Executive Summary

***Project Title*:** Production of Advanced Renewable Fuel Ethanol and Value-Added Chemicals from Biomass Residues

***Project Applicant*:** West Biofuels, LLC

Project Partners: University of California, San Diego; Albemarle Corporation, Bioenergy 2020+

***Project Description*:** This project will develop and validate a pilot-scale mixed alcohol synthesis (MAS) system to convert woody biomass residue to renewable fuel ethanol. The proposed project will utilize a Fast Internally Circulating Fluidized Bed (FICFB) pilot-scale gasifier that has been constructed and is operating at the Woodland Biomass Research Center in Woodland, California, a commercial-scale FICFB gasifier in Güssing, Austria, and a commercially-available MAS catalyst produced by Albemarle. The unique match of highly efficient gasification technology with MAS catalyst and methanol recycling promises to open a pathway to low-carbon renewable fuel ethanol, substituting out-of-state corn ethanol with in-state biomass to ethanol pathways that are over four times less carbon intensive.

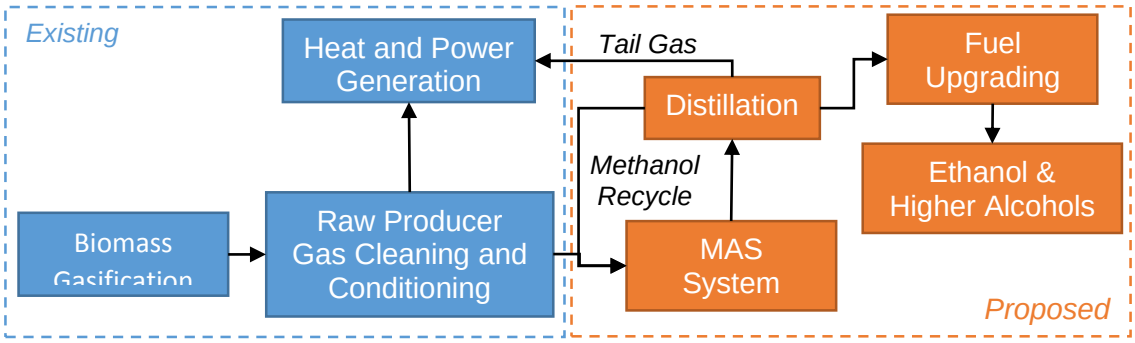

Figure 1. Proposed Project Block Diagram

The system has been validated in Güssing, Austria with a bench-scale unit. The proposed project will scale the system to a pilot-scale facility to refine the design and demonstrate scalable and long-term conversion of synthesis gas to renewable ethanol.

Figure 2. Güssing Renewable Energy Biomass Gasification Combined Heat and Power Plant in Austria (Left) and Pilot-Scale Fast Internally Circulating Fluidized Bed Gasifier at the Woodland Biomass Research Center in Woodland, CA (Right)

Project Goals and Objectives:

Goals	Objectives
Demonstrate the pilot-scale conversion of woody biomass residues to renewable ethanol.	Create a synthesis system, using Albemarle's commercial catalyst that will convert woody biomass-derived syngas into renewable ethanol and higher-value mixed alcohols.
Demonstrate the incremental conversion improvements with methanol recycling.	Improve the ethanol production rates from the MAS system with methanol recycling.
Demonstrate model-based temperature control inside the catalyst reactor.	Develop a temperature control systems to maintain proper temperatures inside the synthesis system that proactively responds to changing operating conditions and the exothermic catalyst reactions.
Demonstrate long-term sustained operational capacity.	Demonstrate that the commercial MAS catalyst can perform over a long-term period on woody-biomass derived syngas.
Demonstrate cost-effective conversion of woody biomass residue to renewable ethanol.	Evaluate that at commercial-scale, woody biomass to renewable ethanol is cost-competitive with alternative renewable ethanol substitutes.
Demonstrate low-carbon renewable ethanol pathways that meet California environmental standards.	Evaluate that at commercial-scale, the environmental impacts of the proposed technologies support California's environmental stewardship goals.

Project's Quantified and Measurable Objects

For each objective above, quantifiable targets have been identified and will be measured by the Project Team using accepted industry methodology. UC San Diego will be responsible for third-party monitoring and verification to establish whether targets have been met.

Project Task Description:

The project is divided into the following tasks and subtasks that address each of the above objectives:

- Task 1: Administration (Mandatory) – administration and reporting tasks for the project;
- Task 2: Development and Testing of Pilot Biomass-to-Mixed Alcohol Synthesis
    - Task 2.1: Parameter Testing for MAS Catalyst with Bio-Syngas
    - Task 2.2: Long-Term Test of MAS Catalyst with Bio-Syngas
    - Task 2.3: Design and Construct Pilot MAS System
    - Task 2.4: Testing of Pilot MAS System
- Task 3: Data Collection and Analysis

Project Benefits:

The proposed renewable energy pathway is estimated to have a carbon intensity value of 22.2 gCO_2e/MJ when using forest residues and 15.4 gCO_2e when using agricultural residues in comparison with 80.7 gCO_2e/MJ for corn based ethanol. Additional benefits to California include renewable in-state fuel ethanol, diversion of biomass from pile burning or landfill, and local clean energy jobs.