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Award Recipient: University of Washington

Name of Project: Washington State Biofuels Industry
Development

Principal Investigator: Richard Gustafson

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Executive Summary

The funding from this research grant enabled us to design, renovate, and equip laboratories to support University of Washington biofuels research program. These laboratories now being used in several research projects. Following are research projects that they are supporting:

- Investigation of novel chip production method in biofuels production
- Investigation of biomass refining following steam explosion
- Several studies on use of different biomass feedstocks
- Investigation of biomass moisture content on pretreatment efficacy.
- Development of novel instruments for biorefinery process control
- Investigation of novel membrane technology to recover fermentable sugars from waste streams
- Development of processes to convert alcohols into jet fuel
- Development of methods to convert beetle killed wood into fuels and chemicals.

Having this equipment was also instrumental in the University of Washington receiving a \$40 million grant from the US Department of Agriculture for biofuels development as well as several other smaller grants.

The research that is being done with the equipment from this grant will facilitate the establishment of a biofuels industry in the Pacific Northwest and enable the University of Washington to launch a substantial biofuels and bio-based product research program.

Comparison of accomplishments and goals

The goal of the project was to renovate equip a laboratory to conduct biofuels process research. The laboratory renovations are complete and all the equipment has been purchased and installed. All the goals of the project have been met.

Project Activities

The University of Washington biofuels process laboratory is completely functional. We now have the capability to investigate both bioconversion and thermal conversion routes to produce fuels and chemicals from biomass. A drawing and photographs of laboratories and some of the new equipment are shown below. The laboratories are currently being used by 8 graduate students, a post-doc, and as many as 10 undergraduate students. We also use the laboratories as part of the Bioresource Science and Engineering undergraduate program.



Artist rendering of University of Washington Biofuels laboratory



Laboratory fermenter and anaerobic chambers.



**High pressure pyrolysis reactor and
GC/Mass spectrometer used for analysis.**



**VSEP membrane separation unit used for
low energy product recovery research.**

Products Developed Under the Award

Publications:

Vajzovic, A., Bura, R., Kohlmeier, K., and Doty L.S., (2012) Novel endophytic yeast *Rhodotorula mucilaginosa* strain PTD3 II: production of xylitol and ethanol in the presence of inhibitors, *Journal of Industrial Microbiology and Biotechnology* 39 (10) 1453-1463.

Ewanick, S., Thompson, W. J., Marquardt, B., J., and Bura, R., (2013) Real-time understanding of lignocellulosic fermentation by Raman spectroscopy, *Biotechnology for Biofuels*, 6: 28.

Ewanick, S., Schmitt, E., Gustafson, R., and Bura, R., (2014) Use of Raman spectroscopy for continuous monitoring and control of lignocellulosic biorefinery processes, *Pure and Applied Chemistry*, in press

Morales-Vera, R., Bura, R., Gustafson, R., and Dooley, J., The influence of particle size on bioconversion of hybrid poplar for sugar production, submitted to "Bioresource Technology" (2014)

Budsberg, E., M. Rastogi, M. E. Puettmann, J. Caputo, S. Balogh, T. A. Volk, R. Gustafson, and L. Johnson. 2013. Life-cycle assessment for the production of bioethanol from willow biomass crops via biochemical conversion. *Forest Prod. J.* **62**(4):305–313

Guanqun Luo, Fernando L.P. Resende "Fast Pyrolysis of Beetle-Killed Lodgepole Pine"; *Journal of Analytical and Applied Pyrolysis*; in submission

Technologies/Techniques

The biofuels laboratories been used to develop technologies to improve the efficacy of conversion of biomass to fuels and chemicals. These technologies are described in the publications listed above and that are forthcoming. Some of the process improvements and technologies that resulted from this equipment include:

- Presteaming (soaking) of biomass prior to steam explosion pretreatment
- Refining of biomass following pretreatment
- New methods of producing wood chips for use in steam explosion pretreatment
- New sensors for fermentation and hydrolysis in the production of biofuels
- Advanced control systems for biofuels production
- Use of ablative pyrolysis to produce bio-oil from beetle killed softwoods
- Catalytic conversion of alcohols produced from biomass to hydrocarbons
- Sustainability assessment of candidate bioconversion processes