Assessment of Small-Scale Biomass Combined Heat and Power Technologies For Deployment in The Lake Tahoe Basin

Prepared for:

Placer County Executive Office

High Sierra Resource Conservation and Development Council

U.S. Forest Service

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ACKNOWLEDGMENTS

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- Joel Swift, Placer County Facility Services Department
- Bruce Goines, U.S. Forest Service

1. Executive Summary

TSS Consultants (TSS) has conducted a study to evaluate existing technologies that produce electrical energy and heat from biomass materials with air emissions low enough to be able to be permitted and other attributes that will allow the technology to be utilized in the Lake Tahoe Basin. The study assessed the possibility of combined heat and electrical power (CHP) generating technology, utilizing locally available fuels (i.e. woody biomass fuels easily accessible and obtainable with no new access road construction in the forest) that would otherwise be wasted resources. Biomass technologies, both direct combustion and gasification systems were evaluated, with the goal of being environmentally compatible and permittable in the Lake Tahoe Basin.

As previously stated, the technical assessment for this study reviewed the technologies for CHP application. However, the heat component of the application was considered an complementary adjunct to the electric power component with the potential of improving the economics of the overall project.

1.1. Results

The results of this preliminary feasibility study are as follows:

- It appears that a new biomass facility using all three of the finalists can be permitted in the Lake Tahoe air basin for construction and operation.
- Of the biomass utilization technologies reviewed, the Advanced Recycling Equipment (ARE) direct combustion system with a condensing steam turbine/generator was the highest ranked and shows good economic and technical promise for the proposed application**.**
- To develop a biomass power plant using the highest ranked technology (ARE), TSS analyses show that the prices at ($25/BDT) for the electric output would range from $0.098/kilowatt hour (kWh) with public/private financing to $0.134/kWh for private financing. This would be the kWh price the facility would need from the utility that would purchase the electrical output of the biomass power plant. The kWh prices incorporate the benefit of heating a building and sidewalks/driveway heating for snow removal. However, the percentage of cogeneration potential (i.e. using the power plant waste heat) is relatively low at potential Burton Creek site (less than 5%).

1.2. Recommendations

Based on this analysis TSS has the following recommendations:

- As it appears that a new biomass power plant facility may be viable at the potential Burton Creek site (or other sites in the Lake Tahoe Basin) even with the low cogeneration, the next phase of the project development should move forward. This next phase should involve the following:
    - Air/Water Pollution and Carbon Credits/Offsets Study
    - Business Plan
    - Logistics Study
    - Energy Economics Analysis
    - Biomass to Energy Technical Requirements Statement of Work and Request For Proposal Process Development Plan
    - New Source Review Permit Analysis
    - Woody Biomass Fuel Source Analysis
    - Communication Plan/Guidebook Preparation

- As there is already 1 MW worth of woody biomass currently being transported out of the Lake Tahoe Basin to existing biomass plants. Thus, not only is there currently enough biomass routinely removed for a 1 MW power plant in the Basin, keeping in the basin would reduce the more long distance truck transportation and its related emissions of pollutants and greenhouse gases.
- To potentially improve the economics, via higher use of cogeneration, Placer County should also review other sites in the North Tahoe area.
- With the work to be conducted for the Air/Water Pollution and Carbon Credits/Offsets Study mentioned above, Placer County might be able to increase the size of the power plant project (up to 3 MW). This will improve overall economics, plus be able to utilize additional woody biomass from continued removal of hazardous woody fuels in the Lake Tahoe Basin region.

2. Project Approach

2.1. Introduction

TSS Consultants was retained by Placer County, via the High Sierra Resource Conservation and Development Council, under a grant from the California Association of Resource Conservation and Development Councils and the U.S. Forest Service (with matching funds from Placer County), to conduct a study to evaluate existing technologies that produce electrical energy and heat from biomass materials with air emissions low enough to be able to be permitted and other attributes that will allow the technology to be utilized in the Lake Tahoe Basin. The study assesses the possibility of combined heat and electrical power (CHP) generating technology, utilizing locally available fuels that would otherwise be wasted resources. Biomass technologies, both direct combustion and gasification systems were evaluated, with the goal of being environmentally compatible and permittable in the Lake Tahoe Basin.

By siting a small woody biomass power plant facility in the Lake Tahoe Basin, several objectives can be met:

- A local facility that can accept and use local woody biomass in an economic manner that will facilitate planned forest thinning operations designed to reduce catastrophic wildfire occurrence in the Basin;
- A local facility that can accept and use local woody biomass wastes as opposed to open burning it to the detriment of the Tahoe airshed, resident's health, and Lake Tahoe water quality;
- A local facility that will reduce the amount of transportation costs and air emissions from having to truck forest thinnings out of the Basin to distant utilization facilities and/or disposal sites;
- A local facility that can add to the electrical grid reliability in the Basin; and
- A local facility that can potentially replace existing emergency back up diesel fuel-fired generation.

This study provides a project assessment with the goal of being environmentally sound, socially compatible, and economically viable, employing appropriate combined heat and electrical power (CHP) generating technology and utilizing locally available fuels that are underutilized.

2.1.1. Background

Wildfire is a severe and continuing problem in many parts of the Inland West, including the Sierra Nevada Mountains. This problem reaches its zenith in the Lake Tahoe Basin with it significant human population and the need to protect Lake Tahoe for both its environmental and economic assets.

The High Sierra Resource Conservation and Development Council (HSRCDC) and Placer County are actively working with public and private forest management organizations, including the U.S. Forest Service, California Department of Forestry and Fire Protection, and local Fire Safe Councils, on a number of forest fuels reduction projects to reduce the potential for catastrophic wildfire events. The Placer County Strategic Plan for the Wildfire Protection and Biomass Utilization Program, along with the North Tahoe Community Wildfire Prevention Plan and the Placer Local Hazard Mitigation Plant (all approved by the Placer County Board of Supervisors), serves in coordinating the wildfire reduction and biomass development activities.

The fuels reduction projects include selective thinning and removal of trees and brush to return forest ecosystems to more natural stocking levels, resulting in a more fire-resilient forest. These forest thinnings can produce a significant volume of woody biomass material that can become a disposal issue. Because this biomass material currently has very little commercial value, most agencies and landowners are faced with the expense of disposal by pile burning, chipping and spreading, or hauling it to remote disposal sites at considerable expense. Utilizing woody biomass generated from the thinning of hazardous forest fuels to generate electrical power and heat is a conversion option that the HSRCDC and Placer County would like to pursue. A critical initial step in the pursuit of this potential opportunity is an understanding of which conversion technologies could be available to optimize the conversion process.

The technology assessment was conducted with a focus on gasification/combustion systems in a CHP application. The assessment was not limited to gasification only, but included potential advanced direct combustion technologies that could potentially meet the stringent air quality standards of the Lake Tahoe Basin (Tahoe Regional Planning Agency), the Placer County Air Pollution Control District (PCAPCD), and the U.S. Environmental Protection Agency.

TSS utilized it database of biomass technology companies to compile appropriate and available technical, operational, and environmental information on over 40 companies/vendors.   TSS then systematically reviewed the benefits, challenges and trade-offs of differing technologies to ascertain which particular technology might be best suited for the particular application. For the Lake Tahoe Basin site, TSS recommends addressing the following parameters:

- Air emissions and air quality standards
- Site considerations such as land use constraints, water supply, etc.
- Conformance with proposed land use of potential site
- Community, regulators, and stakeholder acceptance
- Power/heat – proposed demand on site
- Project economics
- Water use/wastewater discharge
- Estimated capital investment
- Ash composition
- Excess/emergency power potential for the local grid

2.1.2. Potential Project Site and Parameters

For this biomass power technology assessment, the potential new Tahoe Justice Center at Burton Creek was considered as a candidate site for the biomass power plant as it is also a candidate to accept waste heat for non-electric utility needs of the Center's buildings as well as the possibility of installing a snow melting system for the Center's parking areas using residual heat from the power plant. The location and site plan for the Burton Creek facility is shown in Exhibit 2-1 and Exhibit 2-2.

For this project assessment, the amount of sustainable woody biomass fuel that would be available for the power plant was set at approximately 8,000 bone dry tons per year. This would allow for a power plant facility to be sized at approximately 1 MW (depending on technology) and also be able to supply waste heat for cogeneration purposes.

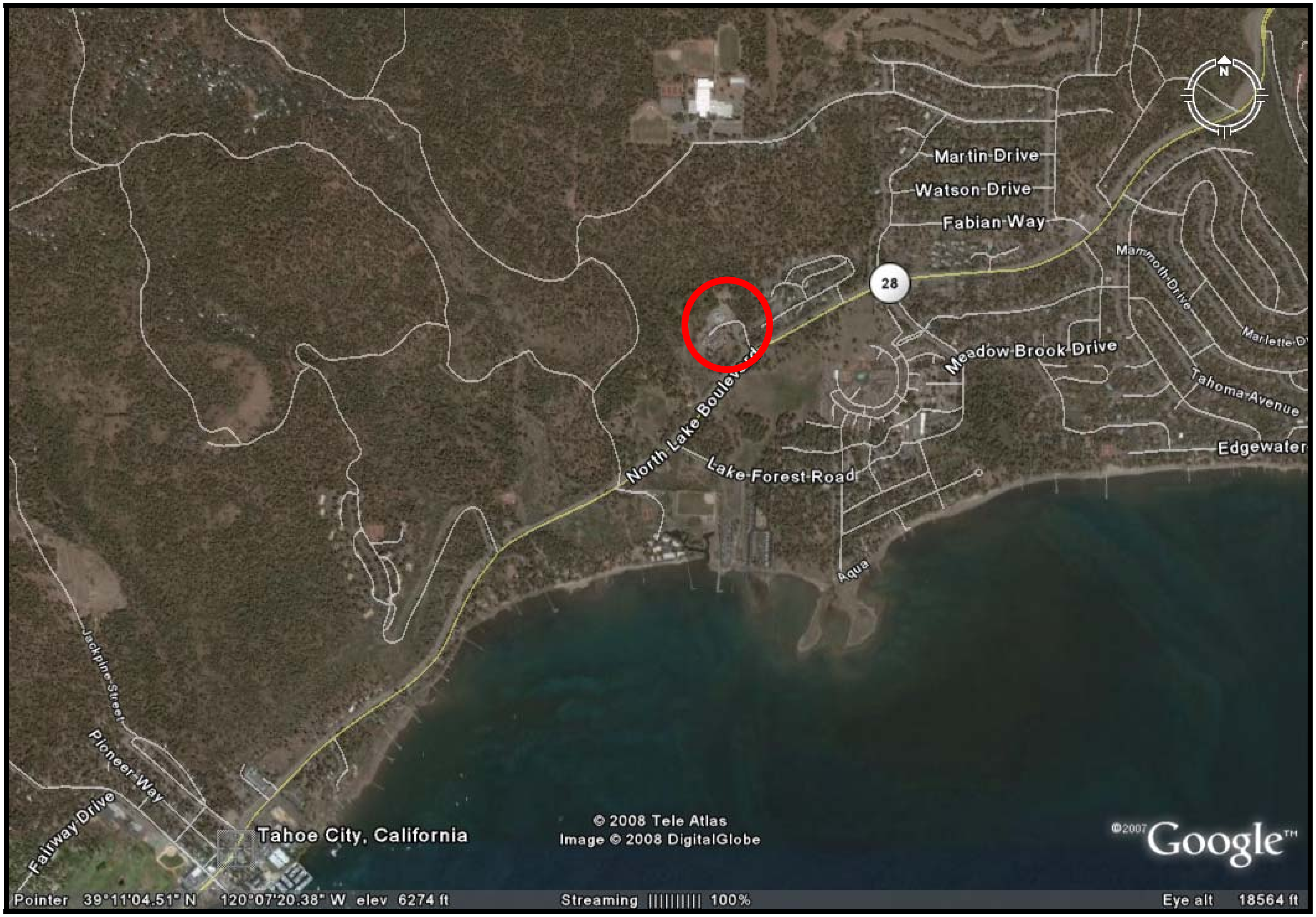

Exhibit 2-1: Burton Creek – Tahoe Justice Center Location

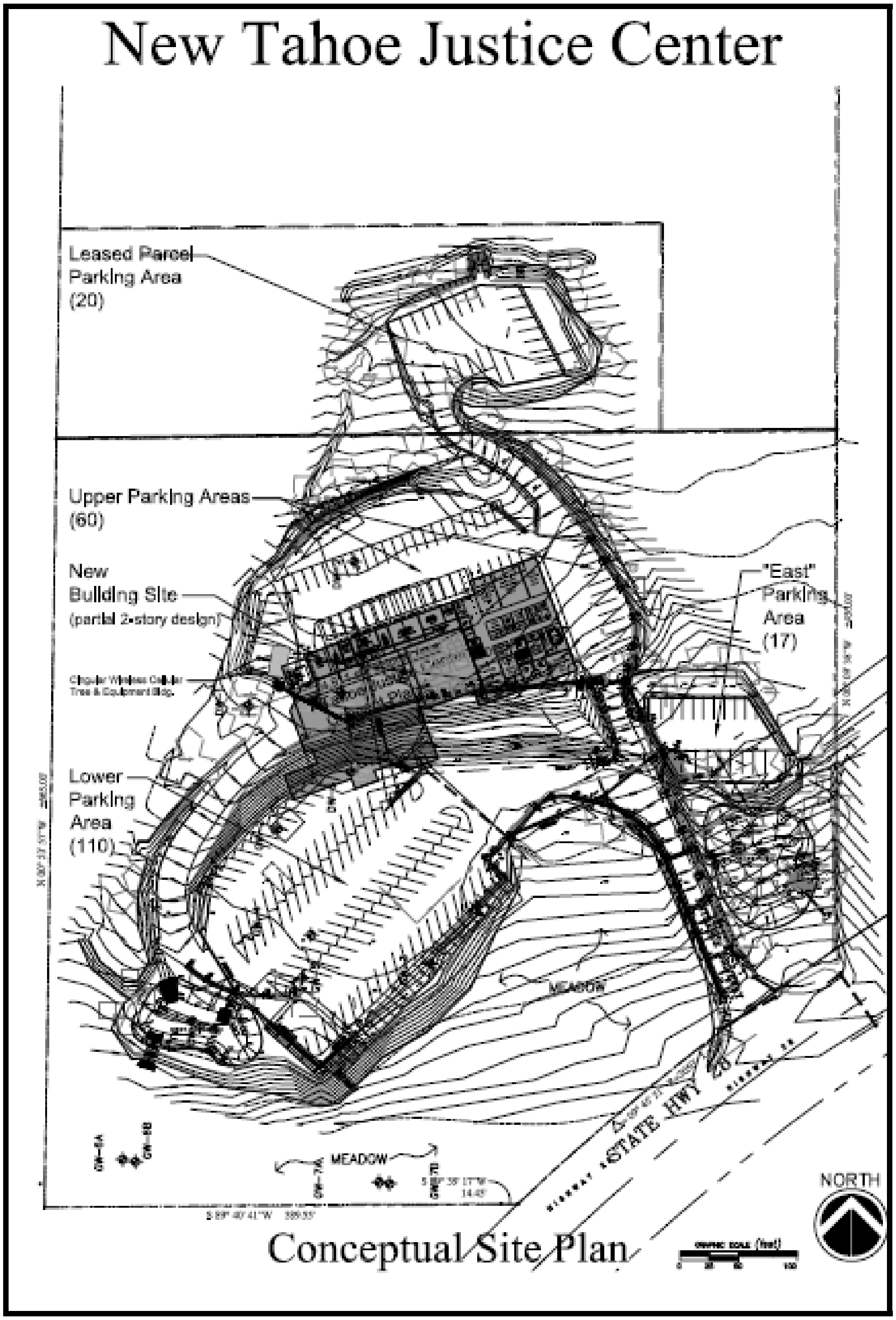

Exhibit 2-2: Proposed New Tahoe Justice Center at Burton Creek

3. Technology Assessment

Biomass utilization was assessed to provide electricity and the potential use of waste heat produced by generation of the electricity. TSS has developed a technology assessment framework that has been utilized in conducting several other biomass technology assessments. The technology assessment framework consists of the following:

- Technology database review;
- Initial selection of technology vendors;
- Prepare and disseminate Statement of Interest;
- Review of responses with technology matrix summary;
- Selection of final technology vendor(s);
- Financial analysis.

3.1. Findings

The technology assessment involved the systematic review of a large database of biomass utilization companies, which resulted in the initial selection of 28 technology vendors to be the recipients of a Statement Of Interest (SOI). The SOI solicitation to these vendors resulted in TSS receiving responses from 11 technology companies. The 11 technical responses were evaluated with ultimately 3 companies being chosen for further financial analysis in Section 4.

3.2. Technology Description

3.2.1. Biomass Utilization

Biomass, such as woody wastes from forest residues, biosolids from wastewater treatment, and municipal solid waste (MSW) can be supplied to energy conversion systems and converted to useful steam, heat, or combustible gases. These energy conversion systems vary widely but fall under two basic categories, gasification and direct combustion.

3.2.2. Gasification

Gasification is the thermochemical conversion of organic solids and liquids into a synthetic gas (syngas) under very controlled conditions of heat and strict control of air or oxygen. The syngas formed by gasification is composed primarily of hydrogen (H_2), methane (CH_4), and carbon monoxide (CO). Gasification also produces carbon char and ash that remain as solids and must be disposed of or may be used for other products (e.g., ash as a soil amendment).

The syngas can be used as a primary fuel in electrical generating units such as a reciprocating internal combustion engine or in a gas turbine. It can also be used as fuel to produce steam or hot water for heating and/or manufacturing processes. In addition to producing syngas from biomass, there are several processes and technologies attempting to produce commercially viable liquid fuels such as ethanol and "green" diesel from biomass (also known as biodiesel). Exhibit 3-1 illustrates one form of a gasification system.

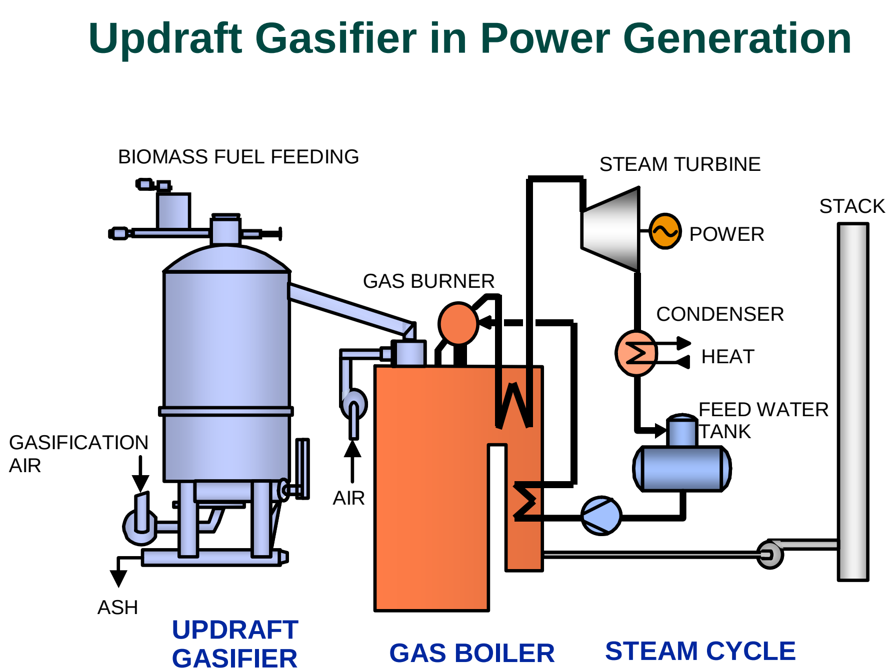

Exhibit 3-1: Small Gasification System Schematic

The earliest uses of gasification date back to the production of city gas from coal in the late 1800's. Gasification of coal has been in commercial use for more than

50 years with the syngas used to produce chemicals. More recently, gasification of coal has been applied to power generation at a few large integrated gasification combined cycle plants in the U.S. and others outside the U.S. Gasification of biomass resources is currently on the upswing in Europe and there is much interest in the U.S.

3.2.3. Direct Combustion

In direct combustion systems, the biomass fuel is directly burned (combusted) in some type of furnace or combustion unit that then supplies heat to a boiler. Most commercial biomass power applications today use boilers in conjunction with a steam turbine to generate electricity. Exhibit 3-2 illustrates a direct combustion system flow process.

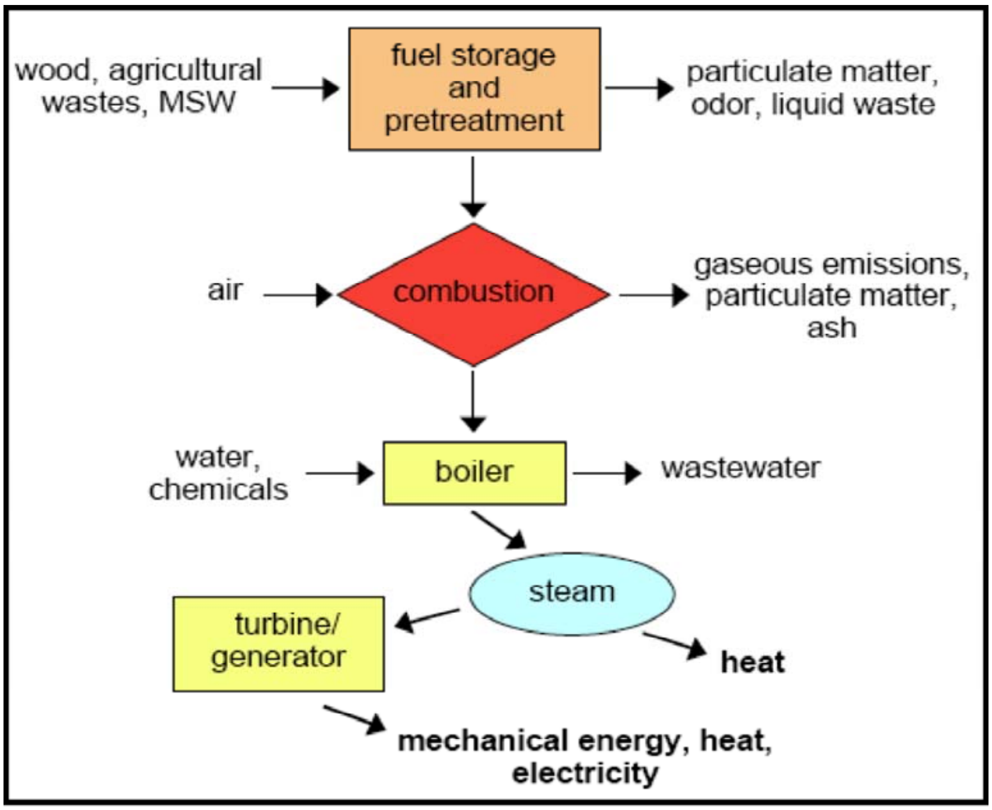

Exhibit 3-2: Direct Combustion Schematic

3.2.4. Biomass Gas Turbine

This technology consists of pressurized hoppers that feed the wood fuel into a pressurized combustor. The hot combustion gasses are passed through a cyclonic separator to remove particulate matter and then directly into the turbine section of a gas turbine. The gas turbine is connected to an electrical generator to provide electrical output. The hot gasses exiting the turbine can be used to generate steam or hot water for cogeneration purposes. Water requirements would be very low since there is no cooling water requirement.

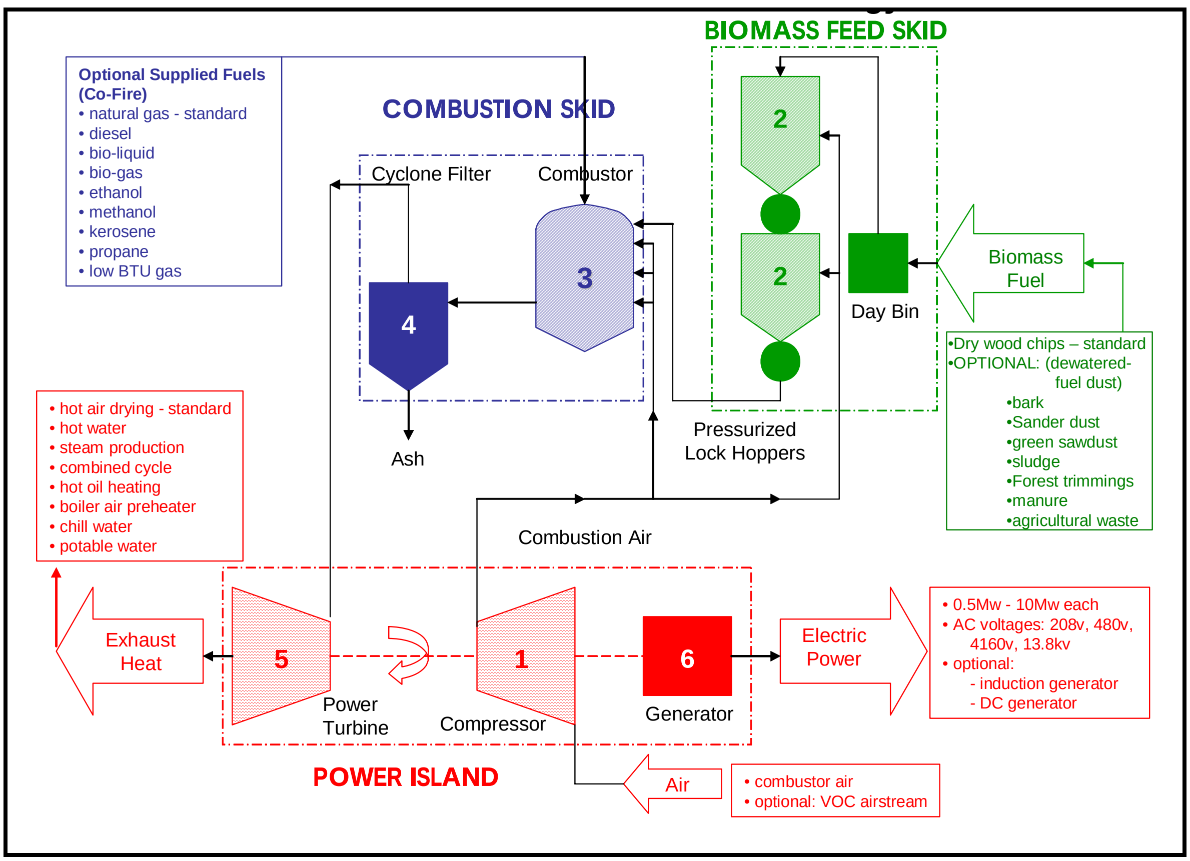

Exhibit 3-3: Biomass Gas Turbine Schematic

3.3. Technology Database Review

TSS maintains a very large database on various biomass gasification and combustion technologies and vendors of those technologies. This database contains information on nearly 250 biomass combustion and gasification technology vendors worldwide. The database was created from numerous private and public sectors sources.

This large database was examined with the technology goals of the project in mind, i.e., gasification or very clean (i.e. low air emissions) combustion technologies. Forty-seven (47) technology vendors were identified to receive the Statement of Interest (SOI – see Section 3.4below). The list of the 47 recipients can be found in Appendix B.

3.4. Statement of Interest

As opposed to a more formal Request for Proposals, the SOI format was considered more suitable for a preliminary feasibility assessment. It allows for the collection of requested information from prospective vendors for a project that is not fully defined and is in the initial stages of consideration. A copy of the SOI is contained in Appendix A.

The SOI was prepared with the following parameters and information requests.

- Project overview – location and type of project proposed;
- Project objective – select woody biomass CHP technology that can be used in Lake Tahoe Basin;
- Technology requirement – gasification or very-clean combustion;
- Air emissions – facility to be located in the very sensitive Lake Tahoe air shed;
- Feedstock parameters – biomass limited to forest residues;
- Interface – with Sierra Pacific Power local grid;
- Project schedule – operational 2010/2011
- Selection for further consideration criteria – six criteria include baseload (24/7 generation) ability, good operating capacity, technical and commercially viable technology, environmental impacts, and estimated capital and operating costs;
- Contents of response submittal – responses were to include description of technology, potentially needed infrastructure, potential environmental impact, estimated turnkey price, and statement of technology vendor qualifications;
- Deadline for response – April 30, 2008 (but flexible to ensure responses);

- Contact – TSS contact information supplied.

The SOI was sent electronically the week of April 1, 2008 to the 47 vendors listed in Appendix B.

3.5. Initial Selection of Vendors

Of the 47 recipients, 28 responded in one form or another, i.e. responded with information per the SOI, declined to reply due to prior commitments or did not have the appropriate technology, or said they would reply but did not. The 28 technology vendors are as follows.

- Advanced Recycling Equipment
- Black & Veatch
- Chiptec
- Community Power
- Detroit Stoker
- Emery Energy
- Enerwaste
- Envirocycler
- Frontline Energy
- GEM Americas
- Grand Teton
- HIS Prime Energy
- Hurst Boiler
- Interstate Waste Technologies
- Johnson Controls
- Nexterra
- Nova Fuels
- Power Energy
- Powerhouse Energy
- Prime Energy
- Siemens
- Taylor Recycling
- Thermo Energy
- Thermogenics
- Torgtech
- Wartsila
- West Biofuels
- Xylowatt
- Zilkha Biomass Energy

Eleven (11) of the identified technology vendors appeared to submit enough information to conduct the next step of the selection process.

3.6. Review of Responses

The following technology vendors that submitted enough information for evaluation were:

Advanced Recycling Equipment, Inc. (St. Marys, PA) - Direct Combustion
Power Ecalene Fuels, Inc. (Arvada, CO) - Gasification
Primenergy, LLC (Houston, TX) – Gasification
EnerWaste, Inc. (New York, NY) - Gasification
GEM Americas, Inc. (Toronto, ON) – Gasification.
PowerHouse Energy (Pasadena, CA) – Gasification
Thermogenics, Inc. (Albuquerque, NM) – Gasification
Johnson Controls (St. Louis, MO) – Gasification.
Xylowatt (Charlerol, Belgium) – Gasification
Emery Energy (Salt Lake City, UT) – Gasification
Zilkha Biomass Energy (Houston TX) – Combustion/Turbine

3.7. Technology Matrix

A technology evaluation matrix was prepared and used to rank the responses to the SOI. The evaluation criteria consisted of:

- Proven Technology: Are there actual units of similar size with operating history in the field on a commercial scale and sold to commercial entities?

- Biomass Utilization Experience: Does the equipment have a history of using biomass as raw material?

- Air Emissions (projected): Has the equipment demonstrated control of air emissions to comply with Best Available Control Technology (BACT) standards? The air quality standards for this project are high due to location at Lake Tahoe, California.

- Water Supply/Wastewater Emissions: What are water supply needs and wastewater discharge requirements?

- Capital Costs: Does the company have actual experience installing units, with actual capital investment and operating costs?

- User Friendly Operation (Projected): Does the technology company have demonstrated ability to operate units using trained local personnel?

A weighted score of 0 to 10 was given in each of the above categories (10 being highest and most responsive to the evaluation criteria category). A total of 60 points was the maximum achievable for any given technology vendor. The matrix evaluation follows in Table 3-1 below.

Table 3-1: Biomass Renewable Energy Facility Evaluation Matrix
Weighted Value Range: 0 to 10   10 = highest rank 0 = lowest rank

	Vendor and Lead Contact	Technology	Biomass Utilization Experience	Air Emissions	Water/ Wastewater Impacts	Capital Costs	User Friendly Operation	Total Points	Comments
1	Advanced Recycling Equipment, Inc. St. Marys, PA Don Kunkel dkare@alltel.net	10	10	7 (with controls)	4	9	9	**49**	Needs NOx control – advanced direct combustion
2	Power Ecalene Fuels, Inc. Arvada, CO Gene Jackson genej@powerenergy.com								Not responsive to SOI. Appears to only make biofuels. No facilities in operation
3	Primenergy, LLC Houston, TX Bill Tietze btietz@primenergy.com	**7**	**7**	4	4	0 (no capital costs given)	**7**	**29**	No capital costs given. Would need NOx control due to standard steam cycle system for syngas
4	EnerWaste, Inc. New York, N.Y. Robert Stoodley rstoodley@aol.com	**7**	**7**	4	4	5	4	**31**	Not clear as to number of systems in the 1 to 3 MW range. Will need NOx control due to standard steam cycle system for syngas
5	GEM Americas, Inc. Toronto, ON Dougles Weltz Douglas_weltz@gemamericainc.com	6	5	5	7	3	4	**30**	Lots of processing and drying equipment drives up cost and complexities. Limited experience in the 1 to 3 MW range.
6	PowerHouse Energy Pasadena, CA Kevin Butler KButler@powerhouseenergy.net	6	5	8	8	4	6	**37**	Capital cost for Pyromex gasifier component seems very high- current cost will hurt in econ analysis
7	Thermogenics, Inc. Albuquerque, NM Tom Taylor linvent@aol.com								Not Responsive upon further examination of submitted information – no size, no details, no costs
8	Johnson Controls St. Louis, MO Alan Kirn Alan.Kirn@jci.com	7	8	7	7	5	6	**40**	Gasification with IC will need NOx control

	Table 3-1: Biomass Renewable Energy Facility Evaluation Matrix Weighted Value Range: 0 to 10 10 = highest rank 0 = lowest rank								
	Vendor and Lead Contact	Technology	Biomass Utilization Experience	Air Emissions	Water/ Wastewater Impacts	Capital Costs	User Friendly Operation	Total Points	Comments
9	Xylowatt Charlerol, Belgium Frederic Dalimier dalimier@xylowatt.com	7	6	5	7	4	6	**35**	Cap costs high, no presence in U.S. Will need NOx control
10	Emery Energy Salt Lake City, UT Ben Phillips bphillips@emeryenergy.com	6	5	7	7	5	5	**35**	Capital costs submitted include construction
11	Zilkha Biomass Energy LLC Houston, TX Jeffrey McMahon jmcmahon@zilkhabiomass.com	7	8	7	8	7	7	**44**	Will build, own, and operate and sell electricity and thermal.

DEFINITIONS:

Proven Technology: Are there actual units of similar size with operating history in the field on a commercial scale and sold to commercial entities?
10 = Many same scale units operating over 5 years with same design and fuels.
5 = Some similar scale units operating over 2 years with similar design and fuels.
0 = No same size units operating in the field.

Biomass Utilization Experience: Do they have experience in biomass utilization?
10 =Experience in combusting woody biomass forest residuals.
5 = Experience in combusting woody biomass, but not necessarily forest residuals.
0 = No experience in combusting woody biomass.

Air Emissions (projected): Demonstrated ability to control air emissions to comply with Best Available Control Technology (BACT) standards.
10 = Demonstrated ability to control air emissions to an "ultra-clean" level.
5 = Demonstrated ability to control air emissions to meet AZ standards.
0 = No demonstrated ability to control air emissions.

Water/Wastewater Impacts: Technology requires water and discharges water.
10 = Requires little water for process and discharges a minimal quantity of water
5 = Requires considerable water for process and discharges a considerable quantity of water that cannot go to sewer or storm drain.
0 = Requires a lot of water and discharges a lot of wastewater that cannot go to sewer or storm drain.

Table 3-1: Biomass Renewable Energy Facility Evaluation Matrix Weighted Value Range: 0 to 10 10 = highest rank 0 = lowest rank									
	Vendor and Lead Contact	Technology	Biomass Utilization Experience	Air Emissions	Water/ Wastewater Impacts	Capital Costs	User Friendly Operation	Total Points	Comments
Capital Costs: Actual experience in installing units pursuant to total capital cost budget. 10= Demonstrated ability to complete turnkey project in accordance with a capital budget. 5 = Demonstrated ability to complete their portion of the budget, but not turnkey. 0 = No installation experience to date.									
User Friendly Operation (Projected): Demonstrated ability to operate units with training of local personnel. 10 = Demonstrated user-friendly operation with minimally trained local personnel. 5 = Systems operated with trained personnel, imported from outside the local region. 0 = No systems operating.									
Total Points: Simple arithmetic summing of rankings; no attempt at weighting score by category.									

3.8. *Selection of Final Technology Vendors*

The top three scores were selected as potential candidates for the project and were to be included in the financial analysis task (Section 3.9). These were:

- Advanced Recycling Equipment – 49 points
- Zilkha Biomass Energy – 44 points
- Johnson Controls, Inc. – 40 points

However, Johnson Controls did not respond to requests for additional information necessary for conducting the financial analysis for this report, so the fourth highest-ranking company was substituted for them. This was:

- Powerhouse Energy – 37 points

The three technologies selected for this final evaluation step are discussed below.

<u>Advanced Recycling Equipment</u>

Advanced Recycling Equipment (ARE) is categorized as a direct combustion technology. The system proposed for the Placer County project is detailed in Appendix C. A similar ARE boiler unit is shown in Exhibit 3-4 below.

Exhibit 3-4: ARE Biomass Combustion Unit

The following outlines the ARE proposal:

- Includes: One (1) 30 MMBTU[1]/hour combustion unit, one (1) 400 cubic yard fuel handling unit, one (1) 20,000 PPH steam boiler, one (1) 1,000 kilowatt[2] (kW) multi-stage condensing steam turbine/generator and all support equipment for the combustion, steam, and feed water system. Emissions equipment consisting of multi-clone, baghouse (PM control), and SNCR (NOx control). Installation drawings for entire thermal train, from fuel storage to stack, service and operating manuals, operator and maintenance training.
- Does not include: Site preparation, system installation (including all foundation work, electrical, plumbing, etc.), and building enclosure. Installation and supply of interconnecting cables, switchgear and connection to the grid or electrical load, chemical treatment station and water softener package, fuel processing and receiving, and permitting. All equipment detailed by ARE in proposal are FOB Point of Manufacturing (East Coast).

Cost estimate: $3,500,000 (without SNCR)

During follow-up interviews conducted by TSS, Don Kunkel of ARE stated that SNCR would add about $400,000 to the estimated cost. Shipping, installation of the proposed equipment, and a building to house the equipment were estimated to add an additional $1,100,000 for a total cost of about **$5,000,000.**

Zilkha Biomass Energy

The Zilkha technology consists of pressurized hoppers that feed the wood fuel into a patented, pressurized combustor. Thus, it is also categorized as direct combustion. The hot combustion gasses are passed through a cyclonic separator to remove particulate matter and then directly into the turbine section of a gas turbine. The gas turbine is connected to an electrical generator to provide electrical output. The hot gasses exiting the turbine can be used to generate steam or high temperature water to meet thermal loads. Water requirements would be low since there is no cooling water requirement for condensing steam.

Zilkha's responses to the SOI are attached in Appendix C.

Cost estimate: $5,300,000[3]

Zilkha did not provide an installed cost in its SOI response, only an estimated cost of electricity and thermal heat (which offsets natural gas for heating). To calculate the installed cost so Zilkha could be compared to the other two technologies, TSS used

[1]MMBTU – Million British Thermal Units of measure.
[2]Kilowatt - A unit of electrical power equal to 1,000 watts or 1.341 horsepower.
[3] Zilkha did not supply the requested capital cost estimate directly. TSS calculated the capital cost based on the information that was supplied

their submitted costs of $0.135/kWh (electricity) and $12.00 per MMBtu (natural gas). Zilkha arrived at these prices using $25/BDT as the cost of biomass fuel. Applying the economic model used in the Financial Analysis section and conducting reverse calculations, TSS estimated Zilkha's installed cost to be approximately **$5.3 million**.

The Zilkha proposal is for Zilkha to build, own and operate the facility and sell electricity and thermal energy to Placer County and excess electricity into the grid. This arrangement is the only one that Zilkha reportedly will consider.

Exhibit 3-5 displays a biomass facility Zilkha is installing in New Hampshire.

Exhibit 3-5: Zilkha Installation in New Hampshire

<u>Powerhouse Energy</u>

Powerhouse, categorized as a gasification technology, provided two options, both of which would utilize a proprietary, Pyromex, 25 ton/day biomass gasification reactor. Gas generated in the reactor would then be used in either a GE Jenbacher internal combustion engine or a fuel cell to generate electricity. Residual heat from the Jenbacher or the fuel cell would be used to provide steam or high temperature water to meet thermal load. Water requirements would be low since there is no cooling water requirement for condensing steam. There is no combustion or release of gas to the atmosphere from the Pyromex reactor. Both the Jenbacher ICE and the fuel cell are expected to meet Lake Tahoe air emission requirements.

Cost estimate: $9,400,000 (with Jenbacher ICE)

The estimated cost is relatively high due to the cost of the Pyromex gasifer that comprises over 70% of the total capital cost. The Powerhouse submittals are contained in Appendix C.

Exhibit 3-6: Pyromex Unit (partial view)

3.9. Financial Analysis

The estimated project economics of the final technology vendors, ARE, Zilkha, and Powerhouse, are analyzed in this section. Wood fuel from the Lake Tahoe area was assumed to be available at 25-30 tons/day and have a heating value of 8,500 Btu/lb.

The final vendors were analyzed using both public and private financing and for assumed wood fuel prices of $15, $25, and $45 per ton. Two public financing cases were analyzed for each of the vendors; financing with one hundred percent debt at 7% and with public funding with zero cost to the project. The private financing cases were assumed financed with 25% equity at a cost of 15%, and 75% debt at a cost of 9%. This resulted in nine cases calculated for each of the three technologies for a total of 27 calculated costs of electricity from the proposed facility. An important assumption in the financial analysis is the quantity of residual heat from the facility that can be utilized to meet thermal loads.

3.9.1. Estimated Heat Load

The co-location of a biomass power plant with a thermal host has the potential to improve the economics of both the power plant and the thermal host. Waste heat from an electric power generation system can be used to heat buildings instead of burning natural gas to produce heat. This is commonly done in Europe, where many municipalities use biomass-fired energy in the form of hot water and/or steam . Such systems can displace enough higher-priced natural gas with biomass to produce heat that electricity may not even have to be generated to provide substantial economic benefits.

Use for the waste heat produced as a byproduct of the electrical generation process, such as heating buildings, allows the biomass power plant to have two potential revenue streams, i.e. electric power and heat. At the potential Burton Creek site the waste heat from the power plant could be used for the proposed Justice Center building (heating and hot water), as well as heat for a snow melting system under the parking lots and concrete walkway and stairway areas[4].

The following sections provide an estimate of the thermal load at the potential Burton Creek site.

Justice Center Building

The heat and electrical loads for the proposed Placer County building at the potential Burton Creek site were estimated based on the heat and electrical loads of the existing building at the site.

The existing building(s) at Burton Creek have a total area of 17,070 square feet. Of this, 11,301 square feet are heated (the remaining area consists of garage and storage). Of the 11,301 square feet, 8,373 square feet (74%) is occupied by law enforcement.

The new, proposed building would be 37,382 square feet in area and 23,310 square feet (62%) of that will be law enforcement area.

The current heat and electrical use in the existing building is 65,879 btu/ft^2/yr. and 18.5 kWh/ft^2/yr. These energy uses were used for the new, proposed

[4] All electricity generated from the biomass power plant will be transmitted directly to the utility grid, not the Justice Center

building with adjustments made for more energy efficient construction in the new, proposed building.

New building construction is generally more energy efficient than older buildings. While the exact increase in efficiency of the new, proposed building is unknown, a factor of 10% more energy efficient seems reasonable. Thus a factor of 0.90 was applied to the unit uses of the existing building to apply them to the area of the new, proposed building.

The result of reducing the unit energy use of the existing building for the difference in increased building energy efficiency was a unit thermal use for the new, proposed building of 49,901 btu/ft^2/yr. and 14 kWh/ft^2/yr. These unit uses were multiplied by the new, proposed building area of 37,382 ft^2 to provide the total estimated energy use for a year (see Appendix D and the spreadsheet entitled "Building" for the calculations).

Pavement Heating

Part of the thermal output from the biomass electrical generating facility could be used to heat the paved area at the facility to remove snow and ice. The amount of heat required for this was estimated using an average snowfall for the site and typical quantities of heat required to melt the snow.

The average annual snowfall at the lake level for Lake Tahoe is 125 inches. This snowfall was assumed for the Potential Burton Creek site.

The estimated heat required to melt this snow was obtained from design factors, and the factor used assumed a rate of snowfall of 2 in/hr. The heat for this rate of snowfall is about 44 watts/ft^2.

It was assumed that the entire pavement area of 118,938 ft^2. would be heated. The calculations and resulting pavement heat load are shown on the spreadsheet entitled "Snow Load".

Total Thermal Load

The total annual thermal load for the potential Burton Creek site is the sum of the building heat load and the pavement snow removal heat load, or about one billion one hundred seventeen million Btus.

Estimated Percent of Heat Load Utilized

The typical thermal residual heat available from a 1 MW biomass electrical generating plant is about 30 billion Btus/yr. The estimated heat load of 1.1

billion Btus/yr at the potential Burton Creek site would be able to utilize only about 3-4% of this residual heat.

3.9.2. Estimated Cost of Electricity

Using a standard financial model, TSS found that based on the parameter inputs in Table 3-2, below; the costs of electricity are as shown in Table 3-2 for the various ownership/financing assumptions. These costs represent the price that would have to be obtained for the electricity generated to make the facility economically feasible.

As stated above in Section 3.9.1, the use of waste heat from the electric power plant in a CHP arrangement can add to the revenues that a power plant could receive. However, given the relatively low percentage of waste heat that the potential Burton Creek facility needs, the proposed biomass power plant will need to rely almost completely on the sale of electric power as its operating revenue source

Table 3-2: Technology Specifications Used for Biomass Power Plant Financial Analysis

Parameter	Advanced Recycling Equipment	Zilkha Biomass Energy	Powerhouse Energy
Plant size (MW net)	1.25	1.05	0.775
Total net output (MWh/year)	9,855	8,278	6,110
Capacity factor - %	90	90	90
Operations (days/year)	329	329	329
Fuel volume (BDT/year)	8,972	6,852	4,060
Fuel cost ($/BDT)	$15, $25, $45	$15, $25, $45	$15, $25, $45
Production Tax Credit ($/kWh)	0	0	0
Project capital cost ($million)	5.5	5.3	9.4
Amount of residual heat utilized - %	3.5	3.5	3.5
Sales price for heat ($/kWh)*	$0.0239	$0.0239	$0.0239
Project O&M cost excluding Fuel ($/year)	$365,700	$462,000	$537,100

**This is the equivalent price of using waste heat from the power plant to offset the cost of heating with natural gas. The cost of heat in $/kWh is calculated from the price of natural gas in the economic model used for this assessment. $7.00 per MMBtu is approximately the current price of natural gas and that value of natural gas is used in the economic modeling.*

The prices of electricity calculated for each of the three final technology vendors in Table 3-2represent three financial/ownership scenarios and three fuel costs. Using the financial model and the inputs from Table 3-1, the scenarios calculated are as follows:

Public/Private Partnership Funded – Zero Cost of Money:

This scenario assumes that the facility would be developed using public money that would have no cost to the project. These funds are assumed to come from contributions by Sierra Pacific Power and other entities. Since there would be no costs of financing the project, the costs for this scenario for the three final technology vendors would result in the lowest cost of electricity for each assumed fuel cost. The scenario was calculated using fuel costs of $15, $25, and $45 per bone dry ton and the resulting prices of electricity finalist ARE were $0.086, $0.098, and $0.122 per kWh. A similar scenario and the resulting prices are shown for the other two finalists, Zilkha and Powerhouse Energy.

Public Financing – All Debt Funds:

In this scenario, funds for the project would be obtained by issuing municipal bonds or other public debt instruments with an assumed cost of 7%. This scenario was also calculated using fuel costs of $15, $25, and $45 per bone dry ton and the resulting prices of electricity for ARE were $0.108, $0.120, and $0.144 per kWh. A similar scenario and the resulting prices are shown for the other two finalists, Zilkha and Powerhouse Energy.

Private Financing:

In this scenario, the facility would be privately owned and financed with owner's funds (equity) and debt funds obtained from a private lender. The equity funds are assumed to cost 15% that is the lowest expected return that a private developer/owner would require to undertake the project. The debt funds were assumed to cost 9%. The owner was assumed to provide 25% of the funds with the other 75% to be debt funds. This scenario was also calculated using fuel costs of $15, $25, and $45 per bone dry ton and the resulting prices of electricity for ARE were $0.128, $0.134, and $0.163 per kWh. A similar scenario and the resulting prices are shown for the other two finalists, Zilkha and Powerhouse Energy.

Table 3-3: Estimated Electricity Prices

Company	Financing	Cost/BDT	Price kWh needed
Advanced Recycling Equipment - St. Marys, PA	Public/Private Partnership funded - zero cost money	$15	$0.086
	Public/Private Partnership funded - zero cost money	$25	$0.098
	Public/Private Partnership funded - zero cost money	$45	$0.122
	Public financing -100% @ 7%	$15	$0.108
	Public financing -100% @ 7%	$25	$0.120
	Public financing -100% @ 7%	$45	$0.144
	Private financing -25%/15%; 75%/9%	$15	$0.128
	Private financing -25%/15%; 75%/9%	$25	$0.134
	Private financing -25%/15%; 75%/9%	$45	$0.163
Zilkha Biomass Energy - Houston, TX	Public/Private Partnership funded - zero cost money	$15	$0.114
	Public/Private Partnership funded - zero cost money	$25	$0.125
	Public/Private Partnership funded - zero cost money	$45	$0.148
	Public financing -100% @ 7%	$15	$0.143
	Public financing -100% @ 7%	$25	$0.153
	Public financing -100% @ 7%	$45	$0.175
	Private financing -25%/15%; 75%/9%	$15	$0.168
	Private financing -25%/15%; 75%/9%	$25	$0.179
	Private financing -25%/15%; 75%/9%	$45	$0.200
Powerhouse Energy - Pasadena, CA	Public/Private Partnership funded - zero cost money	$15	$0.196
	Public/Private Partnership funded - zero cost money	$25	$0.205
	Public/Private Partnership funded - zero cost money	$45	$0.223
	Public financing -100% @ 7%	$15	$0.268
	Public financing -100% @ 7%	$25	$0.277
	Public financing -100% @ 7%	$45	$0.294
	Private financing -25%/15%; 75%/9%	$15	$0.335
	Private financing -25%/15%; 75%/9%	$25	$0.344
	Private financing -25%/15%; 75%/9%	$45	$0.361

A representative financial model used to calculate the electricity prices in Table 3-2 is shown in Appendix E. The model shown is for the ARE public/private partnership funded scenario with a cost of wood fuel of $25 per bone dry ton. Also presented below in Exhibit 3-7 is a graphical representation of the fuel cost sensitivity analysis for the three technology vendors using the public funded scenario with the cost of woody biomass fuel at $25 per bone dry ton.

3.9.3. Effect From Increased Thermal Use

The ability to utilize residual heat from the biomass electric generating facility has a significant impact on the cost of the electricity generated. For the Burton Creek site, only an estimated 3.5 percent of the residual heat could be utilized. For the ARE public/private partnership funded case at $15/BDT, the price of electricity was calculated to be $0.086/kWh. This price incorporated the value of the 3.5% of residual heat that was utilized. It does not, however, include any additional costs in infrastructure that might be incurred by the potential Burton Creek facility to be able to use the waste.

Using waste heat can have a dramatic effect on the needed price of electricity for a small power plant. Use of 100% of the waste heat is not practical, but use of 60% is feasible assuming a continuous use thermal host was available at the facility site (giving an overall thermal efficiency of about 80% for the facility). Using 60% of the residual heat would decrease the needed electricity price for this ARE case to $0.023/kWh. Unfortunately, this is not the case at the potential Burton Creek site, and the biomass facility if sited there would have to rely on electricity sales.

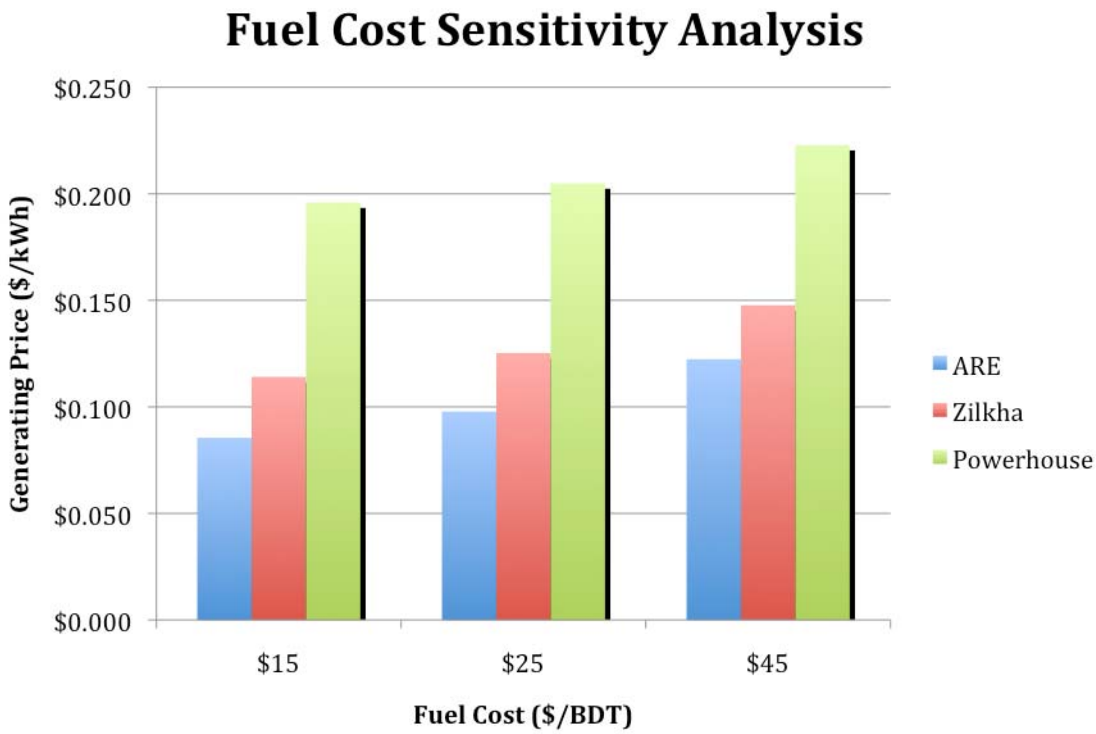

Exhibit 3-7: Fuel Cost Sensitivity Analysis – Electrical Production

3.10. Environmental Review

3.10.1. Air emissions and air quality standards

Although much of the PCAPCD is located in more rural, forested areas, it is nonetheless subject to very stringent air emission requirements due in large part to its western urban area and it's proximity to the Central Valley air shed, which has some of the worse air quality in the nation. Nearly all of the PCAPCD is in State of California nonattainment status for criteria pollutants such as NOx (oxides of nitrogen – precursors to ozone), VOC (volatile organic compounds – precursors to ozone), and particulate matter (PM10). Carbon monoxide (CO) and PM2.5 are considered in attainment. However, the Lake Tahoe Basin portion of the PCAPCD is separately classified from the rest of the PCAPCD. As such it is categorized as Attainment for ozone. However, for the purposes of air quality permitting in the PCAPCD, the entire district, including the Lake Tahoe Basin is subject to the same requirements as would be required of areas that are non-attainment for ozone[5].

[5] Personal communication with Don Duffy, PCAPCD, September 2008

<u>Requirements in the Placer County Air Pollution Control District</u>:

PCAPCD Rule 233 – Biomass Boilers

Section 101 APPLICABILITY: This rule applies to boilers and steam generators which have a potential to emit, as defined in Rule 502, NEW SOURCE REVIEW, **25** tons or more of NOx emissions and which have a primary energy source of biomass consisting of a minimum of 75 percent of the total annual heat input

PCAPCD Rule 502 – New Source Review

Section 301 BEST AVAILABLE CONTROL TECHNOLOGY: An applicant shall apply Best Available Control Technology to a new emissions unit or modification of an existing emissions unit, except cargo carriers, for each emissions change of an affected pollutant, which would have an increase in emissions, according to procedures specified in Section 410, and the potential to emit of the new or modified emissions unit which equals or exceeds the levels specified in Section 301.1. A condition which reflects BACT in a manner consistent with testing procedures, such as ppmv NOx, g/liter VOC, or lbs/hr shall be contained in the latest authority to construct and permit to operate.

Section 301.1	<u>Pollutant</u>	<u>lb/day</u>
	Reactive organic compounds	10
	Nitrogen oxides	10
	Sulfur oxides	80
	PM10	80
	Carbon monoxide	550
	Lead	3.3
	Vinyl chloride	5.5
	Sulfuric acid mist	38
	Hydrogen sulfide	55
	Total reduced sulfur compounds	55
	Reduced sulfur compounds	55

Section 302 OFFSET REQUIREMENTS, GENERAL: 302.1 An applicant shall provide offsets for the affected pollutant, except as provided in Section 304, obtained pursuant to Rule 504, EMISSION REDUCTION CREDITS, or Rule 505, PRIORITY RESERVE, for new and modified sources where the cumulative emission changes of reactive organic compounds, nitrogen oxides, sulfur oxides, PM10 or carbon monoxide calculated pursuant to Section 411 or 412 exceed the level specified in Section 302.1.a, below.

Section 302.1.a	Pollutant	lb/quarter	tons per year
	Reactive organic compounds	5,000	10
	Nitrogen oxides	5,000	10
	Sulfur oxides	12,500	25
	PM10	7,500	15
	Carbon monoxide	7,500	15

Additional Potential Air Quality Standards of the Tahoe Regional Planning Agency

In addition to the PCAPCD air quality jurisdiction, the Tahoe Regional Planning Agency (TRPA) has additional requirements on the permitting of stationary sources, such as a biomass power plant in the Lake Tahoe Basin. These rules include:

Section 91.5 NEW STATIONARY SOURCE REVIEW: Emissions from new stationary sources in the Region shall be limited as follows:

Section 91.5.A ENVIRONMENTAL ASSESSMENT: If the projected emissions from new stationary sources for the peak 24-hour period exceed any of the limits in Table I, below, the applicant shall prepare an environmental assessment. Projected emissions for the peak 24-hour period shall be based on the design capacity. At a minimum, the environmental assessment shall determine the net emissions for the peak 24-hour period, the net emissions for a period not less than 90 days, and shall determine any impacts resulting from the net emissions. If the source exceeds the limits for carbon monoxide in Table I, below, and the source is located in a TRPA, federal, or state designated non-attainment area for carbon monoxide, the environmental assessment shall also include ambient modeling.

TABLE I

Pollutant	Kilograms	Pounds
Nitrogen Oxides	3.0	6.6
Particulate Matter 10	2.0	4.4
Volatile Organic Compounds	8.0	17.6
Sulfur Dioxide	3.0	6.6
Carbon Monoxide	10.0	22.0

Section 91.5.B SIGNIFICANT ENVIRONMENTAL IMPACTS: Any new stationary source of air pollution that produces emissions for the peak 24-hour period beyond any of the limits in Table II below, shall be considered to have a significant adverse environmental impact.

TABLE II

Pollutant	Kilograms	Pounds
Nitrogen Oxides	11.0	24.2
Particulate Matter 10	10.0	22.0
Volatile Organic Compounds	57.0	125.7
Sulfur Dioxide	6.0	13.2
Carbon Monoxide	100.0	220.5

Determination that a new stationary source has a significant adverse environmental impact may also be based on the environmental assessment prepared pursuant to Subsection 91.5.A. New stationary sources that have a significant adverse environmental impact shall be prohibited.

Section 91.5.C OFFSETS PERMITTED: TRPA may require emission offsets as a condition of project approval to bring emissions within acceptable limits if TRPA finds that the proposed source, with offset, meets the criteria specified in Subsection 91.5.B. To accomplish emissions offset, existing emissions shall be permanently retired to offset the unacceptable emissions from the proposed source.

Although these TRPA air emissions rules are more stringent than the PCAPCD, biomass facilities can qualify for an exemption to certain TRPA requirements if they meet the standards as outlined below:

Section 91.5.E EXEMPTIONS

(3) Biofuel Facilities:

(a) The facility is designed to reduce the amount of pile burning through diversion of in-basin material to the facility;

(b) There will be a net reduction in Volatile Organic Compounds, Sulfur Dioxide, and Carbon Monoxide on a per dry ton basis of biofuel as compared to the emissions that would be generated if material were burned in piles, and these pollutants will meet Table II of section 91.5.B, using standard calculation methods;

(c) The facility accepts no biofuel that is imported into the Region;

(d) Material for the biofuel facility shall come from the diversion of material intended for pile burning from forest treatment programs, and cumulative demand shall not exceed 19,000 tons per year.

(e) There will be a net reduction in Nitrogen Oxide emissions of greater than 40% as compared to the emissions that would be generated if material were burned in pile burning. The emissions calculations will follow EPA methodologies;

(f) There will be a net reduction of 90% or greater in emissions of Particulate Matter Less than 10 Microns as compared to the emissions that would be generated if material were burned in pile burning. The emissions calculations will follow EPA methodologies; and

(g) Emissions generated by dual-fueled systems must conform to section 91.5 A through D when operating with fuels other than biofuels.

Potential Emissions from 1 MW Facility

An air emissions source test, using U.S. EPA testing methodologies, was conducted (and witnessed by TSS personnel), using forest-sourced woody biomass in September 2006. This source test was funded by the U.S. Forest Service, Pacific Southwest Research Station. This source test was conducted at the Advanced Recycling Equipment (the top finalist of this Technology Assessment – see Section 3.8 above) facility. Table 3-4 below uses the results of that source test and calculates the potential emissions from a 1 MW facility (assuming 100% online capacity necessary for permitting purposes).

Table 3-4: Emission Test Results

Emission Test Results - September 2006 Source Test using Forest Woody Biomass					BACT			
					Placer	**TRPA**	**Placer Co**	**TRPA limits**
Species	lb/hr	lb/day	1MW = 15 MMBTU[6] lb/day	TPY	TPY		offsets (TPY)	TPY
PM total	0.05	1.20	6.00	1.10	80		15	4
VOC	0.00	0.03	0.15	0.03	10		10	22.9
CO	0.01	0.16	0.81	0.15	550		15	22.9
NOx	0.39	9.29	46.44	8.48	10		10	4.4
SOx	0.00	0.09	0.46	0.08	80		25	2.4

The biomass boiler system tested was equipped with a multiclone for particulate matter control. There was no additional emissions control devices or systems on the tested unit.

Meeting PCAPCD and TRPA Air Emissions Requirements

[6] Scaled up from smaller tested boiler unit

In attempting to meet the PCAPCD requirements a critical threshold to meet is that the power plant emissions are below the concentration levels that trigger the need for offset credits. This is a particularly important threshold, as the PCAPCD currently does not have any available offset credits for NOx. Thus, 10 TPY of NOx (or 2.5 tons per quarter) could be considered essentially a de facto NOx emissions limit for a biomass power plant in the County. In addition, a facility that is a major source would require Title V permitting.

As can be seen in Table 3-4 above, the ARE biomass unit appears under the threshold requiring NOx offsets and is well under the other air pollutants offsets threshold as well. Additionally, the ARE biomass unit would not require Title V permitting as a major source of emissions. However, as the NOx concentration may exceed the TRPA limit for NOx imposed by Section 91 of their regulations, NOx control in the form of Selective Non-Catalytic Reduction[7] (SNCR) appears needed. Indeed during the technology assessment survey, respondents were requested to include the cost of installing SNCR for their power plant system. As it expected that SNCR can reduce the NOx levels by 60 to 80 percent. This would reduce NOx levels to meet the more stringent TRPA levels.

3.10.2. Water use/wastewater discharge

For the ARE system, water use is predicted to approximately 2,500 to 3,000 gallons per day (1 MW facility). Most of this water could be recycled and any residual could be treated to Placer County standards prior to discharge via the sanitary sewer, or collected and disposed of in an appropriate facility.

To put the amount of water supply necessary for a 1 MW facility in perspective, 3,000 gallons per day is only about 50% more than the existing Burton Creek government building use per day. Another perspective would be that the daily water needs of a 1 MW facility would be the equivalent use by about 10 average homes.

3.10.3. Ash Composition

Ash from the combustion of woody biomass in a controlled system, such as a boiler, yields approximately 3 to 5% ash per volume of woody biomass input. Therefore, 8,000 BDT of woody biomass would yield approximately 240 to 400 tons of ash per year.

[7] Selective Non Catalytic Reduction (SNCR) is a method for reducing nitrogen oxide emissions in conventional power plants that burn biomass. The process involves injecting either ammonia or urea into the firebox of the boiler to react with the nitrogen oxides formed in the combustion process.

This ash will either be disposed of in an appropriately permitted facility, or a product use for the ash will have to be found (i.e., use in building materials, road sub-base materials, or returned to the forest as a soil amendment). As the woody biomass to be used in the power plant will all be forest-sourced, it can be expected that the ash will be non-hazardous per California and federal regulations, i.e., it should not contain any constituents that would make it hazardous such as heavy metals. However, to insure this, analytical sampling will be conducted on the ash during the initial operations.

3.10.4. Site Considerations - Land Use Conformance, Constraints and Noise

The Potential Burton Creek site consists of two parcels – a 10-acre parcel that is owned by the County of Placer and a 5-acre parcel (portion of a larger parcel) leased from the U.S. Forest Service. The 10-acre parcel (Assessor Parcel Number 93-010-36) is the location of the current Placer County Government structures and will be the principal site of the proposed new Tahoe Justice Center buildings and parking lots. On the leased Forest Service 5 acres (part of APN 93-010-35) the "upper" parking lot is planned. There it is proposed to park County vehicles and equipment in this upper parking lot.

In consultation with the Placer County Facility Services Department, it appears that the most logical place for the site of the proposed biomass power facility would be in the upper parking lot area, on the Forest Service leased land. This would also trigger some type of special permitting with the Forest Service, as well as requiring input from the TRPA regarding that agency's allowable site coverage for the Forest Service parcel. Due to the potential difficulties in permitting, details of the permitting needs and process will be developed in the next phase of this project.

The current Burton Creek site has also been the subject of litigation over noise levels from planned county activities at the site. The litigation resulted in a settlement agreement that set of Community Noise Equivalent Level (CNEL) of 55 decibels at the property boundary. This is a low to moderate noise level that may be difficult for a small biomass power plant to maintain without adequate mitigation measures (such as being placed inside a well insulated building). A noise study will be needed prior to siting of the facility.

3.10.5. Community, regulators, and stakeholder acceptance

The information contained in this assessment report will be taken to the public, and regulatory agencies for their review and comment.

3.10.6. Excess/emergency power potential for the local grid

There are currently diesel-fired emergency electrical generators located in Kings Beach. Due to the electrical transmission configuration in the northern Lake Tahoe Basin, and the potential for weather-related interruption of electric power from outside the basin, these generators (total capacity of 16MW) are deemed necessary. Per discussions with the local utility (NV Energy, formerly Sierra Pacific Power) the proposed biomass facility would be able to offset some of the need for this emergency power (when and if the need arises) as it would be the only other electrical generating system located within the basin.

3.10.7. Biomass Transportation

Woody biomass will have to be transported by truck to the biomass power facility. It is planned, however, to initially transport the forest-sourced biomass to the Placer County Cabin Creek solid waste transfer facility, where grinding and long term storage of the power plant's biomass fuel will occur. This will eliminate the need for any grinding at the potential Burton Creek site, or large-scale storage of biomass fuel. Truck traffic to the potential Burton Creek site will be low, 1 to 2 trucks per day. These deliveries could be scheduled to meet the neighboring communities needs, such as certain specified hours that deliveries can be made. Details of biomass fuel delivery to the site will be determined in the next phase of this project.

4. Results and Recommendations

4.1. *Results*

The results of this preliminary feasibility study are as follows:

- It appears that a new biomass facility using all three of the finalists can be permitted in the Lake Tahoe air basin for construction and operation.
- Of the biomass utilization technologies reviewed, the Advanced Recycling Equipment (ARE) direct combustion system with a condensing steam turbine/generator was the highest ranked and shows good economic and technical promise for the proposed application.
- To develop a biomass power plant using the highest ranked technology (ARE), TSS analyses show that the prices at ($25/BDT) for the electric output would range from $0.098/kilowatt hour (kWh) with public/private financing to $0.134/kWh for private financing. This would be the kWh price the facility would need from the utility that would purchase the electrical output of the biomass power plant. The kWh prices incorporate the benefit of heating a building and sidewalks/driveway heating for snow removal. However, the percentage of cogeneration potential (i.e. using the power plant waste heat) is relatively low at potential Burton Creek site (less than 5%).

4.2. *Recommendations*

Based on this analysis TSS has the following recommendations:

- As it appears that a new biomass power plant facility may be viable at the potential Burton Creek site (or other sites in the Lake Tahoe Basin) even with the low cogeneration, the next phase of the project development should move forward. This next phase should involve the following:
  - Air/Water Pollution and Carbon Credits/Offsets Study
  - Business Plan
  - Logistics Study
  - Energy Economics Analysis
  - Biomass to Energy Technical Requirements Statement of Work and Request For Proposal Process Development Plan
  - New Source Review Permit Analysis
  - Woody Biomass Fuel Source Analysis
  - Communication Plan/Guidebook Preparation

- As there is already 1 MW worth of woody biomass currently being transported out of the Lake Tahoe Basin to existing biomass plants. Thus, not only is there currently enough biomass routinely removed for a 1 MW power plant in the Basin, keeping in the basin would reduce the more long distance truck transportation and its related emissions of pollutants and greenhouse gases.
- To potentially improve the economics, via higher use of cogeneration, Placer County should also review other sites in the North Tahoe area.
- With the work to be conducted for the Air/Water Pollution and Carbon Credits/Offsets Study mentioned above, Placer County might be able to increase the size of the power plant project (up to 3 MW). This will improve overall economics, plus be able to utilize additional woody biomass from continued removal of hazardous woody fuels in the Lake Tahoe Basin region.