
# Plumas Energy Efficiency and Renewables Management Action Plan (PEER MAP), PIR-12-003

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## Plumas County Energy Vision

While a great deal of thought and effort went into the preparation of Plumas County Energy Vision, this document is intended to be a starting point for renewable energy development in Plumas County, and ultimately will continue to be a collaborative, working document. Solving the economic, ecological, and social challenges facing Plumas County will require creative thinking and problem solving by many groups, stakeholders, and residents of Plumas County. The Sierra Institute for Community and Environment looks forward to the opportunity to work collaboratively with all groups and institutions advancing renewable energy development and biomass utilization in Plumas County.

## Objective

The goal of Plumas Energy Efficiency and Renewable Energy Management Action Plan (PEER MAP) is to identify, develop, and begin to implement a renewable energy plan for Plumas County that focuses primarily on forest biomass and secondarily on solar photovoltaic (PV) technology – the two most abundant sources of renewable energy in the county.

## The Need

The need for a renewable energy plan in Plumas County is primarily defined by financial constraints, human health and air quality concerns, risk of catastrophic wildfire, and current state policy to reduce greenhouse gas emission by increasing California's renewable energy portfolio.

### Financial

Lack of access to natural gas means critical institutions in Plumas County (schools, hospitals, and other public facilities with high heat demands) rely on expensive fossil fuels to meet their heating needs. In any given year the prices of these fuels can fluctuate dramatically, and public institutions, funded with taxpayer dollars, often have to speculate on price volatility during summer months. Depending on which way the market moves, this can have an impact of over $40,000 one way or the other at each facility.[1] In a county with high rates of unemployment, an aging population, and a relatively small tax base (with respect to the rest of California) the expense and volatility of fossil fuel markets places considerable financial strain on these institutions.

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| **Population data**<br>• Plumas County's population is expected to grow only by 0.7% annually through 2050.<br>• The number of county residents under 18 is falling while the number of residents 65 or older is increasing. |
| **Unemployment data**<br>• 2013 average annual unemployment rate was 12.7%, up from a low of 7.7% in 2006.[2] |

Table 1: Plumas County population and unemployment statistics
Plumas County General Plan[3]

### Human Health and Air Quality

Several communities in Plumas County struggle are challenged to meet air quality standards established by the Northern Sierra Air Quality Management District during the winter months due to air inversions in the valleys, heavy reliance on wood-burning stoves, and open pile burning of yard waste and other woody debris. The consequences for nonattainment are significant and include punitive actions such as fines, limited economic develop opportunities, and suspension of transportation infrastructure upgrades.

Additionally, there are well documented studies showing that aging, inefficient oil-fired boilers produce significant quantities of emissions that are harmful to both human health and the environment including

[1] Assuming an average heating bill of $80,000 as shown in Sierra Institute Biomass Heating Feasibility Studies.
[2] http://research.stlouisfed.org/fred2/series/CAPLUM3URN (last accessed 8/18/14).
[3] http://plumascounty.us/index.aspx?nid=479 (last accessed 2/21/14).

fine particulate matter (PM), nitrogen oxides ($NO_x$), sulfur oxides ($SO_x$), carbon monoxide (CO), and volatile organic compounds (VOCs).[4,5] Similar studies present the negative health and environmental implications of disposing of biomass through open pile burning as well as inefficient wood stoves.[6] Large wildfires, which have become an increasingly common occurrence in the Sierra, also pose significant risk to both human health and vitality of local economies dependent on natural resource and tourism economies.

Municipal Green Waste and Prescribed Fire

Quincy has the highest population in Plumas County with approximately 5,500 residents. Until recently Quincy residents were able to dispose of their green waste (grass clipping, pine needles, brush trimmings etc.) by bringing it to Sierra Pacific Industries' (SPI) sawmill for combustion in the co-generation facility. This service has been suspended indefinitely as the mill undergoes significant infrastructure upgrades. Accordingly, county officials are concerned that an increasing number of residents will burn their green waste in open piles, contributing significantly to local air quality issues, or dispose of the waste in the near-by national forest land, contributing to fuel loading and refuse dumping issues.

Efforts to reduce risk of fire in the wildland urban interface (WUI) by Plumas County Fire Safe Council (PCFSC) have also been negatively impacted by the suspension of green waste disposal at the SPI mill in Quincy. Cal Fire requires residents in Plumas County to create 100 feet of defensible space around their homes by clearing back vegetation and other fine fuels.[7] With the mill no longer taking waste, many Plumas County residents are having greater difficulty meeting Cal Fire's defensible space requirements and there is potential for greater fire risk in the WUI unless a permanent solution is found.

Smoke from wild and prescribed fires is a significant source of pollution, particularly with respect to fine particulate matter, in rural forested communities.[8] While smoke from wildfire is not regulated, emissions from prescribed fire are. Accordingly, federal and state agencies that use prescribed fire as a forest management tool take multiple factors into consideration, such as seasonality and wind direction, and apply for smoke permits before commencing operations. However, because several communities in Plumas County are already dangerously close to reaching nonattainment levels, the Northern Sierra Air Quality Management Board is increasingly reluctant to issue smoke permits for US Forest Service and Cal Fire projects, including open pile burning.

This is a problem because Northern Sierra forests have adapted to the presence of frequent, low severity fire, and resource managers agree that prescribed fire is a necessary tool to help promote forest health and return these forests to their historic fire-tolerant structure.[9,10] Furthermore, prescribed fire is an efficient and cost effective method to reduce fuel loading, critical work that would otherwise have to be accomplished by more expensive mechanical or hand thinning. There is concern among local resource

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[4] http://www.epa.gov/ttnchie1/ap42/ch01/final/c01s03.pdf (last accessed 4/18/14).
[5] Nussbaumer, T. *Characterization of particles from wood combustion with respect to health relevance and electrostatic precipitation*. University of Applied Sciences, Lucerne Switzerland.
[6] Mazzoleni, L. R., Zielinska, B, & Moosmuller, H. 2007. *Emissions of Levoglucosan, Methoxy Phenols, and Organic Acids from Prescribed Burns, Laboratory Combustion of Wildeland Fuels, and Residential Wood Combustion.* Desert Research Institute, Division of Atmospheric Science.
[7] General Guideline for Creating Defensible Space. State Board of Forestry and Fire Protection. http://bofdata.fire.ca.gov/PDF/Copyof4291finalguidelines9_29_06.pdf (last accessed 7/18/2014).
[8] http://www.fs.fed.us/air/smoke.htm
[9] Beaty, R, M. & Taylor, A, H. 2007. *Fire history and the structure and dynamics of a mixed conifer forest landscape in the northern Sierra Nevada, Lake Tahoe Basin, California, USA*. Forest Ecology and Management. Vol. 255, pp: 707-719.
[10] Moody, T, J., Fites-Kaufman, J., & Stephens, S, L. 2006. *Fire History and Climate Influences from Forests in the Northern Sierra Nevada, USA*. Fire Ecology, vol. 2 no. 1.

managers that if air quality continues to deteriorate due to an increased tendency to burn green waste, smoke permits will become more difficult, if not impossible, to obtain.

Greenhouse Gas Emissions

Greenhouse gas emissions, the bulk of which come from industrial activities and the combustion of fossil fuels, are warming the earth's atmosphere and potentially leading to global climate change. The state of California is taking a lead in efforts to reduce this trend by developing and implementing policy that limits GHG emissions at large utilities and industrial facilities. This policy also promotes opportunities to increase sequestration of atmospheric carbon through a variety of activities including improved forest management.[11]

**Wildfire fine particulate emissions**

- During the 2013 American and Rim fires, air quality in communities most impacted by smoke was consistently rated "Unhealthy for Sensitive Groups" and "Hazardous" with 24-hour Average PM 2.5 readings exceeding 70 micrograms per cubic meter. In the community of Foresthill the 3-hour Average Maximum exceeded 220 micrograms per cubic meter – a reading 6 times the EPA's 24-hour PM 2.5 standard.[12,13]

**Open pile burning emissions**

| | $NO_x$ | PM | NMOC | CO | $CO_2$ | $CH_4$ |
|---|---|---|---|---|---|---|
| g/dry kg wood | 3 | 6.5 | 5 | 63 | 1,833 | 3 |

**14**,15

**Economic impacts**

- The Earth Economics Institute estimated that the year one economic impact of the Rim Fire on natural lands ranged from $100,017,074 (low end) to $736,013,639 (high end).[16]

Table 2: Air quality data

Plumas Energy Efficiency and Renewables Management Action Plan addresses all of these economic, environmental, and social challenges. When fully implemented PEER MAP can save Plumas County tax payers more than $200,000 in heating costs and reduce fossil fuel consumption by more than 175,000 gallons. Replacing aging heating oil boilers with state of the art biomass boilers and providing an alternative to open pile burning will improve air quality across the county. Installation of solar PV panels at Feather River College, in conjunction with their current geothermal systems and proposed biomass

[11] http://www.arb.ca.gov/cc/ab32/ab32.htm (last accessed 4/23/2014).
[12] http://californiasmokeinfo.blogspot.com/2013_08_21_archive.html (last accessed 8/19/2014).
[13] http://www.arb.ca.gov/desig/pm25desig/pm25desig.htm (last accessed 8/19/2014).
[14] Springsteen, B., Christofk, T., Eubanks, S., Mason, T., and Storey, B. 2011. *Emission Reductions from Woody Biomass Waste for Energy as an Alternative to Open Burning.* Air & Waste Management Association. 61: 63-68.
[15] Jones, G., Loeffler, D., Calkin, D., & Chung, W. 2010. *Forest treatment for thermal energy compared with disposal by onsite burning: Emissions and energy return.* Biomass and Bioenergy. 34: 737-746.
[16] Batker, D., Christin, Z., Schmidt, R., & de la Torre, Isabel. 2013. *The Economic Impact of the 2013 Rim Fire on Natural Lands.* Earth Economics Institute.

boiler, will make FRC a model for how multiple forms of renewable energy can be integrated into college and university campuses. Greater demand for forest biomass will increase forest managers' ability to implement silvicultural prescriptions that promote forest health and resilience in the face of climate change and higher fire risk. Finally, a stronger forest products sector and new employment opportunities will have significant positive impacts on the local economy.

## Opportunity For Biomass

Forest biomass is a locally abundant, renewable natural resource that can serve as an alternative source of heat at public institutions in Plumas County. When sourced from timber harvest residuals and combined with sustainable forest management techniques, forest biomass is a carbon neutral source of fuel.[17, 18] Forest biomass can be harvested, refined, and delivered to institutions with biomass-fired boilers at costs substantially lower than those associated with fossil fuels. Technological advances in biomass-fired boilers, largely driven by European research and development, has lead to modern heating systems that are significantly cleaner and more efficient than their predecessors.

The opportunity to use biomass as a renewable source of heat and electric energy generation is gaining attention from state legislators as well. Senate Bill 1122 requires Investor Owned Utilities (Pacific Gas & Electric, Southern California Edison, and San Diego Gas & Electric) to purchase 50 megawatts of electricity from small-scale (3 MW or smaller) combined heat and power utilizing sustainably harvested forest biomass as their primary fuel source.[19] SB1122 will establish an artificially high price floor as well as a price auction mechanism governing power purchase agreements whereby it becomes economically feasible to generate electricity from biomass at such a small scale. California Department of Forestry and Fire Protection and the California Public Utilities Commission are the public agencies tasked with overseeing and implementing this program as part of Investor Owned Utilities renewables portfolio standard.

## The Benefits of Biomass Utilization

Offsetting fossil fuels with forest biomass as the primary source for generating heat at large public institutions in Plumas County will reduce both direct heating costs and exposure to market volatility associated with oil markets. Reduced and stabilized heating costs will lower financial strain on public institutions – a monetary benefit that can be passed directly to county residents in the form of reduced-priced or additional services at these facilities.

Increasing demand for forest biomass will provide greater economic opportunities for individuals working in the forest products sector. Conservative estimates suggest developing a combined heat and power facility and a woodchip processing plant in Plumas County will result in the creation of 5-7 full-time, wage grade jobs – roughly the equivalent of creating 200-300 new jobs in San Francisco. Viable biomass markets will also bolster traditional in-woods contracting and trucking opportunities, and the construction of all facilities will result in increased need for skilled labor.

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[17] McKechnie, J., Colombo, S., Chen, J., Mabee, W., & Maclean, H. 2011. *Forest Bioenergy or Forest Carbon? Assessing Trade-offs in Green house Gas Mitigation with Wood-Based Fuels*. Environmental Sciecne & Technology. Vol. 25:2 pp. 789-795.
[18] Sedjo, R., & Tian, X. 2012. *What is the Carbon Footprint of Wood Biomass Energy?* Journal of Forestry, Vol. 110:6 pp. 304-311.
[19] http://www.cpuc.ca.gov/PUC/energy/Renewables/hot/SB_1122_Bioenergy_Feed-in_Tariff.htm (last accessed 2/21/14).

Greater demand for forest biomass will enable forest managers to implement a wider array of silvicultural prescriptions, which will lead to additional acres treated for ecological and vegetative management purposes. The result of such treatments will be forests that are more resilient to the impacts of climate change and less prone to catastrophic wildfire. Additionally, healthy, well-managed forests sequester and store greater amounts of carbon for longer periods of time than overly dense, risk prone forests.

**Biomass Utilization in Plumas County**

| Biomass Thermal Opportunities | Current Heating Costs | Fuel Type | Gallons Used | Est. Biomass Used | Est. Savings |
|---|---|---|---|---|---|
| Portola District Heating Facility | | | | | |
| *Eastern Plumas Heath Care* | $ 147,500.00 | diesel fuel | 37,000 | 400 bdt | $ 25,075.00 |
| *Portola High School* | $ 79,500.00 | heating oil | 22,640 | 210 bdt | $ 13,515.00 |
| *Portola City Hall* | $ 4,700.00 | propane | 2,582 | 15 bdt | $ 799.00 |
| *Portola Library* | $ 5,500.00 | propane | 2,750 | 15 bdt | $ 935.00 |
| *Portola USPS Building* | $ 4,000.00 | propane | 2,300 | 15 bdt | $ 680.00 |
| County HHS/FRC | $ 135,000.00 | electric/Prop. | 17,000 | 200 bdt | $ 45,000.00 |
| USFS Supervisors Office | $ 37,000.00 | prop/fuel oil | 11,500/3,260 | 100 bdt | $ 24,500.00 |
| USFS Mt. Hough RD | $ 35,000.00 | propane | 14,340 | 115 bdt | $ 20,625.00 |
| Greenville K-12 School | $ 112,500.00 | diesel fuel | 30,646 | 275 bdt | $ 19,125.00 |
| Chester Heating Facility | | | | | |
| *Wildwood Asst. Living Fclty* | $ 60,000.00 | propane | 26,000 | 175 bdt | $ 38,125.00 |
| *Seneca Hospital* | $ 35,000.00 | diesel Fuel | 11,000 | 100 | $ 8,750.00 |

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| Green Tons/Acre | 10 to 15 |
| Bone Dry Tons/Acre | 8 to 12 |
| Avg. price of chips (raw mtrl). | $ 60.00 |
| Retail chips/bdt (thermal) | $ 125.00 |
| Price of heat | 83% |
| **Thermal Network** | |
| Total biomass needed | 1,620 bdt |
| Acres treated | 150 - 250 |
| **3 MW CHP** | |
| Total biomass needed | 25,000 bdt |
| Acres treated | 2,100 - 3,200 |

| **Increased biomass utilization in Plumas County will have the following annual results:** | |
|---|---|
| **County wide savings:** | **$ 197,129** |
| **Fossil fuel gallons offset:** | **181,018** |
| **Homes powered:** | **3000** |
| **Bone dry tons of biomass used:** | **27,000** |
| **Acres treated:** | **2,250 - 3,500** |

KEY
bdt: bone dry ton
CHP combined heat and power

Table 3: Estimate of financial saving, gallons of fossil fuel offset, number of homes powered, tons of biomass utilized, and number of acres treated under PEER MAP energy vision for Plumas County.

Forest biomass sourced from harvest residuals and sustainable forest operation is a renewable, carbon neutral resource, and increased utilization will reduce consumption of fossilized carbon. Heat and power sourced from forest biomass is a viable step towards addressing California's goal of reducing GHG emissions.

Combusting forest biomass in boilers equipped with electrostatic precipitators to remove PM is significantly more controlled, cleaner, and efficient than open pile burning. While the smaller boilers at critical public institutions require a higher quality "refined" wood chip, larger industrial boilers located at a combined heat and power facility can use a wider variety of fuel, including municipal green waste.

**Biomass-fired boilers vs. open pile burning**

- Compared with traditional open pile burning, utilizing biomass to generate heat and electricity can reduce particulate emissions by 98%, $NO_x$ by 54%, nonmethane organics (NMOCs) by 97%, CO by 97%, and carbon dioxide equivalents ($CO_2e$) by 17%.[20]

Table 4: Comparison of PM, $NO_x$, CO, and $CO_2e$ by combustion methods

Reducing the common practice of burning residential green waste and logging residuals in open piles will improve the air quality in Plumas County, contribute to increases in human health, and reduce the likelihood that Plumas County will fail to meet air quality attainment standards.

## Biomass Thermal Opportunities

The lack of access to natural gas and high cost of fossil fuel in Plumas County make a network of biomass-fired boilers serving critical pubic institutions throughout Plumas County a critical component of the PEER MAP Energy Vision. Information gathered through repeated interviews with stakeholders and key partners has resulted two distinct ownership models: 1) Biomass-fired boilers are owned, operated and maintained by local institutions; and 2) heat is purchased from a third-party provider responsible for owning, operating and maintaining a biomass-fired boiler.

### Institutions potentially owning and operating biomass-fired boilers

**County Health and Human Services facility**

- The 53,000 $ft^2$ building in Quincy is currently heated by geothermal heat pump system.
- The system is under-sized, and as a result the County spends an estimated $45,000 in electrical costs to boost the temperature of the fluid medium in the loop to a higher temperature.
- The proximity of the HHS building to Feather River College's residence halls (approximately 300 feet) presents an opportunity for a shared boiler to meet the heating and hot water needs of those buildings.

**Plumas National Forest**

- Plumas National Forest and USFS Region 5 staff pursued a Department of Energy grant to purchase and install biomass-fired boilers at both the Supervisors Office in Quincy and the Mt. Hough Ranger Station located on highway 70 west of Quincy.
- The Supervisor's Office installation will possibly include absorption chiller technology.
- While efforts with DOE were unsuccessful, PNF and R5 staff continue to explore alternative funding pathways to install biomass technology in Plumas County.

**County Jail**

- Plumas County is in the early phases of planning construction for a new county jail facility. The heat and domestic hot water demands for this facility will be great enough that a biomass-fired boiler will likely make financial sense

[20] Springsteen, B., Christofk, T., Eubanks, S., Mason, T., and Storey, B. 2011. *Emission Reductions from Woody Biomass Waste for Energy as an Alternative to Open Burning.* Air & Waste Management Association vol. 61: 63-68.

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| **Plumas County Courthouse**<br>• Plumas County Courthouse is currently heated with propane.<br>• The heat load is substantial, but switching to biomass heat will require significant retrofits to the facility due to lack of a central heating system. |

Table 5: Institutions potentially owning boilers

### Biomass-fired boilers that are owned and maintained by third party service provider

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| **Portola**<br>• Sierra Institute and Wisewood staff conducted a feasibility study exploring opportunities for a district heating system to provide heat to Eastern Plumas Health Care, Portola High School, and the cluster of buildings around Portola City Hall (county library, US Post Office).<br>• Results indicated the costs associated with trenching and piping were prohibitively high.<br>• Current efforts focus on design and engineering of a boiler for EPHC, with the possibility of including city facilities depending on funding opportunities. |
| **Greenville**<br>• Sierra Institute staff have engaged with county planning officials to discuss developing a district heating system in Greenville.<br>• This system could supply heat to the K-12 school campus, a proposed new fire hall and CSD office, as well as several private business located in the main town area.<br>• This project has the potential to benefit from significant avoided costs because CalTrans is planning major street infrastructure work in Greenville. |
| **Chester**<br>• A shared boiled that provides heat to Seneca Hospital and Wildwood assisted living facility. |

Table 6: Boilers potentially owned and maintained by third party provider

## Plumas Community Wood Chip Processing Facility

Modern biomass boiler technology, much of which has been researched and developed in Europe, is both highly efficient and remarkably clean. To a large extent, this is as much the result of utilizing a value-added fuel source, such as "refined" wood chips or densified wood products, as it is advances in European design and technology. Accordingly, providing a consistent supply of high quality fuel to the network of biomass-fired boilers is an important component of PEER MAP.

In addition to ensuring the quality of available fuel, consistency of supply is also of critical importance. The lifespan of advanced biomass boilers is a minimum of 25 years – and can be significantly greater with routine care and maintenance. Ensuring that local institutions that opt to own and operate a biomass-fired boiler have access to high quality fuel for the duration of the life to their boiler is a central component of PEER MAP.

The resulting solution that addresses both of these issues is to develop a woodchip processing facility in Plumas County capable to taking in-woods chipped material and refining it into a higher quality - uniformly sized and dried to lower than 35% moisture content – wood chip.

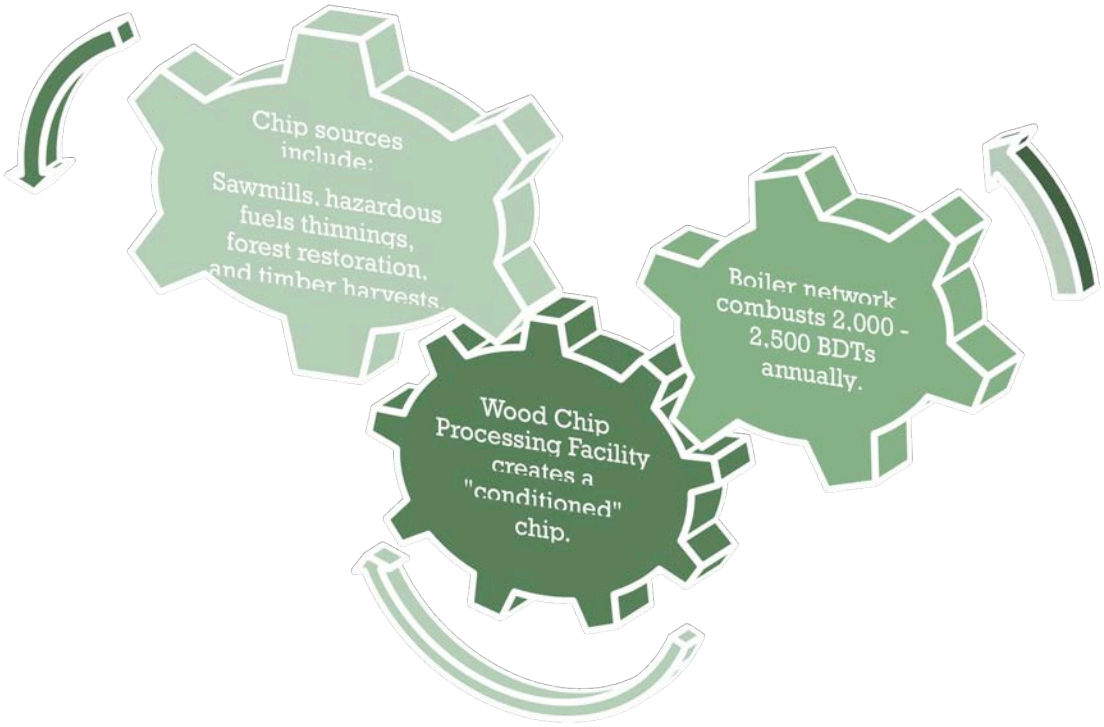


Image 1: Plumas Community Wood Chip Processing Facility

The concept for Plumas Community Wood Chip Processing Facility consists of the following steps:

1. Wood chips will be purchased from local in-woods contractors or directly from one of the major sawmills in the area. Potential chip sources include:
   - Collins Pine, Plumas County Fire Safe Council, Diversified Resources, and Vegetative Management projects on the Plumas National Forest.
2. Plumas Community Wood Chip Processing Facility takes in-woods chipped material and, through a process of screening, regrinding, and drying, refines them into a uniform fuel. These chips are considered "conditioned."
3. Approximately 2,000 – 2,500 BDTs of chips will be needed to power the biomass boiler network at full build out.

## Plumas Community Energy Combined Heat and Power Facility

Senate Bill 1122, which was signed into law in September 2012, requires California's three largest investor owned utilities (IOUs) to procure 250 megawatts of electricity from bioenergy projects that commence operation on or after June 1, 2013.[21] This Feed-in Tariff (FIT) program is an attempt to

[21] http://www.cpuc.ca.gov/PUC/energy/Renewables/hot/SB_1122_Bioenergy_Feed-in_Tariff.htm (last access 5/1/2014).

encourage small-scale (3 MW or smaller) distributed generation and utilization of renewable fuel sources. Accordingly, SB 1122 divides bioenergy projects, and the associated amount of power each IOU is required to purchase, into three categories: 1) biogas from wastewater treatment (110 MW); 2) dairy and other agricultural bioenergy (90 MW); and 3) bioenergy derived from sustainable forest management (50 MW).

The three largest investor owned utilities in California are Pacific Gas and Electric (PG&E), Southern California Edison (SCE), and San Diego Gas and Electric (SDG&E). Of the three IOUs, PG&E, which serves much of Plumas County, is mandated to procure 47 MW of electricity from sustainable sourced forest biomass.

| A number of factors make Plumas County an attractive location for developing a small-scale combined heat and power facility |
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| • PG&E is the IOU service provider to a large portion of Plumas County.<br>• There is an abundant supply of sustainable biomass available, and proximity to harvest sites reduces transportation costs.<br>• Institutional knowledge base exists locally:<br>  o Long history with both biomass power plants and co-generation facilities.<br>• Grid infrastructure supported multiple sawmills with co-generation facilities:<br>  o Line capacity likely exists and interconnection costs are anticipated to be relatively low given the proximity of proposed site to substation. |

Table 7: Biomass in Plumas County

On average forest thinning projects in Plumas County yield approximately 10 bone dry tons of biomass per acre. Recent management activities for fuels treatment, habitat restoration and timber stand improvement by the US Forest Service (Almanor Ranger District, Plumas National Forest, Sierraville Ranger District) and the Plumas Fire Safe Council have addressed 2,425 to 5,725 acres per year and generated between 24,250 and 57,250 BDT per year.[22] A 3 MW combined heat and power facility will consume roughly 30,00 BDTs of biomass per year, and so the fuel for such a facility can be sustainably sourced from 3,000 – 4,000 acres annually. This is a relatively small number, but extrapolated over a 10 year period (roughly equivalent to historic fire return intervals in the northern Sierra),[23,24] this treatment can compound such that 30,000 – 40,000 acres are in continuous treatment. While still small, this scale of forest treatment does yield positive ecological results and allow for much more adaptive management.

Unlike the biomass-fired boilers providing heat to public facilities in Plumas County, the boiler in the CHP is more robust and capable of burning less refined fuel. Once the CHP is operational it will be possible to mix municipal green waste generated by Plumas County residents with woodchips and burn it in the boiler. While this will reduce the efficiency of the CHP facility, it does resolve a distinct county need.

[22] _http://www.sierrainstitute.us/BIOMASS/SI%20Transport%20Assess%20+%20Value%20Added%20Study%20Report%20TSS%20FINAL.pdf (last accessed 5/1/2014).
[23] Beaty, R. M., & Taylor, A. H. 2009. *Fire disturbance and forest structure in old-growth mixed conifer forests in the northern Sierra Nevada, California*. Journal of Vegetation Science. Vol. 18, Issue 6, pp: 879-890.
[24] Moody, T. J., Fites-Kaufman, J., & Stephens, S. L. 2006. *Fire History and Climate Influences from Forests in the Northern Sierra Nevada, USA.* Fire Ecology. Vol 2, no. 1, pp: 114-141.

## Utilizing the Produced Heat Generated During Combustion

On its own, generating electricity from forest biomass is a relatively inefficient process. Multiple variables affect efficiency rates including type and quality of material utilized, moisture content, and conversion technology, and the general range in efficiency for traditional biomass-to-electricity facilities is between 20-40%.[25,26,27] To some extent, this low to moderate level of efficiency undermines the positive benefits intended by SB 1122. However, when biomass-to-electricity plants become true combined heat and power facilities, efficiency rates increase significantly, ranging from 70 to 80%.[28] Accordingly, co-locating a biomass-to-electricity plant with another facility that has high heat demands is critical from an energy efficiency perspective.

The amount of available heat generated at the Plumas Community Energy Combined Heat and Power Facility will vary according to the final technology selected, but in every scenario the amount of heat produced is significant. Current estimates place available produced heat in the 30 million British Thermal Unit per hour range (MMBTU/hr). At this level of production it will be difficult to find a single business capable to utilizing all the available heat.

The monetary value of co-locating multiple facilities in Crescent Mills cannot be explicitly stated until final engineering specifications and capital costs are known. However, accounting for the 10% investor tax credit for facilities that achieve greater than 20% efficiency for heat and power generation, and the avoided cost of constructing cooling towers, the value could range between $7 – 12 million.
Produced heat generated during the combustion process can be captured and utilized for multiple purposes:

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| Drying chips for thermal boilers<br>• Offers opportunity to support the concept of a network of boilers across the county by providing a refined chip (2-inch minus, less than 20% moisture content).<br>• Demand for chips, even at full build out, will inadequately utilize available heat. |
| Drying wood chips for pellet manufacturing<br>• Co-locating with a facility that utilizes forest biomass presents opportunities to maximize heat utilization, reduce operating expense, and share common infrastructure.<br>• Manufacturing wood pellets in Plumas County provides the network of boilers with a more refined, trusted source of fuel.<br>• Volume of wood pellet production could be significant enough to implement forest restoration and thinning efforts on a large scale. |
| Heating greenhouses<br>• Co-locating with greenhouses and/or nurseries offers opportunities to increase CHP efficiency and utilize produced heat. |

[25] Faaij, A., Ree, R. V., Waldheim, L., Olsson, E., Oudhuist, A., Wijk, A. V., Daey-Ouwens, C., & Turkenburg, W. 1997. *Gasification of Biomass Wastes and Residues for Electricity Production.* Biomass and Bioenergy, vol. 12:6 pp. 387-407.
[26] Demirbas, A. 2001. *Biomass resource facilities and biomass conversion processing for fuels and chemicals.* Energy Conversion and Management, vol. 42:11 pp. 1357-1378.
[27] Dornburg, V. & Faaij, A. 2001. *Efficiency and economy of wood-fired biomass energy systems in relation to scale regarding heat and power generation using combustion and gasification technologies.* Biomass and Bioenergy vol. 21, pp. 91-108.
[28] http://www.epa.gov/chp/basic/efficiency.html (last accessed 5/13/2014)

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| • An industrial greenhouse facility could grow vegetables for human consumption and serve larger markets in Chico, Sacramento, and Reno or be developed in partnership with the US Forest Service and grow tree seedlings for replanting burned areas in the Sierra. |
| Industrial manufacturing<br>• Many industrial manufacturing processes require significant amounts of heat and would be perfect co-location partners.<br>• Sierra Institute staff are working with the State Wood Energy Team to identify appropriate types of facilities and developing contacts within the CA Manufacturers and Technology Association. |
| Absorption refrigeration<br>• Absorption refrigeration is a common form of cooling buildings in places where electricity is unreliable or when surplus heat is available on the back end of industrial processes. |

Table 8: Co-location opportunities and utilization of produced heat

## Solar Photovoltaic Opportunities

Regional climatic and geographic conditions are such that solar energy potential in Plumas County is rated at 520 watt hours/feet$^2$/day – making it one of the best locations to generate solar electricity in the United States.

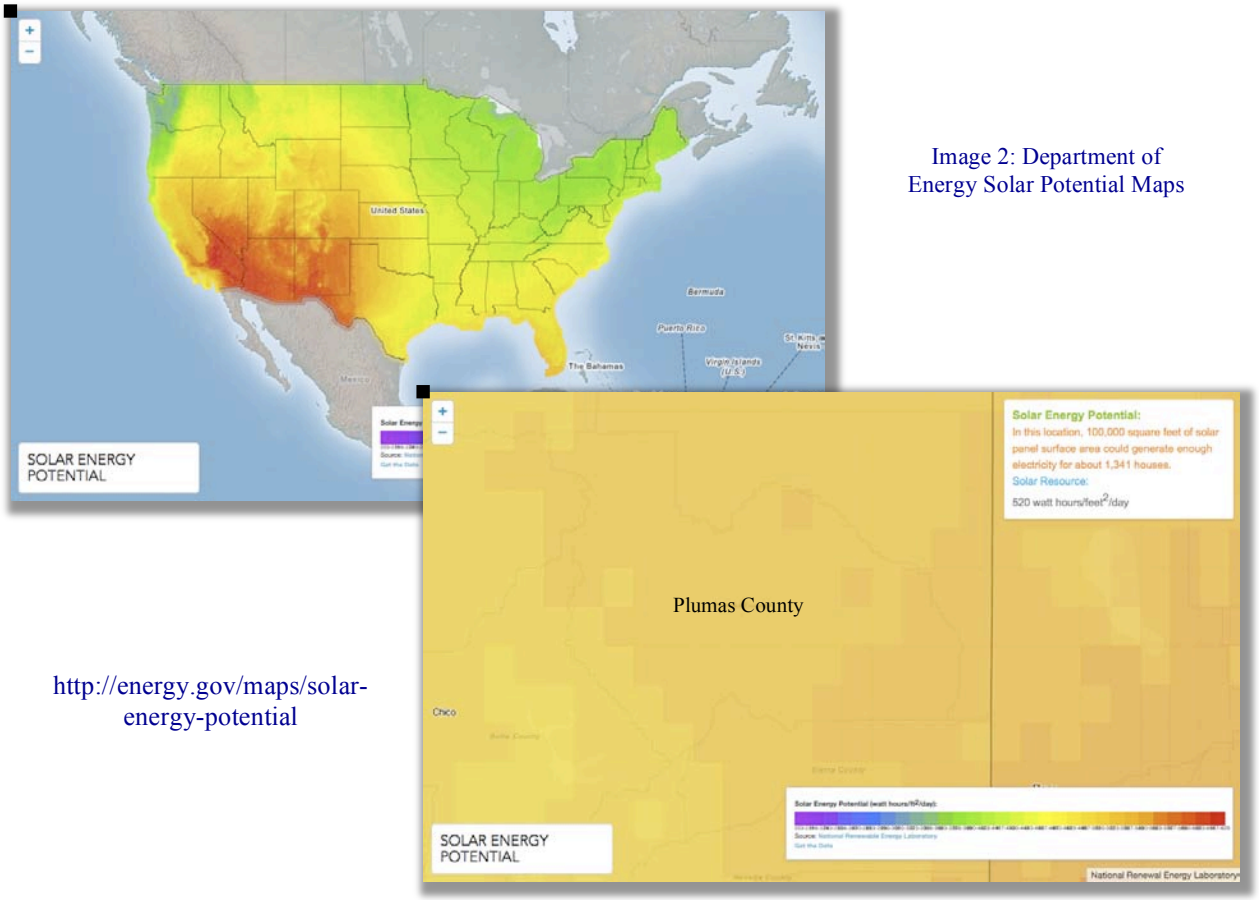


Image 2: Department of Energy Solar Potential Maps

http://energy.gov/maps/solar-energy-potential

The abundant sunshine, high altitude, and clean air Plumas County, combined with the relatively high residential electrical rates and the attractive state and federal tax incentives available to homeowners and private businesses, have allowed for significant solar PV technology development throughout the county.

Unfortunately, opportunities for continuing to install solar PV in Plumas County are currently limited. The California Solar Initiative earmarked $2.167 billion for solar PV development between 2007 and 2016 with the goal of installing 1,940 MW of new generation within this time period.[29] Allocation of incentives vary by utility provider and customer type, but it is notable that the combination of this aggressive policy and federal and state tax incentives resulted in California meeting this target in an extremely short time. In Plumas County, which is largely served by PG&E, there are no longer any incentives available to either private residences, businesses, or non-profit entities, and this has significantly curtailed solar development.

From a policy perspective, Feather River College represents the best opportunity to develop solar PV technology in Plumas County. This is largely because FRC has developed and is in the process of implementing a comprehensive Sustainability Management Plan for the campus that, among other activities, calls for increased energy efficiency and renewable energy development.[30] In addition to increased geothermal development, part of the renewable energy objectives include installing solar panels on the roof of the Fish Hatchery building and replacing current incandescent and CFL lighting systems with LED lights.

Zero-Net-Energy At Feather River College

- FRC currently has an extensive geothermal system in place providing heat to multiple buildings across campus.
- Solar panels are slated for the Fish Hatchery Building and Proposition 39 funds have been approved for installing LED lighting systems.
- Sierra Institute staff are working with county officials and FRC administrators to explore the possibility of providing heat to the college's student residence halls via a biomass-fired boiler owned and operated by the county at the adjacent Heath and Human Services facility.

Table 9: Zero-Net-Energy at Feather River College

Feather River College currently consumes approximately 2.5 million megawatt hours (MW/hr) of electricity annually. In order to meet this demand, FRC would have to develop a 1250 kW solar array. Initial estimates of the overall capital costs for developing a project of this size are more than $9 million.[31] The lack of incentives available to FRC, coupled with the favorable rate that PG&E currently offers the college, make this project extremely difficult to justify from a financial perspective.

[29] http://www.gosolarcalifornia.ca.gov/about/csi.php (last accessed 7/21/2014).
[30] http://www.frc.edu/administration/documents/strategicplan.pdf (last accessed 7/21/2014).
[31] http://www.solarenergy.org/solar-calculator (last accessed 7/21/2014)


Image 3: Feather River College Solar PV Array in Quincy, CA
Scaled System Schematic Generated on PVWatts[32]

However, Feather River College administrators have indicated an interest in exploring this concept further because of the growing need to adopt renewable energy technologies despite low or even non-existent financial returns. Initial conversations have focused on the possibility of utilizing some Proposition 39 funds as a potential down payment for the system in conjunction with a California Energy Commission 1% or 0% interest loan.

Integrating geothermal, biomass, and solar PV technology on a single campus would make Feather River College a unique example of how small colleges and other institutions can become zero net energy facilities.

Currently Indian Valley Community Services District (IVCSD) is in the early stages of working with a project developer, North State Solar Energy, to install a 140 kW system at the water treatment ponds outside of Greenville. This system will provide power to IVCSD's waster water treatment plant, sewer ponds pumps, and the water/sewer office facility. The proposal NSSE presented IVCSD requires no money down and a cash stream that is based on payments to the project developer equal to current electrical bills. Because the IVCSD is a public governing body, NSSE is working to create a Special Purpose Entity (SPE) in order to capitalize on the federal Investment Tax Credit and annual deductions for depreciation of the system.[33]

Sierra Institute staff are still gathering information about this proposal, but it is anticipated that if this project is viable in Indian Valley then Portola and Quincy should be able to follow a similar development model. The major variables that remain to be determined include the exact capital costs of the IVCSD project, the likelihood of an investor purchasing the SPE created by NSSE, and the current electrical rate that IVCSD is paying PG&E. Provided enough similarity across these key variables, Quincy and Portola should engage with NSSE and see what opportunities may exist with their respective communities.

[32] http://pvwatts.nrel.gov/pvwatts.php (last accessed 7/21/2014)
[33] http://www.indianvalleycsd.com/solar-energy.htm

## Conclusion

Plumas Energy Efficiency and Renewables Management Action Plan represents an excellent opportunity for addressing some of the economic, environmental, and social challenges facing Plumas County. PEER MAP will help improve air quality in the region by reducing open pile burning and replacing old, inefficient fossil fuel-fired boilers with state of the art biomass-fired boilers. Increased demand for biomass will strengthen the forest products sector, improve forest health, and reduce risk of catastrophic wildfire. Offsetting fossil fuel consumption at critical public facilities and developing a 3 MW distributed generation facility will help California reduce GHG emission while also increasing energy security. When fully implemented PEER MAP will save the county more than $200,000 and reduce fossil fuel consumption by more than 175,000 gallons annually. By improving the financial strength of public facilities, creating new jobs, and increasing demand of for a local, renewable resource, these savings will directly benefit the institutions and residents of Plumas County.

Moving from planning to implementation will necessitate strong partnerships between participating institutions, the Sierra Institute, the Plumas National Forest, and Plumas County planning officials, among others. Developing viable structures for fully financing these projects will require creative thinking, strong state and federal support, and likely result in a unique public-private partnership. While not trivial, there is sufficient support for momentum behind PEER MAP to move the project from the planning to the development phase.

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