SECTION A. Project Title: Biomass Feedstock National User Facility (BFNUF) R1

SECTION B. Project Description and Purpose:

Revision 1:

Revisions are included throughout the body of the document.

Original:

The Biomass Feedstock National User Facility (BFNUF) offers technology and expertise to help the U.S. bioenergy industry overcome challenges during design, scale up and integration of feedstock preprocessing facilities. Research and Development (R&D) at the BFNUF primarily supports the mission of the Department of Energy's (DOE's) Bioenergy Technologies Offices (BETO) to develop and transform renewable biomass resources into commercially viable, high-performance biofuels, bio-products, and bio-power through targeted research, development, demonstration, and deployment (RDD&D) supported through public and private partnerships. BFNUF also is intended to support the mission objectives of other DOE offices, such as the Advanced Manufacturing Office and the Vehicles Technology Office, other government agencies such as Department of Defense programs for upgrading and utilizing waste materials, and industrial entities. Thus, the operations and activities described in this section are used as required based on customer needs.

This ECP does not include activities at locations other than INL, activities that impact historically significant properties (e.g. EBR-I), diesel generator systems, health and safety equipment, or safety and environmental improvements. Activities not meeting the scope of this ECP require separate, project-specific ECPs. This ECP does not cover replacing and upgrading facility systems (e.g. roof replacement, modifying drinking water systems, replacing or upgrading alarm and surveillance systems, etc.) or modifications to laboratories necessary to accommodate research activities that require project-specific ECPs. Project personnel must contact the program environmental lead (PEL) to verify that various projects are within the scope of this ECP.

The goal of the BFNUF is to study and perform the transformation of raw materials into value-added feedstocks for conversion processes that manufacture biofuels and products. Raw materials are defined as those suitable for upgrading and include (with scale of use):

- Both woody forest products such as clean and whole-tree chips from both soft and hard woods, and herbaceous agricultural products, such as corn stover, wheat straw, switchgrass, and sorghum.
- Waste materials such as construction and demolition waste (construction lumber, paneling, drywall, concrete and masonry, etc.).
- Plastics, which can be grouped into the seven commonly used general categories:
  - #1 Polyethylene terephthalate (PET)
  - #2 High Density Polyethylene (HDPE)
  - #3 Poly(vinylchloride) (PVC)
  - #4 Low Density Polyethylene (LDPE)
  - #5 Polypropylene (PP)
  - #6 Polystyrene (PS)
  - #7 Others that may include polycarbonate, acrylates, nylon, bioplastics, composites, etc.
- Sources of plastics include recycled or collected materials, Municipal Solid Waste (MSW), e.g., plastics such as PS and PE, and engineered materials such as composite resins, epoxies, and polyesters.
- MSW, which is a mixture of woody biomass, food and other organic residues, metals, and plastics.
- Composite plastics may also be processed in the BFNUF. Composites are mixtures of materials where the polymer can act as a structural member or a binder. Carbon fiber is an example of a composite that may be processed. Carbon fiber composites consist of carbon fiber mats bound by a plastic resin. Multilayered materials like candy wrappers (multi-layered packaging), printed circuit boards, and other mixed plastic/metal materials are also considered composites.
- Coal (neat, in mixtures with biomass, or as a source of rare earth elements and other valuable materials). Coal is generally not used at the BFNUF at INL, but products from R&D are often used to reduce the amount of coal used at power or heat generation facilities. Torrefied material (i.e. biomass treated at temperatures around 200-300 °C in an inert atmosphere) behave similar to coal and are a material that can be processed in the BFNUF.
- Farm manures (class B biosolids)
- Cost-advantaged algae

All these feedstock precursors will be handled at multiple scales ranging from lab-scale (grams to kilograms) to processes capable of handling 1-5 tons per hour, depending on project scope and scale of the equipment. The goal is to reduce the amount of material handled to the lowest needed to obtain the desired result.

Most of the work associated with the BFNUF at INL takes place at the Energy Systems Laboratory (ESL) (IF-685), with some biomass characterization occurring at the Energy Innovation Laboratory (EIL), building IF-688, and at the INL Research Center (IRC). All facilities are located at INL's Research and Education Campus (REC) in Idaho Falls.

The BFNUF includes the Process Demonstration Unit (PDU), the Bioenergy Feedstock Library (BFL) and the Bioenergy Feedstock Characterization Laboratory:

Process Demonstration Unit (PDU)

The PDU is a modular feedstock pre-processing system. It is constructed from Original Equipment Manufacturer (OEM) and specially designed equipment to process materials. The PDU equipment offers different processes to breakdown structure, stabilize biological processes, and increase the energy density of these materials. Major capabilities include:

- Size reduction – from gram scale cryogenic attrition mills up to ton scale hammer mills size reduction capabilities span a range of both wet and dry materials.
- Conveyance and separation systems – including pneumatic cyclones and baghouses for dust collection, air classification columns for material separations, as well as oscillating, disc, and ballistic screens for removing dirt and separating 2D from 3D streams in MSW. Additionally, the BFNUF has many drag chain and screw conveyor systems to move materials from one process step to the next.
- Thermal and moisture conditioning systems – these systems range from ton scale rotary drum drying, torrefaction, steam and chemical treatment, and rotating autoclaves to kg scale torrefaction ovens and 3L environmental chambers where the moisture content of a samples can be controlled in detail for month long experiments the BFNUF has many tools to manipulate wastes such that their deconstruction and conversion properties are improved.
- Characterization tools – as part of the characterization laboratory capabilities the BFNUF has many gas and liquid chromatographs, solvent extractors, a pyrolysis unit, particle size analyzers, and spectroscopic characterization equipment like Near IR, Attenuated Total Reflectance, Time Domaine NMR, mechanical analysis, and other tools. These tools help determine what properties of a waste are being altered by the preprocessing steps as well as what properties matter most to downstream conversion processes.

Equipment operation activities include bulk materials handling using loading equipment, manually feeding materials, manually removing samples, removing processed materials from the equipment, and equipment operation.

Reconfiguration activities include moving the PDU equipment and may also include fabrication of transition pieces and modification to existing equipment. Re-assembling and installing components may require using sealants, glue, epoxies, and mechanical greases.

INL configures and operates equipment in accordance with the recommendations identified in TEV-1712 "Hazards Analysis of the Process Demonstration Unit Operation in Energy Systems Laboratory (IF-685)" and in accordance with the City of Idaho Falls operating permit as approved by the Authority Having Jurisdiction.

Biomass Feedstock Library (BFL)

The BFL is a physical sample repository and database for physical, chemical and conversion performance characteristics of biomass feedstock. The library provides tools to store, record, track, retrieve, and analyze data to help researchers and industry overcome challenges posed by biomass variability. Sample collection is an ongoing effort with public and private collaborators.

Activities associated with the BFL:

- <u>Sample handling and preparation:</u> Handling, preparing, and characterizing field-collected samples and archiving them in the BFL
- <u>BFL sample and data management:</u> Populating the BFL when samples and data are sent to INL.

Bioenergy Feedstock Characterization Laboratory (BFCL)

BFCL allows researchers to pinpoint important variables such as chemical composition and flowability to align feedstock characteristics with conversion technologies and end products. Capabilities also include automated dilute acid pretreatment with enzymatic hydrolysis.

Many of the methods used in biomass feedstock analysis involve general laboratory techniques and instruments to determine dry matter loss, moisture content, organic extractables, non-structural carbohydrates, and lipids. The methods use common chemical laboratory techniques such as weighing, measuring and dispensing chemicals, acids and reagents; compressed gases; vacuum filtration; pressure and vacuum equipment; measuring pH, redox potential, heat (drying heat, boiling & heating); cryogenic cooling (dry ice and ethanol, ice baths, chilled glycol solutions); salt solutions; extracting or crystallizing chemicals or metabolic products from aqueous or organic phases; using ground joint glassware; freezing and freeze-drying materials; and using a broad range of analytical instruments and equipment.

Activities at the BFCL include:

1. <u>Chemical Compositional Analysis</u> — Analytical procedures offer methods to determine the composition of biomass feedstock materials by fractionating samples to characterize constituents (e.g., ash, individual chemical constituents, carbohydrates, and lignin). The solid sample deconstruction and sampling systems includes hammer mills, cutting mills, centrifugal mills, and

automated sample dividers for the analytical preparation of biomass samples. Ovens are typically used to dry and prepare biomass materials for analysis, other preparations, and preservation.

Activities also include measuring the following groups of chemical and physical properties of biomass:

- Elemental C, O, H, N, and S content (ultimate analysis)
- Moisture, volatile matter, ash and fixed carbon contents (proximate analysis)
- Calorific analysis (calorimetry)
- Volatile organic compounds (VOCs) and semi-volatile organic compounds (SVOCs)
- Variability of inorganic species (i.e., Ca, K, Na, Mg, Si, Al, S, Fe and P).

2. Thermochemical Feedstock Properties — Proximate and ultimate analysis techniques evaluate the thermal efficiency and energy content of a given feedstock. Thermogravimetric analyzer/differential scanning calorimetry and gas chromatography (GC) determine the caloric effects to understand material properties. INL analyzes biomass to determine elements present in ash samples from varying cultivars and locations. The program uses multivariate chemometrics to build predictive models between the spectral measurements and the primary analytical techniques (Inductively coupled plasma mass spectrometry [ICPOES/ MS]) measured on a subset of calibration samples.

3. Rapid-Screening Techniques — Rapid-screening techniques (predictive near-infrared spectroscopy and laser induced breakdown spectroscopy [LIBS]) determine proximate and ultimate analysis and elemental ash values. The laser is a Class 4 pulsed laser equipped with a control box. A second class 2 laser (less than 1 mW continuous power at 670 nm) is employed to assist in focusing and aligning the primary Class 4 laser. A laser enclosure contains the laser beam and light. A sealed sample chamber within the laser enclosure contains the sample and may be purged with inert argon or nitrogen gas to enhance the LIBS signal and prevent contamination by atmospheric gases.

4. Microscopy and Imaging — Digital, confocal laser, scanning electron and Fourier-Transform infrared microscopy help researchers develop mechanical and chemical preprocessing and densification options that impact the chemical and physical attributes of the feedstocks. Microscopic Observation and Photography of Microorganisms involves researchers attaching microorganisms to solid surfaces such as slides, membranes, or minerals by natural adherence, filtration, heat, or chemical treatment. Cells are prepared using various fixatives, stains, and reagents, including nucleic acid probes and antibodies, with and without fluorescent tags. INL also characterizes the microstructure and binding behavior of biomass pellets using CT scan, SEM, laser microscopy, solid-state NMR, Fourier Transform Infrared Spectroscopy (FTIR), focused ion beam (FIB) tomography, TEM, and XRD techniques.

   INL evaluates tissue level changes in biomass anatomical fractions for changing moisture contents using advanced imaging and analysis methods such as scanning electron microscopy and energy dispersive x-ray spectroscopy (SEM-EDS), Transmission Electron Microscopy (TEM), and time domain nuclear magnetic resonance (TD-NMR). TD-NMR characterized free versus bound water in a material, which can impact the energy needed in drying.

5. Particle-Size Distribution and Morphology — Various methods and instruments are used to determine particle size, size distribution, shape and density. Methods include a Sympatec QICPIC system that can determine geometric mean diameter length and width, sphericity, and aspect ratio for materials ranging from microns to 10’s of mm in both dry and wet formats.

6. Particle Characteristics — Pycnometry determines the true density. Gas sorption analysis determines surface area, pore volume, average pore size, and pore size distribution of microporous and mesoporous solids using classical Brunauer-Emmett- Teller (BET) helium void volume. Mercury porosimetry is also available.

7. Rheology — Rheology capabilities include a rheometer, 2- and 3-D image analysis of size and shape distribution of bulk solids, an automated Schulze ring shear tester, uniaxial compressibility and springback analysis, air permeability analysis, auger feeding tests and hopper flow tests. An Anton Parr rheometer and custom capillary rheometer are also available to measure viscosity of biomass slurries as needed.

8. Lignin Chemistry — Lignin chemistry is analyzed using nuclear magnetic resonance spectroscopy.

9. Biomass Storage Simulation — Storage simulation reactors help researchers monitor feedstocks in a variety of storage conditions to understand biomass losses from microbial degradation. These highly instrumented and automated storage reactors determine microbial action by monitoring the evolution of CO2 over time.

   INL performs experiments to investigate ensiling and model storage conditions at various temperatures, packing densities, oxygen availabilities, and atmosphere drying. Reactors may be operated to maintain aerobic or anaerobic storage environments. Volatiles emanating from the biomass may be analyzed directly by GC or GC coupled with infrared spectroscopy (GC/IR) or mass spectrometry (GC/MS). Individual experimental systems may be 50 ml to 5 gallons and stored in glass vials, buckets or picnic coolers. Larger systems are used when needed to better achieve model storage and practical experimental conditions and may include the use of 55 gal drums or 100-liter temperature-controlled storage reactors. At the completion of the storage studies, the storage simulators are emptied and the contents sampled for subsequent analyses.

   Gas tracer tests measure gas diffusion in feedstocks. This activity uses sulfur hexafluoride (SF6), inserted into a bale or bulk sample then measures the tracer gas in the surrounding air over time, either by photoacoustic detection or GC. For stacks of bales and for bulk storage piles, an estimated volume of SF6 (10 to 100 L) may be used.

Storage experiments are also performed with algal biomass alone or blended with lignocellulosic biomass. Algae may be sourced from photobioreactors, open pond raceways, or algal turf scrubbers and obtained through BFNUF collaborators. Storage experiments may range from 5 ml to 5 gallons. Sulfuric, lactic, and acetic acids may be added to algae to simulate ensiled conditions and will be within the range of pH 2-5 or 0.5-6% acid. Bases may also be added to stabilize biomass and may range from pH 9-11. Mixing algae with lignocellulosic biomass and acid is performed in a chemical fume hood. Nitrogen and argon purging in sealed glass vials or through fermentation airlocks is also performed. All materials contacting algae is decontaminated after use.

Sources for reference materials include the BFL and materials used in research at the PDU. INL uses complete proximate or ultimate and elemental analyses of whole samples and fractions and performs spectroscopy on the samples using the Malvern/Panalytical LabSpec. Researchers combine a secondary method—such as LIBS or energy dispersive x-ray fluorescence spectroscopy (ED-XRF)—with near-infrared spectroscopy (NIRS) to predict elemental ash content.

Microbial inoculants may be added to biomass to promote stabilization. Amendments such as silage inoculum and preservatives may be added to biomass prior to storage. Silage inoculum (e.g., Lactobacillus sp.) is commercially available for use and purchased in a ready-to-use form. Alternatively, organisms may be grown in-house and added to biomass prior to storage. Microbial cultivations use Risk Group-1 (RG-1) whole organisms (e.g., bacteria, yeast and other fungi, viruses, algae). This EC only covers using a C6 fermenting organism, Saccharomyces cerevisiae D5A. Risk Group 1 materials are unlikely to cause disease in healthy adult humans and pose minimal potential hazards to laboratory personnel and the environment. Work with these organisms is done using the Center for Disease Control's (CDC's) Biosafety Level 1 (BSL-1) controls and practices. BSL-1 work is generally conducted on open bench tops using standard microbiological practices.

Cultivation of microbes occurs in a variety of vessels such as flasks, bottles, chemostats, Petri dishes, and culture tubes under aerobic or anaerobic conditions. Cells are collected from the growth media by centrifugation or filtration and washed and stored in physiological saline, nutrient salts solutions, or various buffers pending further use. Cultures are preserved for long term storage by freeze-drying or cold storage in buffer solutions containing glycerol or dimethyl sulfoxide (DMSO). Cryogenic materials, including dry ice and liquid nitrogen, may also be used.

INL completes microbial community analysis in collaboration with Idaho State University (ISU). INL will develop metagenomic libraries of bacterial and fungal communities, based on DNA sequences from illumina sequencing, to understand the impact of storage treatments on microbial communities associated with preservation.

10. Lipid analysis of whole biomass—Determination of total lipids is carried out by direct transesterification of whole biomass. To perform the analysis, a small portion (5-50 mg) is contacted with a 2:1 chloroform: methanol solvent (~200 µL) and HCl: methanol (0.6 M) solution (~300 µL) in a 1.5 mL GC vial. The process is performed in a fume hood. Research uses sonication to extract lipid products from inside the cell. The sonicator is in a sound inhibiting booth. When sonication steps are using algae and solvents, the sonicator booth is moved inside the chemical fume hood.

Waste Type	Amount
Non-hazardous, non-sewage regulated, non-recycled, i.e., unused and quenched biomass feedstock	20-50 L/Yr
Basic or acidic solutions, filtrates, and extracts that are non-hazardous and non- sewer regulated	< 1500 Gal/Yr
Basic or acidic treated biomass	200 kg/Yr
Biomass Pressate (water, dilute-acid, or dilute-alkali)	Estimated to be much less than 10 L/run.
Biomass samples containing arsenic and selenium	2-10 L/Yr
Ethanol or isopropanol wipes (dried)	2-10L/Yr
Feed materials	Minimal; excess around inlet will be collected
Recyclable waste	< 20 Pounds/Yr
Scrubber condensate	Estimated < 50 gallons per year. This will be measured to better approximate the volume.

Sewer regulated waste	2-10 L/Yr	
Sharps such as needles and razors	<5 L/Yr	
Solid materials containing any amount of the following absorbed chemicals - acetone, methanol, or methylene chloride	<2 L/Yr each	
Spent microbial cultures	20-50 L/Yr	
Unused and excess feedstocks (biomass, MSW, plastics, etc.)	1-2 m3/Yr	
Unused and excess solid biomass, including dust (samples)		
Used Gear Oil	Multiple gallons from changing the oil in gearboxes	
Water and steam for the steam generator	Minimal; steam will be consumed in pellet making	

SECTION C. Environmental Aspects or Potential Sources of Impact:

Air Emissions

Air emissions from portable generators, stationary units such as the PDU, thermochemical treatment of biomass, the CPS, fugitive dust from grinding activities, discharges from laboratory hoods, and fugitive releases of SF6 as part of biomass bale permeability studies are anticipated. Emissions from portable generators are exempt since the generators are used only a few days per year. If the generators remain in the same location an Air Permitting Applicability Determination (APAD) is required.

Fine dust created in some processes may be combustible. Dusts can be a product of the processing of multiple feedstocks including biomass, plastics, MSW, and coal. The grinding systems are operated under negative pressure and designed to collect any dust. Explosion detection and suppression systems, and an ember detection system with a water deluge are in the facility. Water hoses and hand sprayers are available to cool hot spots on equipment to avoid potential fires. Dust control and mitigation includes adding or modifying ducting, ducting connectors, fabric sleeves, other fixtures and ducted fans, water sprays, other dust control methods, or enhanced cleaning procedures. Controlling fugitive dust under certain conditions is also required under state air regulations.

The Project may involve the discharge of hazardous air pollutants regulated by the state or EPA.

The Pneumatic Transfer System includes a blower to create the required air flow, a cyclone and airlock to remove the material from the airstream at the end of the conveyance, and a baghouse to remove the fine dust that makes it through the cyclones.

The CPS has an off-gas scrubber drum. The vent scrubber system includes the Scrubber Drum (D-260), the Scrubber Drum Pump (P-261), the Scrubber Cooler (E-262), and the Scrubber Blower (B-263). All fugitive emissions are routed to the scrubber system. The exhaust from the scrubber is connected to the facility exhaust system.

Fugitive emissions from chemical use are exhausted through the facility mechanical ventilation or local exhaust systems.

Pyrolyzed or torrified feedstocks can have gaseous emissions. Feedstocks that contain mainly cellulosic materials can generate oxides of carbon and water. Most plastics and MSW also give off similar gases. Materials of note include aromatic and halogenated plastics that can give off toxic or corrosive fumes upon high temperature heating. PVC is an example that has the potential to generate corrosive hydrochloric acid.

During the thermochemical pretreatment process, volatiles and the water contained in the biomass are driven off the material, and the biopolymers (cellulose, hemicellulose and lignin) partly decompose and give off various types of volatile and semi-volatile organic compounds (SVOCs). Thermal treatment includes cooling the exhaust gases to separate and collect condensable liquids and analyzing the condensable and non-condensable gases, including fixed gases, volatile organic compounds (VOCs) and SVOCs. A gas analysis system supports thermochemical pretreatments. A coalescing gas filter may also be used to trap entrained VOC and SVOCs.

Emissions from BFNUF activities are covered in APADs INL-10-005 and INL-14-005 R2.

Discharging to Surface-, Storm-, or Ground Water

NA

Disturbing Cultural or Biological Resources

Guide (GDE)-674 gives shipping guidance for receiving and shipping of biomass materials. Appendices include Idaho National Laboratory (INL) Bioenergy Program described materials. All biomass materials will be reviewed against the list of noxious weeds identified in IDAPA 02.06.22. If a biomass material is identified in IDAPA 02.06.22 as a noxious weed, approval from the Idaho Department of Agriculture will be obtained before it is imported.

Generating and Managing Waste

The following table lists waste types and anticipated amounts for waste generated at INL facilities that support BFNUF efforts.

Waste Type Amount

Non-hazardous, non-sewage regulated, non-recycled, i.e., unused and quenched biomass feedstock 20-50 L/Yr

Basic or acidic solutions, filtrates, and extracts that are non-hazardous and non-sewer regulated < 1500 Gal/Yr

Basic or acidic treated biomass 200 kg/Yr

Biomass Pressate (water, dilute-acid, or dilute-alkali) Estimated to be much less than 10 L/run.

Biomass samples containing arsenic and selenium 2-10 L/Yr

Calcium oxide/ Kaolin/tungsten oxide 500 g/yr

Chromium chloride < 5 g/yr

Coal samples < 5 kg/yr

Copper Sticks 500 g/yr

Empty grease containers TBD; depends on equipment requirements for maintenance

Empty reagent bottles or gas cylinders NA

Empty sodium azide bottles <1 bottle/Yr

Ethanol or isopropanol wipes (dried) 2-10L/Yr

Feed materials Minimal; excess around inlet will be collected

Glass (broken glassware) 3 cu. Ft./Yr

Hydraulic fluid filters from equipment TBD; depends on equipment requirements for maintenance

Krytox grease, room temperature vulcanizing (RTV) silicone gasket sealant, silicone, mineral oil, gear oil

Liquid hazardous waste from analytical procedure, i.e., chloroform, methanol, ethanol baths, condensates, and extracts. <5L/Yr

Lubricating grease from equipment Only if equipment leaks or is changed during maintenance

Magnesium oxide 500 g/yr

Magnesium Perchlorate (Anhydrone) 500 g/yr

Non-hazardous, non-sewage regulated, non-recyclable, i.e. ash residue, carbon black, paper towels 100 g – 2 Kg/yr

Non-hazardous, non-sewage regulated, non-recycled (i.e., unused and quenched biomass feedstock) 20-50 L/Yr

Organic calibration standards such as 2-butanone, benzene, xylene, cresols, and toluene. <50mL

Petroleum from equipment Minimal from minor spills or leaking equipment

PPE or used rags or q-tips contaminated with acetone or methanol

PPE or used rags contaminated with ethanol or isopropanol

Propylene glycol solutions (50%) < 8 L solution

Quartz Wool 100 g/yr

Recyclable waste < 20 Pounds/Yr

Scrubber condensate Estimated < 50 gallons per year. This will be measured to better approximate the volume.

Sewer regulated waste 2-10 L/Yr

Sharps such as needles and razors <5 L/Yr

Sodium hydroxide coated on silica (LECOSORB) 500 g/yr

Solid materials containing any amount of the following absorbed chemicals - acetone, methanol, or methylene chloride <2L/Yr each

Spent microbial cultures 20-50 L/Yr

Unused and excess feedstocks (biomass, MSW, plastics, etc.) 1-2 m3/Yr

Unused and excess solid biomass, including dust (samples)

Unused chemicals/products TBD

Unused hazardous chemicals, including excess metal powders < 1 L/yr

Unused or out of date sample spikes, reference materials that DO NOT contain regulated or hazardous components 100g/yr

Used Gear Oil Multiple gallons from changing the oil in gearboxes

Used vacuum pump oil < 10 L/yr

Water and steam for the steam generator Minimal; steam will be consumed in pellet making

Releasing Contaminants

Sewer Releases: Small amounts of chemicals may be discharged to the Idaho Falls sewer system in accordance with sewer regulations.

Microbiological Releases: Good microbiological practices will be followed, and surfaces contacting microbial inoculants will be wiped down with ethanol wipes at the end of the work shift, at a minimum. Contaminated materials will be autoclaved prior to reuse or disposal to prevent release of biologicals.

Solid waste disposal: MSW is a feedstock that is a part of this research. MSW will be received at IRC 603 laboratory A9. The maximum amount that will be sourced at any given time will be 1 m3 boxes. Materials to be sourced include mixed and low grade paper, aseptic and polycoats (layered packaging with plastic and metal layers), food contaminated paper and cardboard, shredded paper, and plastics. These materials will be sourced from recycling facilities that separate single and dual stream collected recyclables. These materials go through two levels of presort prior to receipt at INL. First, these materials are placed in recycling bins by the residential customer. For single stream, the bins receive paper, plastic, metals and sometimes glass. For dual stream, one bin receives paper and cardboard, and the other receives plastic, metals and sometime glass. At the recycling facility, the materials undergo a more rigorous sort process where materials are passed over screens and air columns to separate 2D materials such as paper and cardboard from 3D materials such as bottles and containers as well as remove heavy, wet materials such as food particles and fine materials such as broken glass. Additionally, both ferrous and non-ferrous metals are removed. Unused or unneeded MSW will be dispose of through normal INL waste disposal practices, as informed by Waste Generator Services.

INL receives the non-recyclable portion of these streams (see material list above). Because of the multiple sorting steps, receipt of problematic materials such as batteries and medical waste is not anticipated. Materials will be hand-sorted at INL upon receipt as these streams typically have 10-15% non-desirable components (e.g. plastics streams will contain paper and paper streams will contain plastics). Additionally, although the sourced MSW is pre-sorted, small amounts of contaminated materials may make it through the sorting process (e.g., contaminated recyclables that might be encountered include paper towels with blood on them, pizza boxes with food contamination, moldy items, small pieces of metal, larger pieces of glass and other debris). INL's sorting process removes these items. Handful amounts of MSW is removed from the receiving boxes and spread out on a benchtop for further sorting. MSW with visible contamination from fecal material, blood, mold/fungi, and bacteria is segregated and then decontaminated by autoclaving and discarded. Sharps (metal scraps, broken glass, etc.) are placed in hard sided containers, autoclaved and disposed of in general trash. During the visual inspection and hand sorting, work surfaces are decontaminated with 70-85% ethanol or 10% bleach at least once daily throughout the sorting process.

The seven types of plastic can be grouped into three general categories: 1) aliphatic polymers such as polyethylene (PE, LDPE, HDPE) and polypropylene (PP); 2) aromatic containing polymers such as polyethylene terephthalate (PET) and polystyrene (PS); and 3) halogenated polymers, such as polyvinylchloride (PVC). Sources of plastics will include MSW (plastics such as PS and PE), and resins such as epoxies and polyesters. Composite plastics will also be processed in the PDU. Composites are mixtures of materials where the polymer can act as a structural member or a binder. Carbon fiber is an example of a composite that will be processed in the PDU. Carbon fiber composites consist of carbon fiber mats bound by a plastic resin. Plastics preprocessing in the PDU will consist of unbaling, sorting, and size reduction. Size reduction can involve various methods of grinding and shearing plus screening to remove finer particles. The potential for cross-contamination of equipment handling plastics will be addressed by physical cleaning methods, such as manual dusting, sweeping, or scraping. Another possible method is using biomass and its inherent abrasive nature to scour surfaces of equipment prior to running clean batches. Solvents or water are not expected to be needed for cleaning this equipment.

Using, Reusing, and Conserving Natural Resources

The primary purpose of this work is to investigate methods by which energy may be recovered from biomass, replacing other sources of energy. Furthermore, this work will focus on the development of processes and chemistries for conversion of other waste materials, such as MSW and plastics, into feedstocks for energy production. Finally, the work will include engineering to develop feedstocks that can be fed efficiently into conversion systems.

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:

B3.6 "Small-scale research and development, laboratory operations, and pilot projects"

Justification:

B3.6 Small-scale research and development, laboratory operations, and pilot projects. 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); and 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 or developed 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 L. Anderson, DOE-ID NEPA Compliance Officer on: 6/14/2023