2019 Project Abstract
For the Period Ending June 30, 2022

PROJECT TITLE: Forest and Bioeconomy Research - Subproject 4 Advance emerging Minnesota technologies to produce clean syngas from biomass
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APPROPRIATION AMOUNT: $500,000
AMOUNT SPENT: $500,000
AMOUNT REMAINING: $0

Sound bite of Project Outcomes and Results
Synthesis gas (syngas) is a mixture of combustible chemicals that can be used to replace fossil fuels for industrial processes, hydrogen, and fuel production. This project demonstrated that forest residuals from insect-damaged trees can be pretreated to improve their conversion efficiency to make cleaner syngas.

Overall Project Outcome and Results
Achievement of Minnesota's renewable energy transition and associated greenhouse gas (GHG) reduction goals requires development of non-fossil fuel alternatives for fuels and processes that are impractical to convert to electrical power. Key syngas applications include production of renewable diesel, jet fuel, and hydrogen, as well as direct use of syngas for production of iron and steel products. Our objective was to demonstrate that low-value forest biomass could be used to generate clean syngas for these markets in Minnesota by pretreating the biomass to improve its physical and chemical properties.

Our objective was to determine the best pretreatment conditions for one Minnesota biomass that would improve the yield of syngas components (H_2, CO, CH_4) relative to contaminants (tars) with the minimal processing temperature, time, and handling. Our results showed that addition of temperature and steam during pretreatment significantly reduced the tars produced during gasification, but with some loss in syngas yield. Therefore, we concluded that a mild steam treatment between 240-260°C with low residence time was optimal for pretreating black ash to make syngas.

Pilot-scale gasification trials on pretreated biomass was performed at the University of North Dakota Energy & Environmental Research Center, which ran pilot tests in their fluidized bed gasifier on eight different samples of black ash pretreated between 180 and 300°C and untreated biomass controls. The pilot results confirmed that pretreatment reduced tar production at the expense of reduced syngas yield. More importantly, however, the pilot tests showed that pretreatment improves the grindability of the biomass, making it easier to handle and feed to a gasifier.

These results demonstrate that renewable hydrogen, methane, or fuels can be made from Minnesota's biomass residuals by gasification, and low-temperature pretreatment will help.

Project Results Use and Dissemination

Singsaas E, Kolomitsyna O, Kacharov O, Yemets S, Young M, Barry B. 2022. Biomass pretreatment to make clean syngas from Minnesota wood residuals. Natural Resources Research Institute, University of Minnesota Duluth, Technical Report NRRI/TR-2022/17.