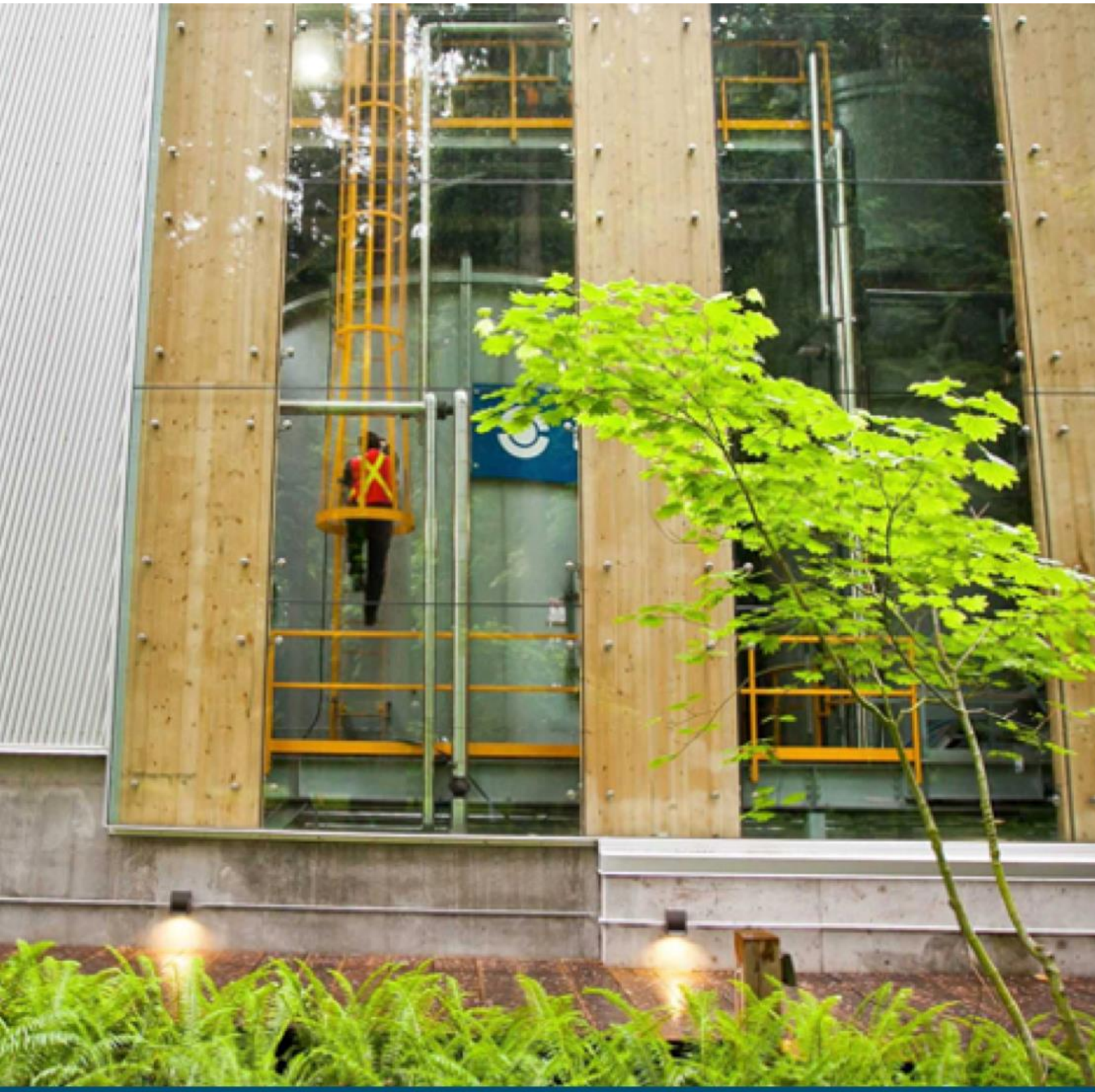

Bioenergy Research Demonstration Facility

Review and analysis of research program

August 2019

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This report was produced as part of the UBC Sustainability Scholars Program, which is a partnership between the University of British Columbia and internal and external partners, including various local governments and organisations in support of providing graduate students with opportunities to do applied research on projects that advance sustainability across the region.

This project was conducted under the mentorship of UBC Sustainability Initiative research staff. The opinions and recommendations in this report and any errors are those of the author and do not necessarily reflect the views of the University of British Columbia.

Cover photo by Paul Joseph Brown

Executive Summary

The Bioenergy Research Demonstration Facility (BRDF) is a wood-to-energy facility at the University of British Columbia's Vancouver campus. The BRDF made KPMG's global list of the 100 most innovative and inspiring urban infrastructure developments. The facility was the world's first demonstration of a community-scale, biomass-fueled heat and power generation system. It was the world's first industrial building made from Cross-Laminated Timber (CLT) and a social license demonstration for having a biomass district heating system in a densely populated area.

The BRDF gives researchers access to an industrial-scale bioenergy plant and synthesis gas. The BRDF engages students by demonstrating how UBC researchers are finding tangible solutions to real-world problems. The facility is extensively used as an outreach tool and to showcase UBC's biomass and bioenergy research and development program to collaborators.

The BRDF has been instrumental in helping UBC meet its greenhouse gas emission reduction targets. Currently, the BRDF produces 6 megawatts of thermal energy (MWth) for campus, reducing UBC's greenhouse gas (GHG) emissions by 12%.

The wood-to-bioenergy process begins when wood waste is delivered to the facility and screened to remove oversized pieces. The biomass is heated to temperatures of 600-900˚C in a controlled oxygen environment such that combustion does not occur. This process—known as gasification—yields a mixture of carbon dioxide, hydrogen and carbon monoxide known as synthesis gas. The synthesis gas replaces natural gas to produce steam and hot water for UBC's academic district energy system.

The BRDF project was developed as a collaboration between UBC building operations, researchers at UBC, and Canadian start-up company Nexterra. This model of using campus infrastructure as a testbed for sustainability made the BRDF a flagship project of the UBC Campus as a Living Lab (CLL) initiative. This study is meant to analyze and provide insight on the application of the CLL model to the innovative and operational BRDF.

The study is structured into four parts. The first part consists of a literature review on published reports, theses, and scientific studies related the BRDF. In total, the author identified and analyzed 7 peer reviewed papers, 3 theses, 8 student projects, and 15 reports. To date, the main research topics have been tar cracking, fuel quality, logistics, and emissions/air quality. UBC researchers have analyzed fuel, synthesis gas, and tar characteristics at the BRDF's onsite laboratory. UBC faculty currently conducting research at the BRDF are Xiaotao Bi, Naoko Ellis, Anthony Lau, and Shahab Sokhansanj from the department of Chemical and Biological Engineering in the Faculty of Applied Science.

The second part of this study explores the expansion of the BRDF which is currently underway. The BRDF will increase productivity to produce the majority of UBC's thermal energy through biomass. This will enable UBC to meet its 2020 GHG emissions reduction target of 67% below 2007 levels. The expansion will feature a new 12 MWth boiler, fuel delivery system, and larger fuel storage bunker. The new 12 MWth boiler features a change in technology. Wood waste will be burned (combusted) to produce thermal energy rather than converted to synthesis gas (gasified). The total energy capacity for the expanded BRDF including the original gasifier and the combustor will be 18 MWth. This will cover 100% of campus heating and hot water needs for 8-9 months of the year.

The BRDF expansion also features the addition of a Biorefining Research and Innovation Centre (BRIC) called the high head lab. The BRIC, funded by the Canadian Foundation for Innovation, will allow researchers to develop new technologies and bioproducts at an industrially-relevant scale. The centre will house state-of-the-art reactors and testing equipment for converting biomass into value-added products. The BRIC building will be separate from the operational plant but will continue to provide syngas for research.

In the third part of this study, 36 key personnel were interviewed to find out about their past experiences with the BRDF. The amazing story of the BRDF's beginning, and all that came together in order for it to happen, are included in this section. Challenges along the way, the current status of research at the BRDF, and plans for the

BRDF expansion are explored from the perspective of UBC executives, operators, researchers and students. Recommendations for the expansion plan are made based on their feedback. Finally, enablers and barriers for operator and researcher collaboration are identified.

The fourth and final part of this report is a case study examining the biomass gasifier at Chalmers Technical University in Gothenburg, Sweden. This 2-4 MWth supports an extensive research program, trains dozens of PhD students and employs several research engineers and operators for 15-20 weeks of the year. Chalmers faculty provided “big picture” suggestions for the BRDF expansion plan.