SECTION A. Project Title: Biomass Preprocessing to Sustainable Fuel Pilot Plant

SECTION B. Project Description and Purpose:

The Idaho National Laboratory (INL), in partnership with industry and in coordination with various Department of Energy (DOE)-program offices, intends to assemble a Biomass to Synthetic Fuels pilot plant to provide input into technology and economic models to demonstrate the market costs of creating sustainably derived hydrocarbon fuels for transportation.

The Biomass to Synthetic Fuels pilot plant is defined as a small-scale research renewable energy research and development project due to its relatively small size when compared to future commercial operations. This pilot plant will consume various feedstocks, beginning with preprocessed biomass, to generate several barrels of usable sustainable fuels daily. The overall process can be partitioned into three key stages: biomass preprocessing and delivery, carbon generation via biomass combustion, and feedstock conversion processes to yield various sustainably derived liquid fuels, similar to kerosene or diesel.

Sustainable hydrocarbon fuels can be utilized in lieu of conventional diesel and other conventionally generated hydrocarbon fuels, while also minimizing the volume and mass of materials placed into landfills. Development of a test bed to test the various equipment arrays using mostly biomass to create sustainably derived hydrocarbon fuels. Data collected from the processing will inform technoeconomic analysis and future plant designs.

The proposed location for the pilot plant is on gravel and concrete pads near INL's recently updated Central Facilities Complex (CFA)-686 Highbay (see Figure 1) to provide access to potable water, de-ionized water, steam, compressed air, along with environmentally conditioned space for staff. No buildings will be constructed. The fence and concrete pads in Figure 1 are part of the CFA-686 project scope. Electrical energy will be primarily from the INL grid. Equipment will include preprocessing equipment, storage bins, combustion unit (propane and electric) with heat recovery, power generation and emissions management systems, and a propane tank (Figure 2).

There may be options for preprocessing biomass off-site, including INL's Biomass National Users Facility (BFNUF) in the INL Energy Systems Laboratory (ESL) -E100 Highbay, or at the United States Department of Agriculture (USDA) research site in Aberdeen Idaho. Both locations are approximately one hour from CFA. The BFNUF and USDA research site are existing research locations and processing of biomass would be conducted with existing equipment at the BFNUF or mobile equipment at the USDA facility.

Figure 1: Location map

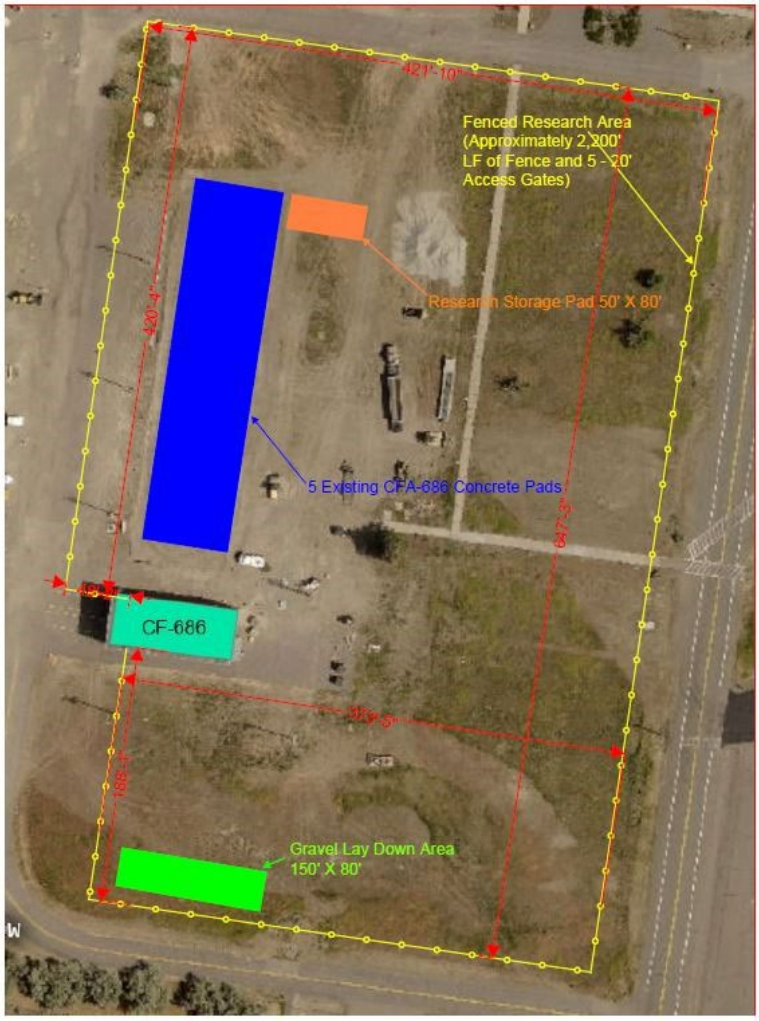
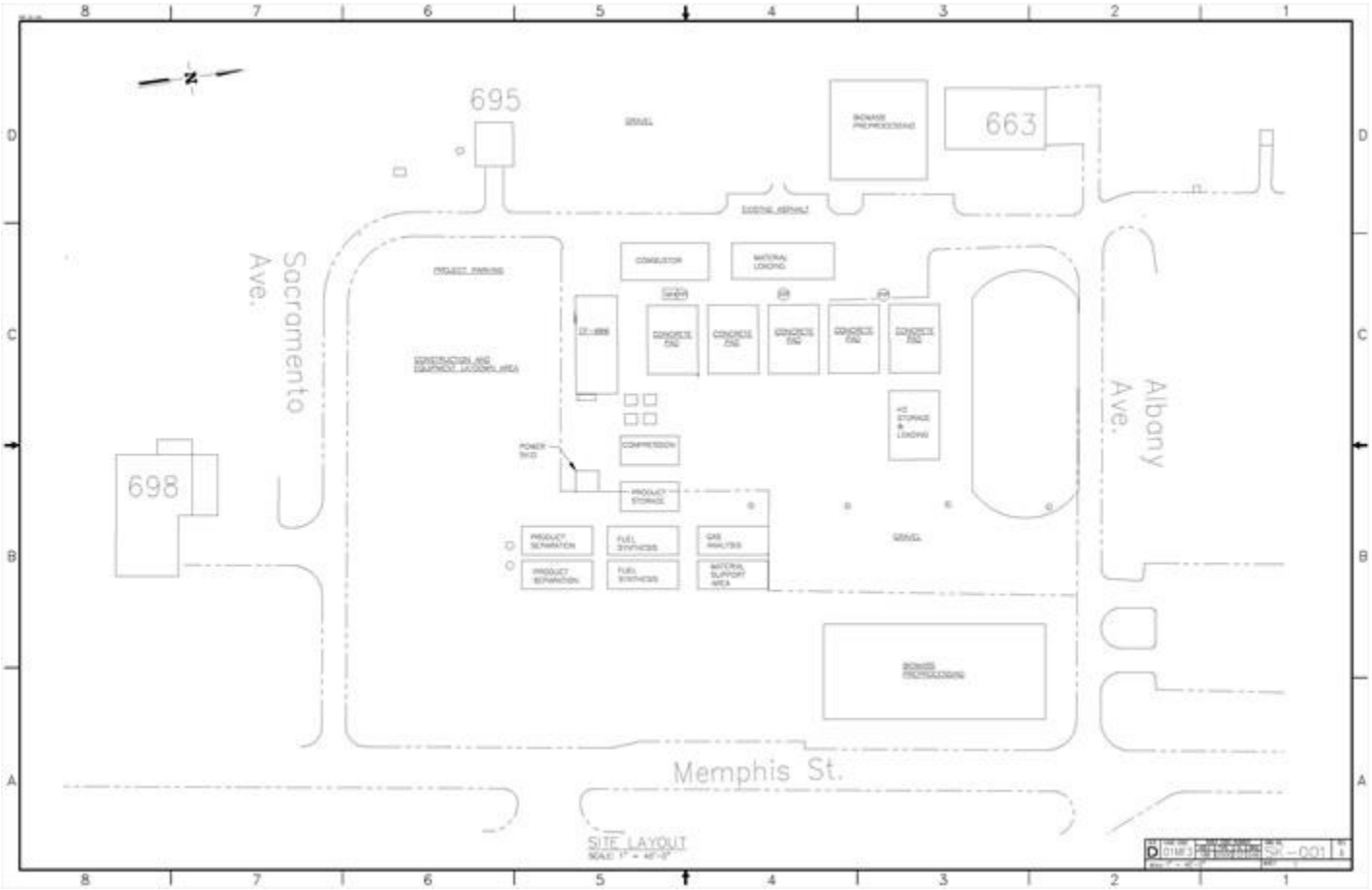


Figure 2: Equipment layout



Tasks include:

Stage One: Biomass Preprocessing

Biomass from onsite operations or derived from agricultural waste will be preprocessed to provide a uniform size and moisture content feedstock. Processing and sizing of biomass will likely be done in batches, as needed, to provide up to one week of material and stored in a product bin placed adjacent to the pilot plant combustor. Selected biomass preprocessing equipment will be placed on gravel pads constructed on disturbed ground adjacent to the High Temperature Testing Facility (HTTF). Equipment in the preprocessing stage will be portable units, that can used as needed to account for different processing requirements based upon biomass input processing needs, similar to the Biomass Feedstock National User Facility (BFNUF) equipment suite. This equipment will consume electrical energy during operations. No chemicals or hazardous materials will be consumed or generated during this step. Reject biomass or agricultural materials would be taken to the INL on-site land fill for disposal.

- Staffing Statement – this a four day a week operation with three staff during preprocessing activities.
- Hauling Statement – Anticipate weekly delivery of biomass (on site landfill, INL BFNUF, or USDA Aberdeen Research Station) to facility, around 3 to 5 tons of biomass per day.

Stage Two: Carbon Generation

Biomass or agricultural waste will be converted to carbon in a combustion unit with exhaust gases collected for delivery as a feedstock. The combustion unit is a factory-built system that includes heat recovery, power generation and emissions management systems. During start up, the combustor will require propane and electrical energy, once start-up propane is not required. Gaseous emissions from the combustion process will be continuously collected for use as a feedstock in the carbon to sustainable fuel conversion stage, with excess thermal energy re-used to generate electrical power and steam. The emissions management system will filter particulate matter for disposal into the INL onsite land fill along with ash from the combustion process. (Bottom ash is bounded at 5% of input mass based upon existing knowledge. If generated, fly ash may be

collected and characterized for appropriate waste disposal).

The combustor will be placed on a gravel pad near CFA-686, as will the emissions collection equipment, carbon feedstock storage equipment and propane fuel tank. The captured carbon dioxide will be provided to the carbon conversion unit in the third stage, for sustainable fuel generation process.

- Staffing statement – once started is this unit will be remotely monitored.
- Hauling Statement – limited hauling of collected ash is anticipated at this step.

Fuel Usage – Propane is used during start up. Anticipating design to include a 500 gallon-tank that would require periodic refills to support startup operations; periodic monitored, fill as needed (assume once per quarter).

Stage 3: Carbon Conversion

The carbon conversion process will be conducted via methanol generation (direct CO2 conversion) to diesel or Fischer Tropsch process to aviation fuel. In either case generation of sustainable fuels requires two primary feedstocks, carbon dioxide and hydrogen. Carbon dioxide will be generated and collected from the biomass combustion process. Hydrogen maybe be provided from operation of Solid Oxide Electrolyzer Cell (SOEC) within the HTTF or from compressed hydrogen delivered to the site. During the initial processing step, carbon dioxide and hydrogen will be combined via a catalyst substrate within the chemical reactor. Any off-specification gaseous or liquid materials generated will be returned to the combustor for reuse. The generated hydrogen-carbon feedstock (methanol or syngas via reverse water gas shift) will be delivered to a second reaction process and combined with steam, pressure, and thermal energy to create a range of hydrocarbon molecules for distillation into sustainable medium chain liquid fuels (e.g. diesel and aviation fuels). During the generation process short chain sustainable hydrocarbons will be created and returned to the combustor to be consumed, and long chain hydrocarbons will be collected for possible further processing or disposal.

While it is anticipated that off specification medium chain liquids from this second step would be returned to the combustor to be re-consumed, it is possible that small amounts of hazardous waste (generally halogen and sulfur) compounds will be generated and require establishment of a Resource Conservation and Recovery Act (RCRA) satellite accumulation area to manage the waste generated. The waste would be primarily composed of long chain hydrocarbon molecules and potentially small quantities of halogenated or sulfur containing hydrocarbons due to impurities in biomass feedstocks.

- Short chains (C1-C4): Exist as gases at room temperature and would be recirculated into the combustor.
- Medium chains (C5-C16): Exist as liquids at room temperature and would be distilled and collected. Off specification liquids would also be recirculated into the combustor.
- Long chains (C17 and above): Exist as solids at room temperature and would be recirculated into the combustor.
- Staffing Statement – operations are anticipated to be autonomous or remotely operated.
- Hauling Statement – anticipated operations will produce two to four barrels (55 gallons/barrel) of sustainably derived hydrocarbon fuel daily that can be consumed within INL operations. It is estimated that <5% of daily production may be sent to the satellite accumulation area for eventual offsite disposal.

Site Provided Utilities

- Power consumption – up to 2 MW at peak
- Water consumption – 5 gpm
- Propane consumption – Assume 500-gallon tank filled quarterly

Equipment

- BETO Funded Equipment
  - Biomass stockpile
  - Transport to site (INL woody debris or nearby agricultural waste or processed in the BFNUF)
  - Preprocessing - 3/8” particle placed into storage bin; reject material to INL onsite landfill
  - Preprocessing Equipment (Loader, Screens, Air Classifier, Hammer Mill, Magnetic Sieve, Conveyor Belts, etc.)
- NE-7 Funded
  - Combustion

- Combustor connected to metering bin and propane source for preheating. Self-contained in 8x8x20 cargo container
- Outputs – carbon emission stream, thermal energy, electrical energy, bottom ash, fly ash. Condensor, Reciprocating Compressor, Pressure Vessel
    - Emission (exhaust) stream is not released, fully collected for use.
    - Ash to be returned to INL landfill
- Carbon Collection
- Combustor connected to collection and storage system (conditioning, compressor, and storage tank)
- Output compressed carbon dioxide (up to 1,000 gallons do not exceed 2,000 psi; conditioning, compression and storage tank)

- FECM Funded
    - Carbon Conversion
    - Sustainable Hydrocarbon Conversion via catalytic reactor with hydrogen input (Methanol reactor, return line, delivery line, an emergency flare will be needed
        - Output is methanol with conversion to diesel
    - Sustainable Hydrocarbon Conversion via Fisher-Tropsch (FT) reactor with CO2, H2, or Methanol, and thermal energy inputs (sustainable hydrocarbon output, return line for light SHC, highly exothermic
        - Output is liquid sustainable hydrocarbon, short chain hydrocarbons (gases) and long chain hydrocarbons (semisolid) would be recycled.
        - Waste form is anticipated to be considered RCRA Characteristic requiring satellite accumulation area (ignitable) and will be managed by Waste Generator Services (WGS) in accordance with laboratory procedures.
        - FT Catalyst includes iron, cobalt, and ruthenium (nickel is not used) Spent catalyst and novel catalytic materials would be transported to vendors for evaluation. Catalyst will depend upon the feedstock and desired end product.
    - Sustainable derived hydrocarbon fuel can be used in lieu of non-sustainable fuels on-site or returned to vendors for additional testing and characterization.

The placement of equipment, modification of existing utilities, and installation of duct banks may require a limited amount of ground disturbing activities as the proposed area for placement is previously disturbed ground.

SECTION C. Environmental Aspects or Potential Sources of Impact:

Air Emissions

Air emissions from the combustion of propane during startup.

Discharging to Surface-, Storm-, or Ground Water

NA

Disturbing Cultural or Biological Resources

Cultural: A Section 106 review was completed under CRMO project number (BEA-25-018) and resulted in No Historic Properties Affected. Please refer to the Hold Points and Project Specific Instructions of the ECP.

Generating and Managing Waste

Small amounts of hazardous waste (generally halogen and sulfur) compounds will be generated and require establishment of a RCRA satellite accumulation area to manage the waste generated. The waste would be primarily composed of long chain hydrocarbon molecules and potentially small quantities of halogenated or sulfur containing hydrocarbons due to impurities in biomass feedstocks.

- Short chains (C1-C4): Exist as gases at room temperature and would be recirculated into the combustor.
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Releasing Contaminants

When chemicals are used during the project there is the potential for spills that could impact the environment (air, water, soil).

Using, Reusing, and Conserving Natural Resources

Project activities have the opportunity to reduce the impact on our natural resources by recycling or diverting materials from disposal in the landfill.

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 and is not related to other actions with individually insignificant but cumulatively significant impacts.

References: B5.15 "Small-scale renewable energy research and development and pilot projects"

Justification: Based on the purpose and need and description of the proposed action and potential environmental impacts, the proposed action fits within the class of actions that is listed in Appendix B CX B5.15. There are no extraordinary circumstances related to the proposed action that may affect the significance of the environmental effects of the proposal (10 CFR 1021.410(b)(2)). The proposed action has not been segmented to meet the definition of a categorical exclusion (10 CFR 1021.410(b)(3)). This proposal is not connected to other actions with potentially significant impacts, is not related to other actions with individually insignificant but cumulatively significant impacts, and is not precluded by 10 CFR 1021.211 concerning limitations on actions during preparation of an environmental impact statement (10 CFR 1021.410(b)(3)).

Authorizing the proposed action will not (1) threaten a violation of applicable statutory, regulatory, or permit requirements for environment, safety, and health, including DOE and/or Executive orders; (2) require siting of new facilities or expansion of existing facilities; (3) disturb hazardous substances, pollutants, or contaminants; (4) adversely affect environmentally sensitive resources; or (5) involve genetically engineered organisms, synthetic biology, governmentally designated noxious weeds, or invasive species.

B5.15 Small-scale renewable energy research and development and pilot projects. Small-scale renewable energy research and development projects and small-scale pilot projects, provided that the projects are located within a previously disturbed or developed area. Covered actions would be in accordance with applicable requirements (such as local land use and zoning requirements) in the proposed project area and would incorporate appropriate control technologies and best management practices.

Approved by Robert Douglas Herzog, DOE-ID NEPA Compliance Officer on: 4/11/2025