Executive Summary

Team Biomassters consisting of Nancy Charco, Jonn Geer, Jesus Rincon, and Sabrinna Rios Romero has prepared this document for the use of the Redwood Coast Energy Authority (RCEA). The objective of this project is to assess the technical, economic, environmental aspects for an alternative use of biomass feedstock in Humboldt County for RCEA. Currently, the majority of Humboldt County's biomass is being combusted at two local facilities: DG Fairhaven and the Humboldt Sawmill Company. DG Fairhaven is an 18.7 MW facility and the Humboldt Sawmill Company is a 32.5 MW facility. The scope of this project does not include the energy that would need to be provided if the existing facilities stop running. RCEA conducted workshops in the community to understand how biomass combustion was perceived by the public. Negative comments received stemmed from concerns about the pollutants and greenhouse gasses emitted from combusting the biomass. Community concern about biomass combustion is the motivation for this project.

Four alternatives were analyzed in this assessment: Gasification, composting, torrefaction, and conversion of biomass to ethanol. Gasification is an energy producing alternative that converts biomass into a gaseous and liquid fuel. Composting is a biological degradation process that converts organic matter to a stable soil amendment. Torrefaction is a thermochemical process which densifies biomass and creates a higher quality product with properties similar to coal. Conversion of biomass to ethanol creates a liquid fuel to be used for transportation by converting the biomass chemically.

The torrefaction alternative proved to be the best nonpolluting, renewable, and yet low-cost alternative out of the four alternatives. The thermochemical process of converting biomass into solid fuel with reduced Oxygen/Carbon and Hydrogen/Carbon ratios provides a cleaner source of energy if utilized for an alternative feed source in boiler combustion. A preliminary analysis was conducted to establish the feasibility of such facility. For the analysis, a total mass of 561,600 MT/yr (at 50% moisture content) or 280,800 BDMT/yr and a density of 247 kg/m^3 was assumed.

The final concept (summarized in Figure ES-1) follows a traditional torrefaction processes incorporating systems such as heat processing, densification, and incorporates heat recycling methods to reduce dependency on fossil fuels. This heat recycling includes the recirculation of flue gas for indirect process heating within the drying process. All biomass (typically at a 50% moisture content) is fed into a drier before entering the torrefier. The dried torrefied product is then conveyed to the cooling system and eventually pelletized for distribution. The gas recycling process involves the combustion of air, fuel, and flue gas for the heat production to operate the heat exchanger. This heat loop flows hot gas through the torrefier to indirectly heat the biomass consequently producing additional torrefied gas (for further combustion and cycling).

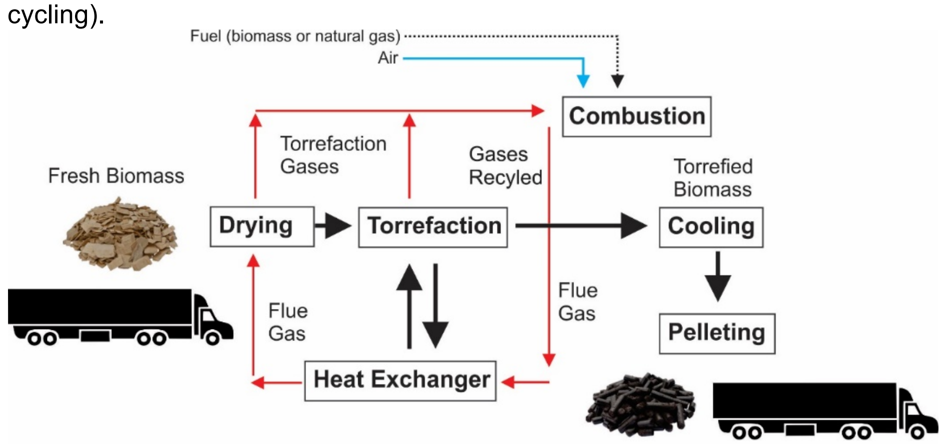

Figure ES 1:Proposed heat processing system to convert biomass into torrefied pellets.

The final product is high-quality fuel pellets, with similar characteristics to coal, with an increase in calorific value (20-24 MJ/kg) caused by the removal of moisture and some organic compounds from the original biomass (Koppejan et al. 2012). The torrefaction process is intended to maintain all volatile matter (and thereby energy) within the final torrefied pellets (Koppejan et al. 2012). The results show beneficial changes such as lower moisture content (1-5%), higher energy density, hydrophobic properties, superior handling and grindability and lastly, low biological degradation. These properties are crucial for long term storage, transportation, and reduction in GHG emissions. The final recommendation is to use a rotary gasifier developed by Torr-Coal; their technology was found to be professionally researched and has records of being implemented at high capacities (30kton/yr) (Cremers 2015). Therefore, with appropriate scaling, this analysis proposes seven parallel reactors would be required to meet the design capacity. Additionally, this analysis provides estimates on the total energy input, the quantities of torrefied pellets produced, the total energy content in produced pellets, and an estimated electricity consumption to operate the facility.

Additionally, other quantifiable indicators such as approximate project area, jobs, emissions, and costs were also quantified to determine the effectiveness of meeting the criteria. Admittedly, the analysis reported an extensive area of 95 acres, including storage for feedstock and final product. However, this value does decrease (by 80 acres) if the facility is designed as a constant process providing little to no storage. In addition, the implementation of a project this size would directly and indirectly result in 250 jobs including permanent operating and maintenance positions and temporary construction work. In fact, this alternative is the only, out of the four, that works within the current biomass supply line not disrupting the market but only providing a pretreatment to effectively reduce emissions. In comparison, emissions from torrefied wood are substantially smaller, estimated at 15,000 CO_2e compared to 282,026 CO_2e for Humboldt Sawmill Company and 182,858 CO_2e for DG Fairhaven. One key advantage of utilizing torrefied wood for co-firing is that it considered a biogenic emission and therefore considered carbon neutral as defined by the EPA (US EPA 2018b). Lastly, a net present value analysis concluded with a payback period of six years, accounting for costs associated with the transportation of both the biomass feed and produced pellets, labor, energy, and the estimated capital cost. The revenue derived from produced pellets was assumed to be $142/ton (Visser 2018). All estimates were derived based on the feedstock input and pellet production, thus estimating a capital cost of $54 million, operation and maintenance of $36 million, and revenue of $37 million per year.

Recommendations

Although the preferred torrefaction alternative is an improvement in biomass utilization, it’s recommended that a more thorough analysis be conducted for estimated system costs. For this analysis, estimates for capital cost and the associated operating and maintenance costs for the equipment were literature estimates and not directly from vendors. A reevaluation on the cost is strongly advised, this is important given torrefaction is an emerging technology and advances in technology could change the cost over time. In addition, its recommended to seek out other financial incentives such as a carbon credits or any other renewable energy programs. Finding and taking advantage of these initiatives could effectively augment the revenue stream and help alleviate the high capital cost associated with this alternative.