DOE-ID NEPA CX DETERMINATION
Idaho National Laboratory

CX Posting No.: DOE-ID-INL-20-077

SECTION A. Project Title: Real time, Integrated Dynamic Control Optimization to Improve the Operational Reliability of a Biomass Dryer

SECTION B. Project Description and Purpose:

The U.S. Department of Energy (DOE) has selected Idaho National Laboratory (INL) to receive funding through the Feedstock Conversion Interface Consortium (FCIC) Directed Funding Opportunity to address technical risks and understand how biomass properties influence preprocessing technologies in collaboration with Idaho Forest Group (IFG).

Variations in feedstock characteristics (e.g., particle size and distribution, moisture, ash, and heat content) may negatively affect feedstock pre-processing systems, which can result in low or unreliable on-stream time and long start-up times. By integrating various FCIC capabilities (e.g. adaptive control capability, sensors, inline instrumentation, predictive modeling of mechanical behavior of biomass particles), this project aims to achieve 90% operational reliability of IFG's continuous vibrating fluidized bed type dryer and improve the drying efficiency by >20%. This project aims to support IFG's commercialization and technical advancement by developing a dynamic feedstock informed process control-optimization model, algorithm, and prototype. Improved feedstock preprocessing performance will be demonstrated at IFG's demonstration site at Idaho.

The main objective of this project is to attempt to integrate key feedstock Research and Development (R&D) technology developed under FCIC with IFG's preprocessing equipment to support IFG's commercialization and technical advancement. The project sets a goal to achieve 90% operational reliability of IFG's continuous vibrating fluidized bed type dryer and improve the drying efficiency by >20% by developing feedstock informed process control method.

Reasons for Cooperation:

Idaho Forest Group (IFG) is setting up new equipment in their pilot plant in Athol, ID to generate engineering data for scaling up a patent-pending biomass fractionation process which fractionates biomass into conversion ready feedstock and high-value co-products. This breakthrough technology is applicable to woody as well as herbaceous biomass. The conversion ready feedstocks from herbaceous biomass can be fed into enzyme hydrolysis reactors with minimal pretreatment (such as slurrying and sterilization). The woody conversion ready feedstock would meet the specifications and critical quality attributes of thermoconversion processes. The IFG biomass fractionation technology therefore lowers the technical and economic barriers for biofuels.

The primary feedstock to be investigated in this study is steam exploded fibers from wood residues (e.g., sawdust) produced from IFG's proprietary process.

For the proposed project, the IFG pilot plant will produce low-ash and low moisture (25-30% moisture content) steam exploded fibers. Prior to being densified into stable conversion ready feedstock, the fibers are dried to about 15% moisture in a 500 lb/h low-temperature vibrating screen dryer. As the steam exploded fibers have high surface area, it is expected that the water evaporation rate would be high. However, moisture content of the dried fibers is a critical attribute and needs to be controlled within a narrow range of about 13% to about 16%.

This is the ideal time for IFG to partner with DOE, FCIC, and project partners to simulate and establish baselines for system performance, incorporate feedstock feed-forward information, and test system controls and efficiencies. Now, IFG has the opportunity, with partners, to hone its vibrating fluidized bed type dryer efficiency.

Technical Objective:

The main objective of this project is to implement key feedstock R&D technology developed under FCIC with IFG's feedstock preprocessing system to support IFG's commercialization and possible technical advancement. In pursuit of the main objective, efforts will be made to implement the following FCIC resources: a) in-line instrumentation and sensors technology, b) intelligent, adaptive control framework, 3) predictive/theoretical model for drying behavior of biomass particles, and 4) software and data science technology from INL's Process Demonstration Unit (PDU).

Task 1: Collect base process performance data

Collect feedstock and some system performance data from IFG's vibrating fluidized bed type dryer. Data collection will seek to identify how variations in feedstock characteristics may affect drying efficiency as well as results in downtimes of equipment used in preprocessing and feedstock feeding systems. Data collection will be limited to softwood sawdust. This task will seek to identify the possible need for new sensors and appropriate feedstock-informed process control methods.

Task 2: Develop predictive model

This task will seek to develop a predictive model to better understand transient behaviors of the proposed process described by ordinary differential equations, differential algebraic equations, or partial differential algebraic equations. This task will seek to leverage knowledge and experience gained in developing predictive physical models and algorithms for the intelligent adaptive control system under FCIC R&D activities.

Task 3: Test on-line sensors for IFG's system

If the research performed in Tasks 1 and 2 indicates that in-line feedstock instrumentation and sensor technology may be needed, then this task will seek to identify the possible appropriate technology for IFG's preprocessing system.

Task 4: Design and develop a feedstock informed "feedback loop" or "feed forward" process control algorithm

This task will seek to measure feedstock properties, in as close to real time as possible, and develop a "feedback loop" or "feed forward" optimal process feedstock control algorithm for IFG's continuous vibrating fluidized bed type dryer to handle the variation of feedstock properties and improve drying efficiency.

Task 5: Support Demonstrating and Testing

Task 5.1: Develop design of experiment for demonstration

This task will seek to identify a design of experiments test program to demonstrate improved feedstock performance. Case studies will seek to be developed based on available softwood saw dust.

Task 5.2: Process demonstration

This task will seek to measure improved operational reliability and drying efficiency of continuous vibrating fluidized bed type dryer. The task will demonstrate the operational reliability of the dryer to 90% and achieve moisture content of wood fibers in the 13%-16% range from starting moisture of 25%-30%.

INL will purchase, tag, and cover shipping costs to IFG items such as level and mass flow sensors, online moisture sensors, adaptive control framework, particle size measurement sensor, and other accessories as needed for demonstration. Upon completion of the project, the above items will be returned to INL, at INL's expense.

Data analysis and modeling work will be performed at the Energy Storage Laboratory in Idaho Falls.

SECTION C. Environmental Aspects or Potential Sources of Impact:

Air Emissions

Fugitive emissions are expected at IFG's facility in Athol, Idaho.

Discharging to Surface-, Storm-, or Ground Water

N/A

Disturbing Cultural or Biological Resources

N/A

Generating and Managing Waste

Waste is expected to be generated at IFG's facility in Athol, Idaho. Waste will be managed in accordance with IFG's procedures. Some pacakaging material (paper, plastic, cardboard,etc.) may be generated at INL.

Releasing Contaminants

N/A

Using, Reusing, and Conserving Natural Resources

All applicable waste will be diverted from disposal in the landfill when possible. Project personnel will use every opportunity to recycle, reuse, and recover materials and divert waste from the landfill when possible. The project will practice sustainable acquisition, as appropriate and practicable, by procuring construction materials that are energy efficient, water efficient, are bio-based in content, environmentally preferable, non-ozone depleting, have recycled content and are non-toxic or less-toxic alternatives. New equipment will meet either the Energy Star or Significant New Alternatives Policy (SNAP) requirements as appropriate (see http://www.sftool.gov/GreenProcurement/ProductCategory/14).

SECTION D. Determine Recommended Level of Environmental Review, Identify Reference(s), and State Justification: Identify the applicable categorical exclusion from 10 Code of Federal Regulation (CFR) 1021, Appendix B, give the appropriate justification, and the approval date.

For Categorical Exclusions (CXs), the proposed action must not: (1) threaten a violation of applicable statutory, regulatory, or permit requirements for environmental, safety, and health, or similar requirements of Department of Energy (DOE) or Executive Orders; (2) require siting and construction or major expansion of waste storage, disposal, recovery, or treatment or facilities; (3) disturb hazardous substances, pollutants, contaminants, or Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)-excluded petroleum and natural gas products that pre-exist in the environment such that there would be uncontrolled or unpermitted releases; (4) have the potential to cause significant impacts on environmentally sensitive resources (see 10 CFR 1021). In addition, no extraordinary circumstances related to the proposal exist that would affect the significance of the action. In addition, the action is not

"connected" to other action actions (40 CFR 1508.25(a)(1) and is not related to other actions with individually insignificant but cumulatively significant impacts (40 CFR 1608.27(b)(7)).

References:
10 CFR 1021, Appendix B, B3.6, "Small-scale research and development, laboratory operations, and pilot projects"

Justification:
The proposed R&D activities are consistent with CX B3.6 "Siting, construction, modification, operation, and decommissioning of facilities for small-scale research and development projects; conventional laboratory operations (such as preparation of chemical standards and sample analysis); small-scale pilot projects (generally less than 2 years) frequently conducted to verify a concept before demonstration actions, provided that construction or modification would be within or contiguous to a previously disturbed area (where active utilities and currently used roads are readily accessible). Not included in this category are demonstration actions, meaning actions that are undertaken at a scale to show whether a technology would be viable on a larger scale and suitable for commercial deployment;"

Is the project funded by the American Recovery and Reinvestment Act of 2009 (Recovery Act) ☐ Yes ☒ No

Approved by Jason Sturm, DOE-ID NEPA Compliance Officer on: 10/7/2020