

## Executive Summary

Humboldt County’s lumber industry has provided an energy resource for the community with the combustion of mill wastes as a biofuel. DG Fairhaven (DGF), located on the Samoa peninsula, and the Humboldt Sawmill Company (HSC), located in Rio Dell, have provided nearly 30% of the power supply to Humboldt County residents in recent years, through PG&E transmission lines. The current treatment of the mill waste is a vital component to the area’s energy demands but has generated community concern regarding health risks associated with criteria air pollutants and their related environmental impacts.

The purpose of this project is to explore alternative uses for 281,000 BDMT/year of mill waste that meet air quality, environmental, financial, and production constraints. The four alternatives that were evaluated consisted of a pyrolysis system, modular gasification system, pulping and tissue manufacturing, and organic mulch facility. These alternatives were then compared to each other using the following economic, environmental, and social criteria: payback period, operational flexibility, life-cycle greenhouse gases, particulate matter, NO<sub>x</sub>, SO<sub>x</sub>, CO, carbon sequestration, decentralized utilization, ecological impact, employment opportunities, and public concern. The criteria were given weights between 1 (least important) and 10 (most important) by the Redwood Coast Energy Authority (RCEA), who placed the greatest influence on the payback period and emissions/pollutants associated with the project.

Modular gasification was chosen as the preferred alternative, in both the Delphi Matrix and Pugh Method. Gasification converts woody biomass feedstock into a synthetic gas mixture of CO and H<sub>2</sub>, commonly referred to as syngas, which is used to produce electricity. A byproduct of the gasification process is biochar, which is a highly porous, carbon-based material that can be used as a soil amendment or in high grade filters. Electricity is sold at a market rate of \$78/MWh, which is a 20% increase from the current rate of \$65/MWh. To offset the costs of producing electricity through gasification, biochar is sold at a market rate of \$1.5/kg to local buyers. Using the project’s capital cost, O&M costs, an 8% interest rate, and revenue from the sale of electricity and biochar, a discounted payback period of 24.1 years was calculated.

GHG emissions for the preferred alternative were calculated to be 317,000 MT CO<sub>2</sub>e/year which is estimated to be a 27% reduction when compared to the business as usual (BAU) case. Combined particulate matter, VOC, CO, SO<sub>x</sub>, and NO<sub>x</sub> had combined emissions of 253 MT/year, a reduction of 89% compared to the BAU case (Figure 1) (CARB 2020c).

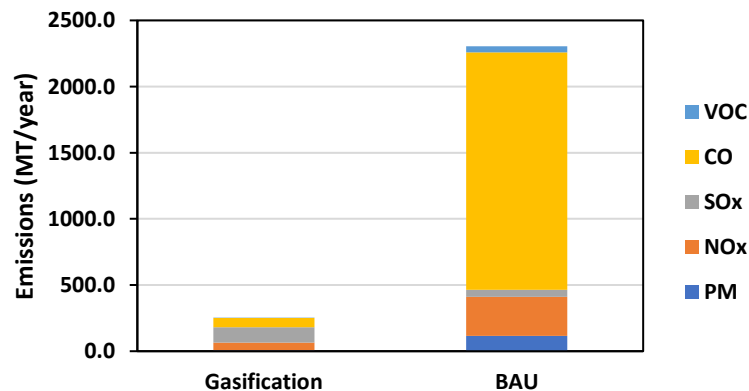
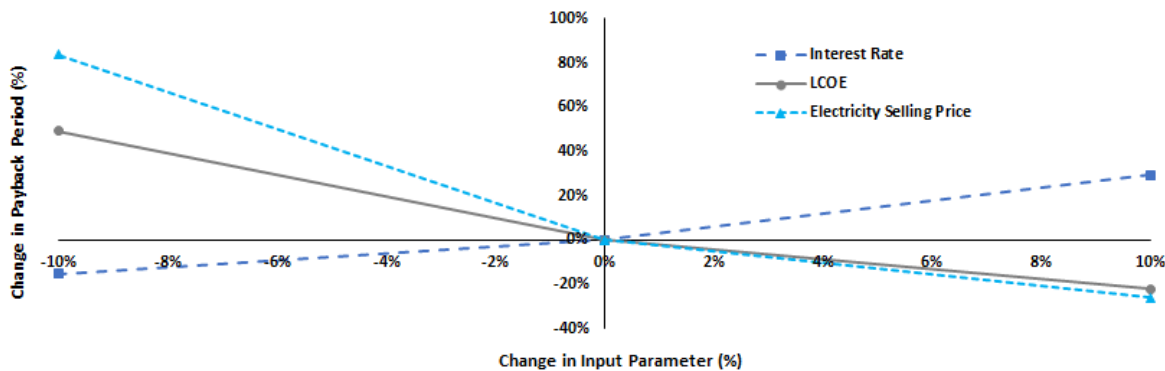


Figure 1. Comparison of emissions for gasification and BAU case.

While the reduced emissions and estimated 287 jobs created opportunities make this an appealing alternative compared to the BAU case, there are many challenges with community-scale gasification. Due to certain biomass characteristics, such as inconsistencies in the type and size of biomass feedstock, large-scale gasification is not technically feasible. To work around this, a total of 16 – 3 MW modular gasification systems, each having an estimated lifespan of 30 years, would be required to replace the existing demand of 48 MW. This presents a substantial total capital investment cost of approximately \$270,216,000. For this alternative to be feasible, there would need to be a biochar market in Humboldt County capable of purchasing approximately 42,150 MT of biochar annually. The biochar could also be exported, which would result in a net change in the overall price of the product. Additionally, the location selected for this alternative assumes that the DG Fairhaven parcel would be used as the site for the gasification systems. This site was selected because of its proximity to the PG&E sub-station. Grid interconnectivity would be required to harness the produced electricity. Ideally, multiple locations with grid interconnectivity would be used to reduce the costs and emissions associated with transportation.

In addition to these challenges, the feasibility of the preferred alternative is highly dependent upon the electricity selling price, the levelized cost of electricity (LCOE), and the interest rate. The LCOE is essentially the cost of producing electricity for this alternative, which is offset through the sale of biochar. A sensitivity analysis was performed on the payback period through independent modifications of the electricity selling price, LCOE and the interest rate (Figure 2). The electricity selling price was the most sensitive input parameter. Selling 100% of the biochar at \$1.5/kg sets the LCOE at -\$61/MWh, which off sets the costs associated with operating the facility and increases annual profit. Reducing the biochar market price would require increasing the rate at which electricity is being sold for the alternative to be feasible.



**Figure 2.** Results of sensitivity analysis performed on interest rate, LCOE, and electricity selling price.

Recommendations for future work include: (1) optimizing the location of multiple modular gasification systems to reduce the costs and emissions associated with transportation of woody biomass, (2) establishing a biochar market within Humboldt County or a method of exporting biochar, (3) educating the public about the advantages of gasification, and (4) identifying possible loans, financing, or incentives that could reduce the capital costs associated with this project. While there are many aspects of this alternative that are attractive, the success of this project is highly dependent upon several factors. Addressing these recommendations would help to solidify modular gasification as an alternative to the incineration of woody biomass within Humboldt County.