The Sierra Nevada Biomass Project

Framework Proposal for an Efficient Response to the Sierra Nevada Fire Emergency

Offered to:
Sierra County and to the City of Loyalton, California

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Executive Summary

The Sierra Nevada Fire Emergency requires immediate and well-organized action from State, Federal, and private entities to remove the overload of hazardous woodlands fuels. The Emergency is, in the terminology of disaster-response professionals, a Sandbag Problem: additional resources deployed earlier are justified by the damage mitigation they would deliver, however there are strong constraints on the ability of responders to deploy those resources. While much of the involved land is owned and managed by the Federal Government, primarily through the U.S. Forest Service, which bears the costs of fire fighting and post-fire restoration work, the enormous indirect environmental and economic costs of the fires are born by the people of California. The State of California, through the Agencies and Offices of State Government, has the skills and competency to organize and direct an effective response, in cooperation with its Federal and private partners, subject to the constraints of the Sandbag Problem. First, it can expand its ongoing work, now underway through CalFire, Caltrans, and other agencies, to perform and contract for fuels reduction operations in the woodlands under their jurisdiction. Second, it can work with local and regional government and private entities to immediately establish Biomass Repositories across the Sierra Nevada to provide safe storage of waste biomass removed from the Sierra Nevada woodlands to support the expanded fuel treatment operations that are essential to an effective response to the Emergency. Third, it can work with its Federal partners, particularly in the U.S. Forest Service, the Bureau of Land Management, and the Federal Emergency Management Agency, to mobilize the substantial human and business resources of the State, to both expand the levels of fuel reduction operations in the woodlands, and to safely and efficiently dispose of the woody biomass both from ongoing fuels reductions operations and stored in the Repositories as part of the initial Response. A long-run response that involves the development of biomass-fueled generating stations, particularly in cogeneration (Combined Heat and Power) and trigeneration (Combined Cooling, Heat and Power) configurations, is an economically and environmentally efficient contribution to the development of sustainable base-loaded generation in California, that substitutes directly for the CO2-intensive energy that California now imports from coal-fired generation across the Mountain West, and is an ignored but core element of California’s energy future.
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1 Background

In 2014, Sierra County initiated a campaign to engage its fellow Sierra Nevada Counties, and with them the Governor and Government of the State of California, and the Federal Government, as well as other interested individuals and organizations, to respond to the hazardous fuels and fire emergency conditions that exist across the Sierra Nevada woodlands. The severity of the situation is a long-standing issue of deep concern in Sierra County and its surrounding Northern Sierra region. Sierra County’s government expressed this concern by

- Preparing a staff Background Report analyzing the situation[14],
- Proclaiming, by Resolution of the Board of Supervisors, a State of Local Emergency, and Requesting specific relief and action by the Governor[13], and
- Requesting, by Resolution of the Board of Supervisors, supporting Proclamations and Requests by the other Boards of Supervisors of the Sierra Nevada Counties[12].

Sierra County’s action received immediate support both from within the County (see, for example, the endorsement of the Sierra Valley Resource Conservation District[9]), and from its neighbors (for example, the Plumas County Proclamation[8]). Twenty nine Counties have joined in the Campaign that Sierra County has initiated, joining in a Petition to the Governor for relief, leadership and coordination, and the resources of the State in addressing the threat these Sierra Nevada Counties share.

2 Answering the Governor’s Question: What Needs to Be Done?

The Governor[7] has welcomed the Petition of the Counties, responding by requesting information about what needs to be done to effectively Respond to the Sierra Nevada Fuels Emergency.

Sierra County, with others of the Counties, can answer at both the general level and with reference to local and regional conditions.

County Government in general, particularly the rural Sierra Nevada Counties, especially their smallest, lack the resources to answer the Governor’s open-ended Question in anything more than general and localized terms. However, these Answers may give the Governor sufficient direction to move the Campaign forward. At a high level, Sierra and the other Sierra Nevada Counties can offer three Answers:

1. Immediate and longer-term funding is needed (a) to support the immediate Action required to mitigate the immediate risks during the 2015 fire season and to prepare for 2016 and beyond, (b) for maintenance and restoration work in the woods to mitigate the immediate Emergency fuels overload and to manage towards a Healthy Woodlands trajectory, (c)
the planning and coordination work, particularly in local, regional, and State government, supporting broad public and private sector initiative and participation, to develop an effective and efficient Response to the Emergency and to plan and manage towards a Healthy Woodlands trajectory, and (d) to provide for ongoing research and evaluation work to develop knowledge essential to the health and recovery of the Sierra Nevada woodlands (see section 2.1);

2. **A central organization is needed** (a) to efficiently mobilize and apply the specialized resources that are required in both the immediate Emergency response and in the long-term Healthy Woodlands future; (b) to encourage and orchestrate local and regional initiatives, and otherwise (c) to integrate work in the diverse conditions across the Sierra Nevada into an effective and efficient Response to the Emergency and towards a Healthy Woodlands trajectory; and

3. **The Governor’s leadership, authority, and skills are needed** (a) to Declare an Emergency in the Sierra Nevada Counties and thereby to mobilize the Federal, State, and other resources required for an effective Response to that Emergency, (b) to direct, organize, and coordinate the Government and resources of the State of California, in cooperation with its Federal and private partners, to identify, develop and implement a Health Woodlands policy trajectory, and (c) to fully integrate the goals and activities of the Response, both in the near term urgent response and during the development and implementation of Healthy Woodlands policy, into the other goals and activities of the People and Government of California.

These three Answers are consistent with a major effort, led, organized and directed by the Governor, as an important element of the policy of the State of California. Such an effort is consistent with the interests of Sierra County and the other Sierra Nevada Counties, as it is with the broad public interest of the State of California and of the United States Government.

The Campaign for a Response to the Sierra Nevada Fuels Emergency, and for the development and implementation of policy consistent with a Healthy Woodlands trajectory, was initiated in and by Sierra County, and supported by concerted action by the other Sierra Nevada Counties. The Sierra Nevada Region is rich in human as in physical resources, as is the rest of our State of California. The Governor can provide significant leadership and other policy support to promote close integration of the Counties’ Government and private organizations and individuals into the Response, building on the initiative and momentum the Counties have brought to the Campaign.

### 2.1 The Need for Funding

#### 2.1.1 Funding Emergency Action

The Sierra Nevada Fuels Emergency has developed over many years, and will continue to evolve. It is likely, regardless of the actions taken now or soon, to get worse, although early and continuing actions—accelerated well-chosen removal of hazardous fuels from the Sierra Nevada woodlands—reduce the likelihood, intensity, and environmental and economic damage from the fires that are inevitable in the Sierra Nevada woodlands. The situation is, in terms used by emergency management professionals, a complex Sandbag Problem. In funding terms, if one were to deploy society’s resources up to their physical limits to the rational reduction of the fuels hazards in the Sierra Nevada woodlands, the cost of those resources, plus the expected cost of (fighting, damage
from, and restoration following) the inevitable wildfires will be less than the total expected costs of any other program of mitigation actions and resulting fire costs.

During the urgent, Sandbag, phase of emergency response, the focus of emergency management is upon the early deployment of resources to high value activities, on the establishment of control, and on the identification and response to critical constraints and other issues.

A critical resource in any response to the Fuels Emergency is crews with the training and equipment to safely remove fuels from the woodlands, consistent with appropriate environmental policy. There is a substantial pool, sometimes underemployed, of such crews across California, working for a range of public and private organizations including State Agencies, utilities, municipal, county and regional governments, and a wide range of private contractors. Even if one could deploy every crew in California, and beyond, with chainsaws, chippers, and more specialized equipment, to remove to best effect fuels from the Sierra Nevada woodlands, fires will occur in the Sierra Nevada whose costs will exceed the costs of additional fuel treatments, if there were crews available. The availability of crews is a Sandbag constraint. Effective emergency funding and management arrangements support the deployment of the limited crews (and other resources), and compensates those delivering the resources on a cost recovery basis.

The Sierra Nevada Fuels Emergency does not exist in isolation. Above all, the same resources that can respond to the Sierra Nevada Emergency are valuable in other activities, some of them also urgent, such as similar, and similarly urgent, fire-danger mitigation actions in a range of residential/wildlands interface areas outside of the Sierra Nevada, particularly in California’s metropolitan regions. Many of these same resources are also core elements of California’s fire response system, including its share of larger national wildlands fire response. Utilities crews carry, in addition to their ongoing core business responsibilities, a role of the national utilities’ disaster response systems, using common cooperative cost-sharing arrangements.

A1.a The Response to the Sierra Nevada Fuels Emergency needs emergency funding, both to accelerate the removal of hazardous fuels from the Sierra Nevada woodlands, and to support the effective and efficient deployment of Emergency Response resources.

2.1.2 Funding Immediate Fuels Mitigation and Woodlands Maintenance and Recovery

A primary historical reason for the present Emergency conditions in the Sierra Nevada woodlands has been the lack of budgetary support for the maintenance of a landscape regrowing from previous logging and wildfire episodes. These woodlands are in no stable recovery trajectory, but are instead subject to the periodic episodes of catastrophic wildfire, followed by a range of consequences, often very bad. Absent a substantial increase in funding for woodlands maintenance—for, above all, the removal from the woodlands of the Emergency’s excessive concentrations of fuels—the Emergency will worsen, with sometimes dramatic consequences, every year. An effective Response needs, above all, full funding for a trajectory towards sustainable health of the Sierra Nevada woodlands, and for the health, safety, and property of the people living there—the Healthy Woodlands Trajectory.

The Emergency requires a response that, from its Sangbag-Solution initiation, evolves to support a Healthy Woodlands trajectory. Given the substantial Federal ownership of the Sierra Nevada woodlands, this almost certainly requires substantial increases in Federal appropriations to support major increases in fuel treatments, including appropriate planning, environmental protection, and
other associated activities. Noting the current challenges of Federal appropriations policy, the scope, within a Healthy Woodlands trajectory, for shifting the woodlands workforce between commercial timber harvesting and publicly-funded fuel treatment activities makes the longer-term response an excellent location for countercyclical fiscal policy\[3\].

The State of California has a strong interest in the reduction of hazardous fuels, and other work to restore the health of the Sierra Nevada woodlands, in addition to that expressed in (a) its direct existing funding of fuel treatments and other woodlands work on and off land that it manages, and (b) the indirect contribution that California makes to Federal funding of fire-danger reduction on and off Federal land in California. Additional expenditures of California’s public funds are in the broad public interest. It may be possible to tie increased California expenditures to increased Federal expenditures.

A1.b The Response to the Sierra Nevada Fuels Emergency, and management towards a Healthy Woodlands trajectory, needs full funding of deferred and ongoing maintenance of the Sierra Nevada woodlands.

2.1.3 Funding Coordination, Integration, and Initiative

Developing a Response to the Sierra Nevada Fuels Emergency is a complex problem, requiring decision-making under changing circumstances and substantial uncertainty. The need for strong central management is discussed in section 2.2; these coordinating functions need funding. There are substantial technical problems in planning, logistics, woodlands management, workforce development, and other areas whose solutions require reliable funding. Open solicitations, such as Requests for Proposals, can solicit localized expertise and initiative, embodied in Projects, within management structures that support integration with other Projects within and across Counties, Regions, and the full Sierra Nevada. Such structures, supporting and integrating decentralized resources, carry an administrative burden which may be born locally but also requires funding.

A1.c The Response needs funding to mobilize the substantial human resources, inside and beyond the Sierra Nevada Counties, whose skills and capabilities are essential to the effectiveness of the Response.

2.1.4 Funding Research and Evaluation

Developing a Response to the Sierra Nevada Fuels Emergency is a complex problem, requiring decision-making under changing circumstances and substantial uncertainty. The need for strong central management is discussed in section 2.2; these coordinating functions need funding. There are substantial technical problems in planning, logistics, woodlands management, workforce development, and other areas whose solutions require reliable funding. Open solicitations, such as Requests for Proposals, can solicit localized expertise and initiative, embodied in Projects, within management structures that support integration with other Projects within and across Counties, Regions, and the full Sierra Nevada. Such structures, supporting and integrating decentralized resources, carry an administrative burden which may be born locally but also requires funding.

A1.d The Response needs funding to support the research and evaluation work essential to the efficient short and long term management of the Sierra Nevada woodlands.
2.2 The Need for Centralized and Coordinated Resources

2.2.1 Efficiently Mobilize and Apply Specialized Resources

The Emergency that the Counties have identified is highly complex, and an effective Response raises highly technical problems in a range of disciplines. Even Proposal Evaluation in many of these areas is beyond the current technical expertise of most of the Counties, and in any case many of these issues cross multiple jurisdictional boundaries. Part of the answer to the Question is best answered from the perspective of the full Sierra Nevada, or even from that of California. The Response requires the deployment of technical, planning, and administrative resources coordinated and managed over multiple Counties. An efficient Response will share resources across and among Counties, requiring unified coordination, direction and control.

Research and evaluation work were critical elements of the Herger-Feinstein Quincy Library Group Forest Recovery Act of 1998 (HFQLG Act). Indeed, this program, initiated from the Northern Sierra region, was designed as a pilot project, with a central role for research and evaluation. This work has included a wide range of fuel treatments and other activities to reduce wildfire probability and intensity, including evaluation of effectiveness following wildfire events. Support for these sorts of research and evaluation activities is an essential part of forward-thinking woodlands policy. The University of California’s Division of Agricultural and Natural Resources (DANR), in partnership with the US Forest Service and a range of private partners, is a key center of expertise in woodlands science and technology for the Sierra Nevada, and a key resource for extension of the HFQLG work across the Sierra Nevada.

A2.a A central organization is needed to efficiently mobilize and apply the specialized resources that are required in both the immediate Emergency response and in the long-term Healthy Woodlands future.

2.2.2 Encourage and Orchestrate Initiatives

The Counties have substantial resources, both in County Government and in the private sector, which can, with financial support, contribute significantly both to the development and execution of a Response. The Counties have a wealth of expertise and experience, and detailed knowledge of local conditions, that are essential to an effective Response. The Counties’ initial Petition, and their Answers, individually and collectively, to the Governor’s Question, are an expression of the Counties’ own resources. The development of a Response to the Emergency has already begun, through the Counties’ Campaign and Petition, and as the Counties answer the Governor’s Question.

Appendix B provides an Overview of a proposed Northern Sierra Biomass Project. This is a prototype to illustrate how local expertise and other resources may be mobilized to provide an early response that may be integrated both into long-term planning for the Northern Sierra and, through the co-ordinating function discussed below, with other subregional initiatives, into an efficient and effective response to the Sierra Nevada Fuels Emergency and to related Fire Seasons for 2015 and beyond.

A2.b A central organization is needed to encourage and orchestrate local and regional initiatives.
2.2.3 Integrate Local Initiatives

The features of the Emergency, and coordination required for an effective Response, overlay considerable diversity of local conditions and resources, accompanied by diffuse information about the situation. Many elements of the Response involve substantial regional co-operation in all phases of Response development and execution. Co-ordinated decentralization of initiative, accompanied by strong information-sharing systems, is an effective structure for the development of a Response to the Sierra Nevada Fuels Emergency, and is consistent with the initiative that Sierra and the other Sierra Nevada Counties have shown.

A2.c A central organization is needed to integrate work in the diverse conditions across the Sierra Nevada into an effective and efficient Response to the Emergency and towards a Healthy Woodlands trajectory.

2.3 The Need for the Governor’s Leadership, Authority, and Resources

2.3.1 The Governor’s Emergency Leadership, Authority, and Resources

The leadership, authority, and resources of the Governor of California are essential to an effective response to the Sierra Nevada Fuels Emergency and to the development and implementation of a Healthy Woodlands policy for the Sierra Nevada woodlands. The need for emergency assistance is acute; the Governor has the authority to Declare an Emergency in the Sierra Nevada, thereby initiating, through the Governor’s Office of Emergency Services, the orderly delivery of resources, including planning and organizational expertise, needed for the Response. Early urgent response, to remove the most hazardous fuels concentrations from the Sierra Nevada woodlands, mitigates the damage from the inevitable wildfires and reduces the total costs of wildfire response and post-fire remediation.

This condition, of inevitable disaster but with the benefits of feasible remediation exceeding costs, is known among disaster-response professionals as a Sandbag Problem, by analogy to the last-minute remediation in advance of a predictable high-water event. The Sierra Nevada Emergency is slower-unrolling than most flood events, but the same principal applies, just as it applies to the ongoing efforts to mitigate flood damage in low-lying areas from future flood events that are, like wildfires, certain to come even if the timing and location can be known at best in probabilistic terms. It is an appropriate use of the Governor’s authority to mobilize a range of Emergency resources, from both Federal and State sources, in order to reduce the costs of firefighting, post-fire mitigation and restoration, and of damage to public and private property and to environmental values.

A3.a The Governor’s emergency leadership, authority, and resources are needed to declare an Emergency and to seek Federal participation in the urgent response, to alleviate the immediate danger from the impending fire season.

2.3.2 The Governor’s Leadership in the Development of a Healthy Woodlands Policy

The dangerous current state of the Sierra Nevada woodlands is a serious failure of Federal policy, which weighs particularly heavily upon California. While the immediate direct impact of both the Fuels Emergency, and of the response and its consequences, is primarily on the Sierra Nevada
Counties themselves, the health of the Sierra Nevada’s woodlands and communities is of general interest to California. The Counties, along with the great many Californians with a shared interest in the health of the Sierra Nevada, need the Governor’s leadership to help us develop common goals for the Sierra Nevada woodlands, that move away from the current cycles of catastrophic wildfire on landscapes regrowing densely on previously burned and/or logged landscapes, and to translate those goals into State and Federal legislation, backed by suitable appropriations, to manage towards a Healthy Woodlands trajectory.

**A3.b The Governor’s leadership is needed to develop a Healthy Woodlands policy**

### 2.3.3 Integrating Healthy Woodlands Policies Into State Priorities and Activities

The Response to the Sierra Nevada Fuels Emergency, specifically the development of a Healthy Woodlands policy objective and trajectory, interacts with a wide range of policy objectives and activities which fall under the Governor’s jurisdiction and responsibility. First, the responsible management of the Sierra Nevada woodlands supports the predictable and timely delivery of water to California’s agricultural industries. Second, efficient management of the Sierra Nevada woodlands involves a substantial contribution to California’s energy portfolio. Third, the management of wildfire and its consequences is at the core of California’s responsibility, shared with the State of Nevada, for the the ongoing health of Lake Tahoe. Finally, responsible and effective management of the Sierra Nevada woodlands incorporates and integrates a broad range of other activities and responsibilities of the State of California, that are the ongoing responsibility of multiple Agencies of the Government of the State of California.

**Interaction with California’s Water Policies** The current woodlands regime, of repeated cycles of fire and undermanaged regrowth, has adverse consequences for California’s water supplies. In the short run, catastrophic wildfires dramatically reduce the water-holding capacity of the land, allowing more water to escape to the ocean during the run-off. Healthy woodlands modulate the annual hydrologic flow, with many environmental and economic benefits. In the longer run, the erosion from catastrophic wildfires contributes to the reduction in storage capacity of reservoirs downstream.

**Biomass from the Sierra Nevada in California’s Energy Portfolio** The Sierra Nevada’s hazardous fuels overload is, potentially, a major contributor to a renewable-energy mix for California’s power portfolio. Even the obsolete 20 MW Loyalton Biomass Station, delivering energy into a remote corner of the NV Energy transmission system under a 30-year-old gas-based power purchase agreement (PPA), with no steam customer, with no pricing of CO2 and other greenhouse-gas (GHG) emissions, is almost competitive with NV Energy’s North Valmey Power Station.

Power stations burning woody biomass that must be removed from the woodlands deliver a joint product: disposal services needed as part of a Healthy Woodlands trajectory, and renewable energy to the power system. When integrated with steam customers in a cogeneration configuration (also known as Combined Heat and Power, CHP) such as the lumber-drying kilns that motivated the original Loyalton Cogen, they deliver even better energy economics. Trigeneration configurations (Combined Cooling, Heating and Power, CCHP) provide the most efficient current technology, provided there is an economic need for refrigeration and/or air conditioning.
The Sierraville District Ranger estimated that desired fuel reductions in his jurisdiction could supply 10 stations the size of Loyalton—200 MW total—indefinitely. A future fleet may be sketched with 200 MW Cogeneration or Trigeneration stations, in locations known to be logistically advantageous (because of their past advantages for milling lumber), such as Loyalton, Greenville, Chester, and Oroville in the Northern Sierra, the Southern Cascades mill towns, and down the western slope of the Sierra Nevada, to a biomass fleet that could reach 2 GW or more of baseloaded renewable coal-displacing generation. Capacity values may be increased in some locations, with some shaping of the output, through multiple-fuel configurations with lower-heat-content agricultural waste, such as rice straw, burned during the off-peak hours[4].

California’s Shared Stewardship Over Lake Tahoe California shares, with Nevada and with our Federal partners, responsibility for protecting the unique environment and qualities of Lake Tahoe. Lake Tahoe’s clarity, in particular, is at risk from adverse but plausible combinations of weather and wildfire events. In spite of substantial fuel treatment work since the Angora Fire of 2007, there remain substantial risks, avoidable at costs, to life, property, and a range of environmental values. The regulatory and policy environment is complex, and an effective response to the fuels Emergency in the Lake Tahoe Basin will require strong leadership from the Governors of the States of Nevada and California.

Interactions between the Sierra Nevada Woodlands Health and Other California Missions, Agencies, and Other Actors The development and implementation of a Healthy Woodlands policy for the Sierra Nevada is a complex undertaking, involving the identification and resolution of many interests, sometimes but not always complementary. The Governor has the unique responsibility for reconciling and integrating California’s various interests and resources, and for delivering an efficient package of public policies and activities to support the private and community aspirations of the State’s people.

The response to the Emergency demands expertise in a broad range of technical and managerial disciplines. The Agencies and Offices of the Government of the State of California provide a rich, organized, and appropriately motivated and managed structure to provide the core of the public response to the Emergency. Several Agencies (and Offices) have significant roles in the unfolding response to the Sierra Nevada fuels Emergency. The overall coordination of the California State Response, including the identification, mobilization, articulation and integration of State public and private resources, into and with with the broader Federal interest and activity, is a responsibility of the Governor. A non-exhaustive list (with correctable omissions due to ignorance) of specific Agencies and Offices includes:

Office of Emergency Services The Governor’s Office of Emergency Services (EOS) delivers both technical expertise and the primary policy, administrative, and other interfaces in the preparation for and response to Emergencies, and as a central role in at least the early stages of the development and implementation of California’s Response to the Sierra Nevada Fuels Emergency. EOS provides, in particular, the interface with the emergency facilities and policies of the United States Government. As an unfolding Emergency, the Sierra Nevada Fuels Emergency has characteristics in common with the storm-driven prospective flood events around and near the Atlantic Seaboard of the United States, with high regional and large scale benefits to costly damage-mitigation efforts. EOS, with its responsibilities to prepare for and respond to a wide range of potential catastrophes and disasters, is California’s primary insti-
tutional representative in, and therefore a leader in, the national and international community of disaster and emergency responders. OES is an appropriate organization to initiate, and to manage the early stages of, the Response to the Sierra Nevada Fuels Emergency.

**CalFire** CalFire has the Resources-Agency lead on both the State’s preparation for and response to wildfires in California’s woodlands, including the National Forests. CalFire provides primary interface between the State’s resources and those of the US Forest Service, BLM, and other Federal land managers. CalFire’s fire-fighting resources, particularly its private-sector contractors, are critical potential suppliers of fuel-removal and other treatment services; early deployment of these resources, possibly under CalFire’s active management and sponsorship, can be a mechanism for initiating the response to the Emergency.

**CalTrans, CCC, Fire Departments, City Crews, Utility Teams,**... A range of significant organizations can contribute a range of services and expertise, as they already do, including logistics and transportation planning and engineering, fire risk evaluation and planning, landscape evaluation and planning, and a range of fuel treatments including removal and disposal. Mobilization and administration of the range of existing options, as well as encouragement of further initiatives, is a core function of State Government leadership and execution.

**County and Regional Government** The County Governments of the Sierra Nevada, including various more or less formal groupings, have significant resources that can support, as they have now and in the past, work to manage both the biomass supplies of the region and fires and other disasters. The mobilization of local and regional government agencies, and of resources associated with those agencies, and integration of those resources and organizations into other elements of the State’s response to the Sierra Nevada Fuels Emergency, is an core function of State Government.

**Workforce Development Organizations** Particularly in the short run, the effectiveness and reach of the Response to the Fuels Emergency will be limited by the supply of crews with the skills and training, as well as equipment, needed for safe, efficient, and environmentally responsible fuels-reduction and other damage mitigating work in the woodlands. Acceleration of fuel treatment work may require increases in technical workforces, including a range of specialties in environmental, watershed, habitat, and other sciences, to support both the planning and implementation of fuel treatment projects in environmentally sensitive conditions.

The expansion of the workforce, organized into appropriately managed crews, is a principal challenge for the development of the Response, and will require leadership and ingenuity from the existing woodlands-contracting industry to expand and adapt to meet the needs of the Emergency Response. The expansion of woodlands crews for fuel treatments can, with planning, training, and other preparation, coincide with the expansion of the workforce, organized into appropriately managed crews, that may be quickly deployed to the wildfires that will follow even the most aggressive fuel treatment programs.

A range of public organizations can significantly support the expansion of the trained and organized woodlands workforce.

The **Employment Development Department** (EDD) has lead responsibility for State policy in this area, and has existing systems to support the development of catalogues of both skills required and skills under-used. EDD’s strong participation in the development of the Response, in mobilizing California’s human resources, is an essential contribution of the State of California to the Response, while carrying on its primary responsibilities to California’s
workers and employers.

The Sierra Nevada region has high concentrations of veterans of the last decades’ foreign wars, including many who have moved from out of the area to join comrades in communities with high levels of formal and informal support. Many of the skills and attitudes essential to both the work in the woodlands and team leadership, logistical, planning, and other technical skills and specialties needed for the full Response, are found amongst the veterans population. Calvet, both as a California Agency and through its work with the Federal Department of Veterans Affairs, can support in the identification of skills, aptitudes, and interests among California’s veterans, and support their mobilization in the Response and in the longer term management towards a healthy Sierra Nevada woodlands.

The community colleges and other elements of California’ post-secondary education system have an important role to play in identifying and filling the training needs. A range of Woodlands Technician titles may be described, to support, lead, and perform woodlands work using safe, efficient, and environmentally responsible practices. Workforce development policies that emphasize the development of skills are essential not just to the Emergency Response, but to the long term health of the region’s economy.

**Research System** Both the short-term Emergency Response phase and the longer-term identification of and management towards a Healthy Woodlands trajectory will be carried out in an evolving understanding of the science of the Sierra Nevada woodlands. This builds in part on the outstanding work performed as a critical part of the research-intensive HFQLG Act program, although ideally with a focus on the entire Sierra Nevada rather than just the Northern Sierra. The University of California’s Division of Agriculture and Natural Resources (UCDANR) will continue to play a role at the center of research in the range of woodlands sciences. UC Merced’s Sierra Nevada Research Institute, while not a recipient of substantial DANR support, helps to deliver the University’s research expertise to the region, and may have a role to play in the Response. Humboldt State University (and other CSU campuses) has substantial expertise, including competency in research and evaluation activities, in woodlands science and technology, and continues to be an important participant in the evolving landscape of California’s woodlands.

**Private Sector** Even at its current low levels of activities, the Sierra Nevada woodlands support a rich private sector of contractors and subcontractors, often organized into long-lasting networks of private businesses and crews. This woodlands-contractor sector possesses the range of equipment and skills necessary for fuel treatments, as well as commercial logging, fire fighting, and post-fire remediation activities, although not necessarily at the scale needed. An effective Response to the Emergency, and subsequent implementation of a Healthy Woodlands policy trajectory, mobilizes this sector and ensures that policy and financial structures support the efficient expansion of this sector.

A specific obstacle to the growth of this sector may be found in the shortage of large-scale capacity to dispose of woodlands-source biomass near the region. The largest owner of such capacity is Sierra Pacific Industries (SPI), which uses biomass-fueled co-generation stations to produce steam for the kilns at its lumber-mill facilities. Under current timber-harvest-and-fuel-treatment activities, purchasers of saw logs from National Forest timber sales must perform specified fuel treatments in addition to cleanup associated the timber sale itself. SPI and its contractors are often the only parties who can meet the fuel treatment requirements, allowing SPI to reliably win timber-sale auctions at very low bids, so that the cost of the
sawlogs is primarily the cost of the associated cleanup project (and other in-woods and transportation costs).

The timber-harvesting activity, which should deliver value to the National Forests through a competitive sales process, needs to be unbundled from the costly fuel treatment activity. The current arrangement essentially finances costly fuel treatments and other woodlands maintenance by establishing a cross-subsidy from the SPI sawlog monopsony to the woodlands maintenance. This is inefficient policy, at least from the standpoint of the public and of contractors that are independent of SPI.

SPI and other mill and timber operators are important and valuable members of the region’s woodlands-based economy. Existing mill operations are logical locations (due in part to their demonstrated locational values convenient to growing biomass) for expanded biomass generation. SPI and other participants in timber planning, growing, purchasing and cutting businesses have substantial knowledge, skills and interests that will make them important participants in the development and implementation of a Healthy Woodlands policy as well as in the long-run planning associate with the proposed Sierra Nevada Biomass Project and other elements of the Response.

**The Federal Relationship** Both the current Sierra Nevada Fuels Emergency, and the effectiveness of a Response, reflect in part the health of the relationship between California, particularly the Sierra Nevada Counties, and its Federal partners, particularly the USFS and BLM land managers. Improvement of this relationship is essential. The Governor, with the support and participation of the State Legislators representing the Sierra Nevada region and of the State’s Congressional delegation, can lead and direct restructuring and reformation of this critical relationship, as part of the Response. It is appropriate for the Governor to take a primary leadership role in developing integrated State and Federal policy oriented towards a Healthy Woodlands trajectory.

**Fiscal Policy** Any significant effective response to the Sierra Nevada Fuels Emergency must involve a substantial increase in public expenditures on fuels reductions and other measures to mitigate damages from the impending disaster.

Much of the land that is involved is in the National Forests of the Sierra Nevada. As such, formal responsibility for the maintenance and recovery, or even for the identification of the appropriate future state and near term trajectory, for the woodlands, is held by the Federal Government. In identifying failures in policy, at whatever levels of Government, that have contributed to the development of the unfolding Emergency, and in proposing some specific Responses, the Counties assert a need for significant immediate and continuing expansions in levels of Government expenditures to support both the immediate Emergency response and, going forward, a Healthy Woodlands trajectory for the Sierra Nevada.

The need for significant increases in public expenditures as part of a Sierra Nevada Healthy Woodlands policy raises issues of State and Federal budgetary policy.

The State, lacking the ability to issue money, must maintain budget balance sufficient to satisfy its creditors of its future ability to service and repay the State’s debt. In practice, California’s dynamic economy, and the correlations between California’s tax revenues and macroeconomic economic conditions, makes California’s budget power—its ability to spend—highly pro-cyclical: it produces a
budget surplus through economic expansions, and tends towards deficit during recessions. In the current macroeconomic situation, California’s economy is once again in expansion, with the result that there is scope for increases in State expenditures, at least during the years of expansion.

The California Government cannot run the multi-year deficits that are the essential elements of macroeconomic stabilization policy, especially during liquidity-trap episodes of very low interest rates and high unemployment of labor and other resources. Such depression conditions emerged broadly as an immediate consequence of the last decade’s financial crisis, and while there has been substantial, sometimes spectacular, recovery in important segments of the California economy, interest rates remain very low, and high unemployment persists in most of the Nation, as well as in parts of California, particularly outside the Coastal regions.

National macroeconomic conditions are important here, at least because in practice low tax revenues, delivered by a national economy that continues to operate at well below its potential, impinge on the ability of Federal land managers to maintain California’s National Forests. The State Government cannot replace the Federal government, with its control over monetary policy allowing, in coordination with responsible fiscal policy, effective management of economic growth that has avoided, for most of the last three quarters of a century, the worst crises of boom and bust. However, to the extent of its limited but significant budget power, California can act as a pump-primer in areas of the State that share the stagnation observed across much of the American economy.

California is a sufficiently large and self-contained economy (including its neighbors; the economies of the West Coast, including Nevada and Arizona, move very much together) that the macroeconomic impact of California’s fiscal policy is experienced with particular force within our own economies, before spilling out to the rest of the National and world economies. Especially at current near-zero interest rates, and if directed to regions with significant underemployment of labor and other resources, State expenditures pay for themselves.

The macroeconomic interest in spending is in addition to California’s primary microeconomic interest in rational if costly woodlands policy. Microeconomic considerations are appropriate criteria for project selection, such as deciding between two fuels reductions projects, or between Healthy Woodlands activities and an unrelated infrastructure project.

The evident underinvestment in the Sierra Nevada woodlands is the result of arrangements in the political economy that displace the incidence of the results of spending decisions from those with financial responsibility. Financial responsibility falls primarily on the Federal taxpayer, as expressed by Congressional budgetary actions, while the impacts are experienced mostly locally (including, of course, the millions of recreational users of the woodlands who reside outside the Sierra Nevada). What is a critical matter of State interest and policy for California has often had less importance in Washington, D.C.

A similar displacement of benefit incidence from funding responsibility has often been observed in agricultural research, where there is major diffusion of benefits to consumers and, in some crops, competitors. A satisfactory resolution, applied in several California specialty crops, matches grower contributions with public funds, so that both sets of beneficiaries—producers and consumers—share in the cost, while receiving an immediate incentive—the research supported by the other

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3Local governments recognize that, during recessions, the State’s inability to accommodate deficits triggers sharp reductions in State funding of local Governmental functions.

4From the standpoint of conventional macroeconomic stabilization policy, this linkage of spending to tax revenues is directly counterproductive. It is a fact of the 2015 political economy.
party’s match—for further investments in research.[1] This is an example of a matching structure, whose earliest known manifestation was Benjamin Franklin’s 1751 establishment of a matching fund in support of a hospital.[7], p. 148. This Alston/Franklin approach may be applied directly, on a generalized scale, to the project-selection problems associated with the Sierra Nevada Fuels Emergency.

At the high level, there is a National interest in the health of the National Forest and other Federally managed woodlands, but for a variety of reasons the National institutions reflect this interest weakly. As California delivers a strong, incentive driven, cost bearing signal that this is an appropriate use of the National purse, by putting California money into the Project, it offers strong direction to the managers of the Federal budget.

We do not yet know what is the “correct” level of match, that accords the interests of California, and its Regions, with those of the larger communities to which we belong. We can at least guess that it is positive, and that California’s share of the full Response, including the future Healthy Woodlands financial trajectory, must be less than 1 (the Rest-of-World has a positive interest in the health of the Sierra Nevada Woodlands). A starting-point approximation, surely delivering more useful results than the [0, 1] endpoints, is \( s = 0.5 \): for each $1 that California delivers, from its private and public sources, for the improved maintenance, quality and generalized value of the Federally-owned land in California, the Federal owner will deliver $(1 - s)$ in co-operating funding, including in-kind resources.

The correct match rate \( s \) is a policy variable, determinable in principal for different policy situations. Until acceptable solutions may be found, the number is arbitrary until negotiated. \( s = 0.5 \), for the case of California’s encouragement of Federal expenditures on maintenance of the National Forest’s Sierra Nevada woodlands, is a useful starting point. Specifically, Sierra County, with its private- and public-sector members, and of its cooperating neighbors and partners in Plumas County and beyond, to support an immediate and effective Response to the Sierra Nevada Fuels Emergency:

- offers its Resources, mobilized and organized to our abilities, to the Governor of California,
- asks that the Governor recognize and support our initiative by matching and multiplying these Resources, to a degree consistent with the broad interest of our State, with the Resources of the State of California, and
- recommends that the Governor seek further multiplication of our Resources as the Federal interest, expressed in at least Federal ownership of California’s National Forests, should warrant.

This is a story of California. Earlier generations built, often with public support, railroads, ditches, reservoirs, canals, roads, schools and universities, which we and our descendants use. In the process of building those great assets, California’s workforce, and population, grew, and grew in skills and expertise. California’s working people, and the things they built and build, are a great source of the wealth of California. It is an appropriate time for the Governor to find those investments that are available today, in infrastructure, in science, technology, and education, as well as in California’s treasures in the Sierra Nevada. This generation, and those that follow us, can and must show imagination and courage to match those who came before.
3 Recommendations

The previous Section 2 proposes several answers to the Governors’ Office question, “What is needed of the State of California to mount an effective response to the Sierra Nevada Fuels Emergency. These proposed answers, and the attached sketch proposals for a Northern Sierra Biomass Project in the context of a Sierra Nevada Biomass Project, form the elements of the following Recommendations to the Sierra County Board of Supervisors and their peers in the other Sierra Nevada Counties.

- **Answer the Governor’s Question**, with concrete recommendations for actions and activity by State Government as well as by identifying roles for resources within the Counties. Section 2 offers a set of Answers to the Governor’s Question, Appendix B provides an example of how a response appropriate to the Northern Sierra might be launched.

- **Work closely with Partner Counties.** The proposed Northern Sierra Biomass Project, described in Appendix B, supports the development of an integrated response over several Counties, centered on Sierra and Plumas Counties. These Counties have cooperated well with Sierra County in the earlier phases of the Emergency Response process. In the proposal for a Northern Sierra Biomass Project, see Appendix B Loyalton has particular value as the center for biomass disposal for a substantial region east of the Sierra crest, from Lassen County south into the Tahoe Basin. Greenville and Chester have similar value in Northern Plumas County. The Western Slope of the Yuba and Feather drainages support a coordinated regional solution involving as well Nevada, Yuba and Butte Counties. Sierra County should work, with the region’s State Legislators and its Northern Sierra and Sierra Nevada partners, to initiate and encourage effective regional, State, and Federal responses to the Fuels Emergency.

- **Solicit Proposals.** The Northern Sierra Biomass Project and its component Loyalton Project, proposals summarized in Appendices A and B are intended as working models and examples to encourage broad discussion of a detailed regional response—the NSBP prototype, based on a specific proposed solution, the use of the site and facilities at Loyalton, for the Eastern Sierra, which may be matched by other solutions for the Lake Almanor/Northern Plumas area, for the Western Slope, and other areas. Sierra County, and its neighbors in and beyond Plumas County, can encourage a strong response both for the Northern Sierra and across the Sierra Nevada, by actively soliciting and encouraging comments and improvements to these proposals, as well as alternative approaches.

- **Re-assert Previous Request for Forum.** In its initial Proclamation, Sierra County requested the Governor’s assistance and support in summoning a Forum, along the lines of the Presidential Forum on Lake Tahoe. Sierra County can and should invite representatives from the other Sierra Nevada Counties, and other interested parties, to Loyalton or other convenient location, under the direction of the Governor or his nominee, to review the Fire Emergency, including progress towards a Response, at the Governor’s earliest convenience.

4 Consulting Proposal

I will consult with Sierra County on the same terms as proposed to the City of Loyalton in Section 3 of the Loyalton Biomass Project Proposal, attached as Appendix A.
Glossary

**HFQLG Act** The Herger-Feinstein Quincy Library Group (HFQLG) Forest Recovery Act of 1998 was the legislative product of a process that began with ad-hoc community meetings held in the Quincy Library. The HFQLG Act supported a range of fuels reductions and fire damage mitigation strategies, with supporting research and evaluation activities. The activities supported under this act are a principle source of the regional expertise in fuels management planning and practice. [5][10]

**SPI** Sierra Pacific Industries, forest products company based in Anderson, California, owns and manages nearly 1.9 million acres of timberland in California and Washington, and is the second largest lumber producer in the United States. Owner of the site of the lumber mill formerly operating in Loyalton, California, including the mill’s cogeneration facility and a business park. [11]
References


[12] Sierra County Board of Supervisors. In the matter of implementing a proclamation of local emergency throughout the Sierra Nevada region of California and requesting support of the Board of Supervisors of the twenty-two Counties of California comprising the Sierra Nevada. Board of Supervisors Resolution 2014-067, County of Sierra, State of California, July 2014.


Appendices
A Proposal: The Loyalton Biomass Project
Loyalton Biomass Project

Proposal for City of Loyalton Sponsorship

Offered to:
City of Loyalton, California
email jasonchr@gmail.com
Jason Christian, Associates
April 15, 2015
1 Background

In 2014, Sierra County initiated a campaign to engage its fellow Sierra Nevada Counties, and with them the Governor and Government of the State of California, and the Federal Government, as well as other interested individuals and organizations, to respond to the hazardous fuels and fire emergency conditions that exist across the Sierra Nevada woodlands. The severity of the situation is a long-standing issue of deep concern in Sierra County and its surrounding Northern Sierra region. Sierra County’s government expressed this concern by

- Preparing a staff Background Report analyzing the situation[7],
- Proclaiming, by Resolution of the Board of Supervisors, a State of Local Emergency, and Requesting specific relief and action by the Governor[6], and
- Requesting, by Resolution of the Board of Supervisors, supporting Proclamations and Requests by the other Boards of Supervisors of the Sierra Nevada Counties[5].

Sierra County’s action received immediate support both from within the County (see, for example, the endorsement of the Sierra Valley Resource Conservation District[3]), and from its neighbors (for example, the Plumas County Proclamation[2]). Twenty nine Counties have joined in the Campaign that Sierra County has initiated, joining in a Petition to the Governor for relief, leadership and coordination, and the resources of the State in addressing the threat these Sierra Nevada Counties share. The Governor has asked that the Counties identify what they need to respond to the Fuels Emergency.

In an effective response to the Hazardous Fuels Emergency, Sierra County will continue to collaborate and cooperate with its neighbors in the Northern Sierra and across the Sierra Nevada in answering the Governor’s Question aggressively and with some detail, with specific requests for strong Governor’s leadership in developing an adequately funded and well-managed Program that mobilizes California’s tremendous resources both to an immediately effective response to the current urgent Emergency, but towards the development of an effective, efficient, and sustainable long-term Healthy Woodlands trajectory for the Sierra Nevada.[1] A part of this recommendation is that Sierra and other Counties both offer specific projects and approaches, actively encourage other initiatives and proposals, and otherwise seek the Governor’s assistance in directing California’s human and financial resources to transform these and other projects and proposals into an effective response to the Fuels Emergency with increasing detail as a Response to the Fuels Emergency develops.

2 The Loyalton Biomass Project: Proposal for City Sponsorship

The idle Loyalton Biomass Station, often known by its previous name as the Loyalton Cogen, and the surrounding Loyalton Millsite, both now owned by Sierra Pacific Industries (SPI), are critically valuable resources that are essential to any effective and efficient response to the Fuels Emergency.

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1 The package of Background Report and Resolutions is available through the Sierra County Board of Supervisors website at http://ca-sierracounty.civicplus.com/AgendaCenter/ViewFile/Item/1442?fileID=1838. Additional context is found in the Memorandum to Interested Individuals and Organizations, from Paul Roen, Chairman of the Sierra County Board of Supervisors, transmitting the package.[4]
The Loyalton Biomass Project is an effort, initiated by several past and present members of the Greater Loyalton community, to develop ownership and operating arrangements to support both the early return to service of the Loyalton Biomass Plant, initially in its present simple (no cogeneration) configuration, and its eventual replacement by a modern Loyalton Trigeneration Station, delivering both power to the transmission system, and thermal services (heating and cooling) to industrial and building users on the Millsite and, potentially, in the City of Loyalton itself.

The Loyalton Biomass Project proposes that the City of Loyalton be one of its sponsors. It can do so by passing the following Sponsorship Resolution, as well as several further Resolutions, discussed further below and brought together in section 6:

**RESOLVED:** That finding substantial public benefit in the early return to operation of the Loyalton Biomass Station, as discussed in the document entitled “Loyalton Biomass Project: Proposal for City of Loyalton Sponsorship” discussed at the City Council Meeting held in Loyalton on April 21, 2015; That responding to the Resolutions of the Sierra County Board of Supervisors regarding the fuels and fire emergency existing in and beyond Sierra County; Therefore the City Council endorses and sponsors the Loyalton Biomass Project, and requests that its neighbors and partners in Sierra and Plumas Counties and across and beyond the Northern Sierra work with the Director of the Loyalton Biomass Project to develop and implement arrangements leading to application of the Loyalton Biomass Station and its surrounding Loyalton Millsite as critical elements of the Response to the Northern Sierra and Sierra Nevada Hazardous Fuels and Fire Emergency. The City can take three further actions which will substantially promote the Project.

First, the City can engage, direct, and authorize a Consultant, as Director of the City of Loyalton’s Loyalton Biomass Project, under appropriate controls and oversight, to identify and mobilize such other partners and other resources as are necessary. Section 3 proposes such a Consulting Arrangement.

Second, noting the prior initiative of the Sierra County Board of Supervisors, followed by Plumas and other Counties, and the importance of the Loyalton facility to the eastern parts of Plumas and several other Sierra Nevada Counties, the City of Loyalton can request of the Sierra, Plumas, and other relevant County Boards of Supervisors (at least Sierra, Plumas, Nevada, Placer, El Dorado, and that part of the Lake Tahoe Basin that is in Nevada) that they work with and support the City of Loyalton and its Biomass Project in developing a region-wide Response to the Northern Sierra Fuels Emergency.

Third, the City of Loyalton can create Loyalton Biomass Project Steering Committee, composed initially of the Vice Mayor, a second Councilmember, and the Consultant/Biomass Project Director, with the authority to add members (for example: the Sierra County and Plumas County Boards of Supervisors might be invited to appoint members), and to direct and oversee the Project Director’s identification of and communications and negotiations with potential partners in the Project, subject to appropriate controls and limits (for example, no City resources can be committed, nor contracts executed, without such full Council review and authorization as the Council should require).

There are several reasons why the City of Loyalton should sponsor the Loyalton Biomass Project.

First, the return of the facility to operations, as well as its eventual replacement, have major direct effects on every part of the life of the town. Both encouraging early use of the site and facility, and participating in the design and construction of its replacement (along with decisions regarding
municipal use of thermal services for buildings), is in the strong interest of the City of Loyalton.

Second, as an existing legal governmental entity in the State of California, the City of Loyalton has a range of attributes (among others: existing and adequately functioning structures of authority and management; contracting systems with, in particular, structures of co-operative cost-sharing arrangements with other government entities).

There are two related strong objections to Loyalton’s proposed sponsorship of the Loyalton Biomass Project.

First, it has in the past been stated that Loyalton was “too small to think about” the future of the Loyalton Biomass Station.

The Loyalton Biomass Project certainly will involve resources far beyond those now in Loyalton or even across the Northern Sierra. So, however, to the benefits of the Project, which involves putting together the resources at hand (among others: an ideally placed power station, some locally available planning, solution design, and other technical expertise, strong local and regional community institutions and political will, the range of local businesses active in and dependent on the Northern Sierra woodlands) with a range of out-of-area partners (among others: a power station operator, engineering, accounting, legal and other professional and technical business services providers, for-profit and foundation investors and donors, partners in other local government bodies in Sierra County and its neighbors across and beyond the Northern Sierra, a range of Offices and Agencies of the State and Federal Government). The problem is not that Loyalton is “too small”; rather the challenge is to put together some of the wonderful assets of Greater Loyalton, and the Northern Sierra, with resources from outside the region. The Consulting Proposal (section 3) is designed in part to support efforts to put all these resources together.

Second, the Project is expensive and the City of Loyalton has no money to pay for it.

Among the out-of-region resources that the Project requires is financial support. While once the Loyalton Biomass Station is in operations, only a small amount of funding support is required to cover its regular costs of ownership and operations, such support is necessary, as will some up-front funding of organizational costs, acquisition of the Facility (unless some arrangement that keeps it under SPI ownership is found), and possibly repair and startup costs. A principal task to the Consultant/Director is to find and establish, under Steering Committee direction (5) and for City Council review and decision, appropriate financing and funding arrangements. Indeed, the Consultant has no ability to be compensated without accomplishing this task. See section 3.

3 Consulting Proposal

Jason Christian, Associates proposes that the City of Loyalton appoint Dr. Jason Christian as Consultant and Director of the City of Loyalton’s Loyalton Biomass Project (“Consultant/Director”), reporting to the Loyalton Biomass Project Steering Committee, to provide and arrange for such administrative, technical, and other professional services as are necessary to accomplish the objectives of the Loyalton Biomass Project.

The Consultant/Director will, subject to the availability of appropriate legal resources, and under the direction of the Steering Committee, direct the preparation and, subject to the review and approval of the Loyalton City Council, such Professional Service Agreements between and other
contracts as are consistent with good municipal government.

The Consultant/Director’s compensation, unless modified through the mutual agreement of the Consultant/Director and the City of Loyalton, will be 3% of the value of any transactions arranged by the Consultant/Director, to be paid at closing of each such transaction (Commission Charge). The City will, when funds are available, compensate Dr. Christian’s actual expenses under existing City of Loyalton policy. It should be noted that Dr. Christian is a resident of Portola, which may be in conflict with some interpretations of the City of Loyalton’s procurement policies.

Jason Christian, Associates and Dr. Jason Christian as an individual may provide other parties with consulting services, under the limitation that the Consultant/Director informs the Steering Committee of all such arrangements that involve the Loyalton Biomass Project, including identification of any potential conflicts of interest, prior to entering such Related Consulting Arrangements. The Steering Committee will have 5 business days after being informed to object, under reasonable grounds, to any Related Consulting Arrangements; if no objection is made the Related Consulting Arrangement may be executed.

Dr. Christian’s full professional Resumé is found in Appendix C.

This Consulting Proposal may be accepted by Resolution of the Loyalton City Council, using language such as:

**RESOLVED, that the City of Loyalton shall engage Dr. Jason Christian as Consultant and Director of the Loyalton Biomass Project under the terms and conditions contained in the document entitled “Loyalton Biomass Project: Proposal for City of Loyalton Sponsorship,” as modified in the City Council Meeting held in Loyalton on April 21, 2015.**

4 Towards a Northern Sierra Biomass Project

The Loyalton Biomass Project offers value as the key resource for the storage and economic disposal of hazardous fuels from a stretch of the Northern Sierra woodlands from the Lake Tahoe Basin in the South to Plumas County in the North. Other solution elements will be required and may be available, in the Lake Almanor/Indian Valley region, and down the west side, possibly as low as Oroville or Marysville. Efficient planning and operations under a Loyalton Biomass Project require transparency and coordination with the solutions that are developed for other, especially neighboring, parts of the Northern Sierra, such as the Highway 70 corridor West of Lee Summit, or some application of the Greenville site, which shares many of the logistical and geographical advantages of the Loyalton site, but without the idle power station. Some fuels may come to Loyalton from the west side of Sierra County, depending upon the existence and convenience of arrangements in Western Sierra, Yuba, or even Butte or Sutter Counties. A regional approach is required. As a specific proposal, we offer a Northern Sierra Biomass Project.

Appendix A outlines and offers such an approach, the Northern Sierra Biomass Project (NSBP), as an example and starting point for discussion. The Loyalton Biomass Project is an element of the larger Project, which in turn may be an element of a larger Sierra Nevada Biomass Project. We propose that, once steam is available at Loyalton, buildings on the Millsite are an efficient site for some of the Projects’ substantial administrative and technical work. Noting the impacts of the Loyalton Biomass Project on Eastern Plumas County and of the Plumas County woodlands on the
Loyalton Biomass Project, the historic role of Quincy as the center for regional collaboration in issues involving the Northern Sierra woodlands, the size of both the population and of woodlands-based work in Plumas County, and with honor and respect to the Sierra County Board of Supervisors’ continuing political courage and leadership in this region, we suggest and recommend that Plumas County join Sierra County in leading, and to the extent feasible and appropriate, conducting the Northern Sierra Biomass Project.

Dr. Christian is, separately, recommending specific actions to the Sierra County Board of Supervisors at its Meeting of April 22, 2015[1]; this Document is framed as a Consulting Report, intended as a valuable contribution to the success of the Sierra Nevada, Northern Sierra, and Loyalton Biomass Project. While it seeks no action from the City of Loyalton, it may be useful to the City of Loyalton, and is therefore directed to Loyalton as well as to Sierra County. No financial compensation is sought for this report. It is attached as Appendix B.

The City can ask the Sierra County Board of Supervisors to support and sponsor the Loyalton Biomass Project, and, following its previous initiative in leading all 38 Sierra Nevada Counties (of which Plumas County was the first to join) in the Proclamation of Fuel and Fire Emergencies across and among the full Sierra Nevada. It can do so by Resolution similar to the following:

**RESOLVED:** Finding that the Loyalton Biomass Project offers benefits to Sierra and Plumas Counties, and across the Northern Sierra; that fuel removal and treatment options across the Northern Sierra are important to decisions regarding the Loyalton Biomass Project, that a regional Northern Sierra response is needed for the Northern Sierra Fuels Emergency, that Plumas County in particular has substantial resources valuable to the development and implement a response to that Emergency, the Loyalton City Council instructs the Mayor of Loyalton to communicate, with the support of the Loyalton Biomass Project, with the Boards of Supervisors of Sierra and Plumas Counties, requesting their sponsorship, direction, leadership, and participation of a multi-County Northern Sierra Biomass Project.

5 **Launching the Loyalton Biomass Project**

The City of Loyalton’s Sponsorship of the Loyalton Biomass Project is implemented above all, and the Project launched, by the formation by the City of the Loyalton Biomass Project Steering Committee, to supervise, direct and advise the Consultant/Director of the Project.

We propose that the Steering Committee be composed initially of the Vice-Mayor of Loyalton, an additional Councilmember to be chosen by the City Council, and the Consultant/Director. The Steering Committee will choose its own Officers and additional Members, and will form standard practices for the conduct of public business. When suitable legal resources are available, the Steering Committee will promptly draft and deliver to the City Council such legal documents as are consistent with good-practice conduct of public business.

The existence and operation of the Steering Committee is essential in authorizing, directing, advising and supervising the Consultant/Director of the Loyalton Biomass Project in developing and implementing the many cooperative and commercial arrangements that will be necessary for the conduct of the Project. The creation of the Steering Committee is a companion to the proposed appointment of a Consultant/Director.
The City of Loyalton can launch the Loyalton Biomass Project by Resolution similar to the following:

**RESOLVED:** Finding that the early initiation of the Loyalton Biomass Project, as described in the Document entitled “Loyalton Biomass Project: Proposal for City of Loyalton Sponsorship” discussed at the City Council Meeting held in Loyalton on April 21, 2015; That initiation and successful conduct of the Project for the benefit of the City of Loyalton is promoted by the engagement, management, and direction of a Consultant/Director as described in that Document; therefore the City Council appoints its Vice-Mayor, a second member Councilmember, and the Consultant/Director of the Loyalton Biomass Project to form the Loyalton Biomass Project Steering Committee; furthermore, the City Council instructs the Steering Committee, as discussed in section 5 of the Document, to take such action, using good practice for the conduct of public business, to promote, direct, supervise and conduct the Loyalton Biomass Project.

## 6 Action Items

The City Council of Loyalton, California, can sponsor, launch and substantially promote the Loyalton Biomass Project by passing four Resolutions similar to those discussed in the previous sections. They are brought together and numbered for convenience here:

1. **Sponsorship RESOLVED:** That finding substantial public benefit in the early return to operation of the Loyalton Biomass Station, as discussed in the document entitled “Loyalton Biomass Project: Proposal for City of Loyalton Sponsorship” discussed at the City Council Meeting held in Loyalton on April 21, 2015; That responding to the Resolutions of the Sierra County Board of Supervisors regarding the fuels and fire emergency existing in and beyond Sierra County; Therefore the City Council endorses and sponsors the Loyalton Biomass Project, and requests that its neighbors and partners in Sierra and Plumas Counties and across and beyond the Northern Sierra work with the Director of the Loyalton Biomass Project to develop and implement arrangements leading to application of the Loyalton Biomass Station and its surrounding Loyalton Millsite as critical elements of the Response to the Northern Sierra and Sierra Nevada Hazardous Fuels and Fire Emergency. (See section 2.)

2. **Engagement of Consultant/Director RESOLVED:** That the City of Loyalton shall engage Dr. Jason Christian as Consultant and Director of the Loyalton Biomass Project under the terms and conditions contained in the document entitled “Loyalton Biomass Project: Proposal for City of Loyalton Sponsorship,” as modified in the City Council Meeting held in Loyalton on April 21, 2015. (See section 3.)

3. **Northern Sierra Biomass Project RESOLVED:** Finding that the Loyalton Biomass Project offers benefits to Sierra and Plumas Counties, and across the Northern Sierra; that fuel removal and treatment options across the Northern Sierra are important to decisions regarding the Loyalton Biomass Project, that a regional Northern Sierra response is needed for the Northern Sierra Fuels Emergency, that Plumas County in particular has substantial resources valuable to the development and implement a response to that Emergency, the Loyalton City Council
instructs the Mayor of Loyalton to communicate, with the support of the Loyalton Biomass Project, with the Boards of Supervisors of Sierra and Plumas Counties, requesting their sponsorship, direction, leadership, and participation of a multi-County Northern Sierra Biomass Project. (See section 4.)

4. LBP Steering Committee Formation **RESOLVED:** Finding that the early initiation of the Loyalton Biomass Project, as described in the Document entitled “Loyalton Biomass Project: Proposal for City of Loyalton Sponsorship” discussed at the City Council Meeting held in Loyalton on April 21, 2015; That initiation and successful conduct of the Project for the benefit of the City of Loyalton is promoted by the engagement, management, and direction of a Consultant/Director as described in that Document; therefore the City Council appoints its Vice-Mayor__________, a second member Councilmember ____________, and the Consultant/Director of the Loyalton Biomass Project to form the Loyalton Biomass Project Steering Committee; furthermore, the City Council instructs the Steering Committee, as discussed in section 5 of the Document, to take such action, using good practice for the conduct of public business, to promote, direct, supervise and conduct the Loyalton Biomass Project. (See section 5

References


[5] Sierra County Board of Supervisors. In the matter of implementing a proclamation of local emergency throughout the Sierra Nevada region of California and requesting support of the Board of Supervisors of the twenty-two Counties of California comprising the Sierra Nevada. Board of Supervisors Resolution 2014-067, County of Sierra, State of California, July 2014.


Appendices
A Proposal: The Northern Sierra Biomass Project

See Master Appendix.
B The Sierra Nevada Bomass Project: Framework Proposal for an Efficient Response to the Sierra Nevada Fire Emergency

See Master Appendix.
C  Resumé

C.1 Jason E. Christian, Ph.D., Principal Proponent and Consultant

See Master Appendix.
B  Proposal: The Northern Sierra Biomass Project
The Northern Sierra Biomass Project

Proposal to Apply the Loyalton Biomass Station
and Other Resources to an Efficient Response to the
Northern Sierra Fire Emergency

Offered to:

Sierra County, California
email jasonchr@gmail.com
Jason Christian, Associates
April 15, 2015
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1 Background

In 2014, Sierra County initiated a campaign to engage its fellow Sierra Nevada Counties, and with them the Governor and Government of the State of California, and the Federal Government, as well as other interested individuals and organizations, to respond to the hazardous fuels and fire emergency conditions that exist across the Sierra Nevada woodlands. The severity of the situation is a long-standing issue of deep concern in Sierra County and its surrounding Northern Sierra region. Sierra County’s government expressed this concern by

- Preparing a staff Background Report analyzing the situation[8],
- Proclaiming, by Resolution of the Board of Supervisors, a State of Local Emergency, and Requesting specific relief and action by the Governor[7], and
- Requesting, by Resolution of the Board of Supervisors, supporting Proclamations and Requests by the other Boards of Supervisors of the Sierra Nevada Counties[6].

Sierra County’s action received immediate support both from within the County (see, for example, the endorsement of the Sierra Valley Resource Conservation District[4]), and from its neighbors (for example, the Plumas County Proclamation[3]). Twenty nine Counties have joined in the Campaign that Sierra County has initiated, joining in a Petition to the Governor for relief, leadership and coordination, and the resources of the State in addressing the threat these Sierra Nevada Counties share. The Governor has asked that the Counties identify what they need to respond to the Fuels Emergency.

The Consulting Report that this Proposal accompanies recommends that Sierra County collaborate and cooperate with its neighbors in the Northern Sierra and across the Sierra Nevada in answering the Governor’s Question aggressively and with some detail, with specific requests for strong Governor’s leadership in developing an adequately funded and well-managed Program that mobilizes California’s tremendous resources both to an immediately effective response to the current urgent Emergency, but towards the development of an effective, efficient, and sustainable long-term Healthy Woodlands trajectory for the Sierra Nevada.[2] A part of this recommendation is that Sierra and other Counties both offer specific projects and approaches, actively encourage other initiatives and proposals, and otherwise seek the Governor’s assistance in directing California’s human and financial resources to transform these and other projects and proposals into an effective response to the Fuels Emergency with increasing detail as a Response to the Fuels Emergency develops.

The present document forms one of two proposed Projects attached as Appendices to the Consulting Report as concrete illustrations and proposals, to at least contribute to the development of an effective Response to the Fuels Emergency. This Northern Sierra Biomass Project is built around the Loyalton Biomass Project Proposal to the City of Loyalton, also an Appendix to the Consulting Report.[1]

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1 The package of Background Report and Resolutions is available through the Sierra County Board of Supervisors website at http://ca-sierracounty.civicplus.com/AgendaCenter/ViewFile/Item/1442?fileID=1838. Additional context is found in the Memorandum to Interested Individuals and Organizations, from Paul Roen, Chairman of the Sierra County Board of Supervisors, transmitting the package.[5]
2 Geography of the Northern Sierra Woodlands

The dangerous condition of the Northern Sierra woodlands is summarized well in the Staff Background documents prepared in 2014 for the Sierra County Board of Supervisors.[8] The nature of the response to the Emergency is dictated by three sets of geographical considerations: transportation logistics, the regional power transmission system, and special considerations associated with the Lake Tahoe Basin.

2.1 Logistical Geography of Biomass Removals Past and Present

The costs of hauling biomass are major determinants of the best locations for storage and disposal or other use of hazardous fuels removed from the woodlands. In the days of large scale logging, such locations as Sierra, Mohawk, Indian, and American Valleys (as well as Truckee and South Lake Tahoe) were hosts of large-scale lumber milling operations, based on the large acreage, the sawlog hinterlands, that those locations served. The same geographical considerations hold. Locations that once provided low-total-cost milling services for large supplies of sawlogs are similarly low cost for delivery of fuels storage and disposal services from biomass hinterlands at least as large as the old sawlog hinterlands. Loyalton, along with mills at Sattley, Sierraville, Graeagle, and Portola, had a large and important sawlog hinterland which are the natural hinterland (along with areas further South, through the Lake Tahoe Basin, for which Truckee and South Lake Tahoe may no longer be able to fully serve). Empty millsites, such as in Indian Valley and elsewhere, may have space, formerly used for log decks, which may be suitable for short-term emergency stockpiling of material removed from the woodlands, until long term solutions can be found. In the medium term, more proposals, whether for relatively small scale heating-of-public-buildings system, presumably in cogeneration configurations, as for utility-scale trigeneration systems as demonstrated by the Loyalton Biomass Project proposal, are potentially valuable contributions to a Northern Sierra Biomass Project.

2.2 Power System Considerations

Long-term development of biomass-fueled generation in the Northern Sierra demands and supports substantial reinforcement and redesign of the high-voltage transmission system between the eastern regions of the Northern Sierra, served now through NV Energy, and the large and growing markets for renewable energy west of the Sierra Crest. Long term, a critical element of a successful Northern Sierra Biomass Project is the development of a strong Northern Sierra Transmission Interface. The transmission element of the project offers as well, to lower-elevation loads, valuable access to the exceptional solar-power potential of the Great Basin.

2.3 Special Circumstances of the Lake Tahoe Basin

Fuels must be removed. The only facility that can dispose of the removed LTB fuels is at Loyalton.
3 Loyalton Biomass Plant in an Efficient Response

3.1 Biomass CCHP Trigeneration is Least-Cost-Efficient

Proposition 1. Utility-scale trigeneration fueled with woodlands-based biomass, scaled appropriately to support Healthy Woodlands management in the Northern Sierra, delivering renewable energy and possibly a range of ancillary services to the grid and thermal services (heating and cooling) to industrial, significant-scale commercial, and municipal-style systems, exploits substantial economies of scale, provide a least-cost solution to the joint problem of forest-waste disposal and of the delivery of combined cooling, heating, and power (CCHP).

Transparency in woodlands planning will be an essential part of the engineering and design of the fleet of Biomass Trigeneration Facilities that, possibly in combination with other uses of hazardous fuels removed from the Sierra Nevada woodlands at Loyalton as at other sites suitable for generation fueled from the Sierra Nevada woodlands. The Loyalton Biomass Project, along with other contributions to long term solutions to the Emergency, requires the development of an effective long-term Healthy Woodlands trajectory, with known and accepted targets, likely including some tracts for which the target is Management Towards Primeval Conditions (defined somehow), while others may have sustained-yield-of-sawlogs-and-fuels-subject-to-environmental

3.2 Proposition 2. Loyalton Biomass Trigeneration is Long-Term Least-Cost-Efficient for California’s Energy and Healthy Forests Futures

Loyalton, like other long-term-successful sites for lumber milling operations, is a logistically-efficient location for biomass processing, including fueling of trigeneration systems, serving a substantial biomass hinterland in the southern Lassen and Eastern Plumas and Tahoe National Forests, possibly including the Lake Tahoe Basin (a two-state area whose National Forest properties are combined in the USFS Lake Tahoe Basin Management Unit). Potential valuable commercial, industrial, and municipal uses for thermal services exist on and near the current Loyalton site. Transmission at the Loyalton site supports delivery of power to the Eastern Sierra system, and to compete, at high enough power prices (for example, in the presence of a CO2 tax or a sufficiently restrictive cap-and-trade system for greenhouse gases), with the coal-driven pricing of the surrounding NV Energy transmission and market area. One set of renewables-intensive power futures for California involves substantial development of the Northern Sierra Transmission Interface, to deliver the most-valuable-in-world solar resources of the Western Great Basin, as well as essentially unlimited, if costly, geothermal resources, into Lower Elevation Northern California. In those futures, with a strong and reliable Northern Sierra Transmission Interface linking Northeast California into the rest of California’s otherwise-well-integrated system, a fully engineered, appropriately scaled Loyalton Trigeneration Station, with supporting users of thermal services, is a cornerstone of any long-term-efficient solution to the joint planning problems facing California.

Such long-term-efficient solutions involve the design, to existing best practice, supported by on-going research and engineering, of utility scale installations, with the simultaneous and related development of thermal service clients, including both industrial and commercial (including transient housing) and other building services, with substantial visibility between the plant design’s
power characteristics and related transmission planning activities. The planning for a new Loyalton Biomass Plant must take into account both the hazardous fuels disposal requirements of the surrounding fuels hinterland (approximately what once delivered logs to mills North from the South Lake Tahoe to Loyalton and the mills along Highways 89 and 70 East of Lee Summit, while considering such other uses, such as other proposals for town-oriented biomass cogeneration.\textsuperscript{2}

3.3 Proposition 3. Loyalton Biomass Generation is Least-Cost-Efficient for Emergency Response to Northern Sierra Fuels Emergency

The existing Loyalton Biomass Station, without any thermal-services customers, scaled to meet the steam and on-site waste disposal needs of the now-gone Loyalton Mill, delivering power under an obsolete Power Purchase Agreement with no regard to Renewable Energy Credits or other incentives for the delivery of renewable energy in California, cannot recover its going-forward costs, including allowances for several capital costs, without revenue in addition to those it can now earn under its PPA with NV Energy, where it makes no payments for the biomass it would burn. However, the revenue support that it needs in the short term, under all existing commercial arrangements, is small relative to the transportation costs associated with any other existing solution. Co-operative cost-sharing arrangements may be negotiated, with the existing owner, with another conventional for-profit owner, or with a new or existing public-benefit or governmental entity, to support operations of the Loyalton Biomass Plant as a biomass-disposal utility. Operation of the existing facility as a cost-recovering or cost-sharing utility is an efficient and effective short-run solution to the urgent short-run problem of disposal of hazardous-fuels biomass from the Northern Sierra woodlands.

3.4 Proposition 4. Loyalton Site and Biomass Cogeneration and Pilot Trigeneration are least-cost suppliers of building services to the Emergency Response and Healthy Woodlands Program

The development and execution of an effective response to the Northern Sierra and broader Sierra Nevada Fuels Emergencies, as well as the longer-term development and implementation of a Healthy Woodlands policy, will create demands for office and housing space. The Northern Sierra region, similar to other woodlands areas of the Sierra Nevada, has substantial ability to provide attractive living space at costs much lower than in most of California.

The Loyalton Site, in common with other former millsites, has the near-term capacity, with some site preparation for cleanup and isolation of on-site junk and scrap, establishment of water and sanitary services, electric hookups, etc., to provide Emergency housing and office facilities, as it can during response to a forest fire or other disaster.

The Loyalton site has additional advantages for the delivery of office and other building services, be-\textsuperscript{2}Economies-of-scale dictates a few large power plants, balanced by (a) the value of smaller-scale cogen associated with built-up towns, specifically schools and other public offices and facilities, and (b) the economies of localization in mountainous regions. Millsites in and adjacent to towns provide excellent candidate solutions. Valley towns with large food-industry thermal-services potential are also candidates, particularly for solutions that either blend or schedule nuisance Central-Valley agricultural wastes with higher-value woody biomass.
Beyond the substantial residential attractions of Loyalton and the other towns of the Northern Sierra. It has a strong highway connection, via neighboring Truckee, with Sacramento and beyond. It is convenient to full-service Reno-Tahoe International Airport, with General Aviation service through nearby Beckwourth-Nervino Airport and jet-capable Truckee-Tahoe Airport. Its transmission substation, suitable to connect a 20 MW power station to the NV Energy grid, The Loyalton Biomass Plant can, with little additional costs beyond those associated with planning, local plumbing, and installation in specified buildings, deliver low-cost heating to commercial and temporary-housing structures installed adjacent to the existing LBP. On a pilot and experimental basis, with appropriate technical and engineering support, the thermal-service deliveries can be extended, at low cost relative to new installations, to cooling (freezing, refrigeration, chilling and air-conditioning) services. Noting the existence of economies to scale in the conversion of low-cost (waste, in the near-term in Loyalton, and therefore free) heat into cooling, substantial concentrations of structures served by Loyalton Biomass Trigeneration, even using the obsolete and designed-for-other-reasons Loyalton Biomass Station, which could be supported by primary project economics. A near-term efficient and effective Emergency Response, that supports transition towards the long-term-efficient Healthy Woodlands trajectory, will include some use of the Loyalton Site’s thermal-services potential, including the development of trigeneration pilot projects to deliver cooling services useful to the office, short-term-housing, and other building services.

4 Key Elements of the Northern Sierra Biomass Project

4.1 Ownership and Organization

Ownership arrangements have important implications in the medium and long term for incentives for efficient development and operations of the Loyalton Biomass Station and other projects. Several approaches are available, ranging from continued ownership by a private for-profit entity to pure public ownership under several alternative arrangements. The analysis of and selection among alternative ownership arrangements for various elements of the Response to the Northern Sierra Fire Emergency is an important task for the Northern Sierra Biomass Project.

Any ownership arrangements must allow for recovery of the full costs of owning and operating the various elements of the response. The full costs of the Loyalton facility, for example, are shown in Table 2 below. Costs not covered by power market revenues might be met, for example, by a tipping fee of a bit over $65 per truck of chipped biomass. Values received for the delivery of thermal services would reduce, and possibly eliminate or reverse, this charge.

This Proposal assumes, as a starting point for discussion, the creation of a regional Northern Sierra Biomass Project under the auspices of an overarching Sierra Nevada Biomass Project, as sketched in the Consulting Report.[2] Alternative arrangements are possible. Participation of the City of Loyalton, based on its potential role as a supplier of building thermal services as a municipal utility, is a possibility. The Loyalton Biomass Project will identify, evaluate, and choose among alternatives.

Table 1 shows one framework, noting that it is assumed that the Eastern region solution, built around the Loyalton facility, will coordinate with resources in the Lake Almanor region (the north-
ern Northern Sierra) and down the Western Slope through a central office in Quincy, with substantial technical and administrative work performed in Loyalton and elsewhere, as appropriate and economical, as well as in Quincy.
Table 2: Full Annual Cost of Biomass Disposal in the Northern Sierra: Working Example

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<th>Variable</th>
<th>Description</th>
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<td>Power Market Revenues</td>
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<tr>
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<td>Annual Operating Costs $W + M + O$</td>
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<td>$S_B$</td>
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<td>$\bar{R}$</td>
<td>No-Risk Revenue Requirement $L_I + S_B + S_W$</td>
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<td>F</td>
<td>FCRO Disposal Fee Revenue Requirement</td>
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\[
F = R - Y = \frac{\bar{F}}{1 - \frac{m}{12}}
\]

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<tr>
<th>B</th>
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<td>V</td>
<td>Annual Chip-van Loads</td>
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<td>$65.17</td>
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</table>

Reference: Workbook LBP Cost Model v1.2.xlsx, sheet Key Variables
References


[6] Sierra County Board of Supervisors. In the matter of implementing a proclamation of local emergency throughout the Sierra Nevada region of California and requesting support of the Board of Supervisors of the twenty-two Counties of California comprising the Sierra Nevada. Board of Supervisors Resolution 2014-067, County of Sierra, State of California, July 2014.


C Resumés

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Areas of specialization

Power Systems: Medium- and Long-Run Modeling, Renewables Integration, Risk Measurement and Analysis, Market Design

Agricultural and Resource Economics: Energy, Agricultural Marketing, Cooperative Research and Marketing, Agricultural Research Policy

Economics: Models of International Trade with Technological Change, Market-Responsive Induced Innovation, Intellectual Property and Appropriability Regimes, Models of Technologies with high fixed and low variable costs

Positions held


stakeholder processes and advised senior management during Market Redesign Process, drafted tariff language, prepared and delivered testimony

1991-1998
University of California, Department of Agricultural and Resource Economics, Davis, CA. Postdoctoral Research Associate, Assistant Researcher. Perennial-Crop Economic Modeling, Agricultural Research Policy

1989-1991
Laval University, Department of Applied Economics, Quebec City, Canada. Visiting Assistant Professor, taught undergraduate and graduate microeconomics, undergraduate microeconomics and industrial economics (in French)

1983-1988
U.S. National Science Foundation, Washington DC. Science Policy Analyst, Program Officer, Science and Technology Indicators Unit, writing biennial National Science Board’s Science Indicators reports, managing associated grants and contracts.

1981-82
Organisation for Economic Co-operation and Development (OECD), Paris, France. Trainee, consultant, Science and Technology Indicators Group, delivered papers to National Experts working group on role of patents and other intellectual-property arrangements in science and technology policy, contributed chapter to biennial report, initiated and led transfer of international science resources database to magnetic support

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1981
M.Sc in Economics, London School of Economics, London, UK. Exams in Microeconomics, Macroeconomics, Econometrics, and the Economics of Technological Change and Long-Term Growth

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Journal articles, Contributions, Books


**Technical and Consulting Reports**


Other Documents


Projects


