olenyn 2018)

150 (Woodworks 2012)

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ABOUT SIERRA BUSINESS COUNCIL

Sierra Business Council (SBC) is working to secure the environmental, social, and economic health of the Sierra Nevada for this and future generations by implementing projects that model proactive change. SBC advocates on behalf of the Sierra, helps small businesses start, grow, and thrive, and fosters climate resiliency throughout the region. Our goal is a diverse, inventive, and sustainable region where the economy is vibrant, the land is thriving, and the communities offer opportunity for all.

More information on SBC's impact can be found at www.sierrabusiness.org

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