EXECUTIVE SUMMARY

This report is the result of a partnership between UBC Sustainability Initiative and UBC Energy & Water Services. The project's goal is to review the current Bioenergy Research & Demonstration Facility (BRDF), commercially available biomass technology, and analyze potential plant expansion capacity to meet UBC's 2020 GHG emission reduction target of 67% below 2007 levels.

The BRDF came online in September of 2012 as a combined heat and power demonstration facility. It currently provides approximately 50,000 MWh of heat to the campus district energy system.

Biomass technologies include direct combustion, pyrolysis, gasification and anaerobic digestion. Commercially viable technologies specifically include industrial combustion, combustion coupled with steam cycle, direct combustion, 1-stage anaerobic digestion landfills, and small manure digesters.

UBC has a significant amount of GHG reductions to carryout in order to achieve their 2020 targets. To do so will require a major shift away from natural gas for heating purposes, with bioenergy providing a viable solution. UBC's Climate Action Plan stipulates the following reductions based on 2007 levels; 33% by 2015, 67% by 2020, and 100% by 2050. GHG Inventories produced by UBC Sustainability were used to calculate the amount of reductions necessary by 2020, totaling 20,771 tonnes of CO_2. To offset this mass the bioenergy expansion would require an 18.1 MW expansion. Nine different options between 10-18 MW capacity of singular and modular design at varying contributions to district heating load are considered. It is determined that a 12 MW modular expansion is most practical given the available space at the BRDF.

Fuel, dry flue gas and moist flue gas mass flow rates are calculated for an 18 MW biomass plant at varying fuel moisture contents. For moisture contents ranging from 0-60%; fuel, dry flue gas and moist flue gas mass flow rates are calculated at 0.9-1.4 kg/s, 5.9-9.4 kg/s, and 0.4-1.5 kg/s respectively. Specific heat capacity is also calculated at varying fuel moisture content to determine the recoverable heat, varying between 959-966 J/kgºC. Heating value is determined to decrease as fuel moisture content increases, varying between 20-12 MJ/kg. A detailed analysis of an economizer addition considering only sensible heat revealed that significant savings of between 600-1000 kW are possible.

Specific commercial design information is unattainable, therefore the following features should be considered at a later date: Air emissions (as BRDF is permitted for only 15 mg/Nm^3), varying turndown ratios, and fuel flexibility.

Two scenarios are considered for achieving the GHG reduction goal: first, installing a 12 MW expansion and secondly, purchasing renewable natural gas from FortisBC. Assuming $8-million and $0 capital costs respectively for each scenario, the 15 year NPVs are calculated at $3.5million and -$35.5million (negative). Purchasing renewable natural gas from FortisBC is not a feasible option to achieve 2020 GHG reductions. Expanding the BRDF is clearly feasible as it pays for itself while also significantly reducing emissions. A sensitivity analysis yielded, in order from highest impact to lowest impact, NPV is affected by changing annual fuel savings, capital cost, and discount rate.

Further studies should be performed to explore the possibility of including an ORC for electricity generation and the specific energy savings of installing a condensing economizer.