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NVREC subtask 1.2: Thermal treatment of biomass

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NVREC Subtask 1.2: Thermal Treatment of Biomass

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Introduction
The purpose of NVREC 1.2 is to investigate the use of a small scale gasification unit - Biomax15 - manufactured by Community Power Corporation (CPC). Gasification is a widely used method to convert woody biomass to a combustible gas, known as syngas. Biomax15 is designed to be a stand-alone, off-grid energy system producing 15 kWe from wood chips. It will be tested with both raw woodchips and torrefied woodchips.

Background
Gasification is the process of heating biomass to temperatures ranging from 700˚C to 900˚C to drive off combustible gases consisting mostly of H2 and CO. Gasifier vessels can either be sealed and pressurized with or without the presence of oxygen, or open atmosphere like Biomax15. Biomax15 is a down-draft design where biomass is fed into the open top and heated as it drops through four different heat zones. Air enters through the top, but additional air forced into the vessel through nozzles on a “tree” shaped injector creates controlled heat in each zone. Syngas is removed from the bottom of the gasifier using the manifold vacuum from the internal combustion engine.

Biomax15
This unit, shown in Figure 2, is one of the few first generation prototypes built under DOE contract and demonstrated in Truckee, Ca. It consists of three units: hopper/feeder, gasifier unit (gasifier, heat exchanger, and gas clean-up), and internal combustion engine generator. Repairs and upgrades were necessary to the engine, generator, automated control system, and feed system. The system begins with the engine running on propane. The electrical power produced is used to fire the gasifier, and the vacuum of the engine’s fuel intake draws air through the entire system.

Syngas Characterization
Syngas samples will be drawn downstream of the filters, and diluted as necessary. Detailed chemical analysis will be completed at DRI on syngas from both raw and torrefied woodchips. Dilution sampling, shown in Figure 3, is necessary due to the large amount of tar and other impurities present in the syngas.

Mass and Energy Balance
A mass and energy balance analysis will be performed for the entire system on both feedstocks. Measurements will be taken at three locations: gasifier inlet, syngas dilution sampler, and engine output.

Characterization of Bio-Char
Bio-char is separated out of the syngas in the knock-out pot and is collected after each run. It is being investigated for its effectiveness as a soil amendment. An experiment was set up using ash (from a biomass boiler), torrefied woodchips, and plain soil to grow Teff (Eragrostis tef) in a controlled environment inside a greenhouse, as shown in Figure 5. Bio-char produced by Biomax15 will be compared to the these soil amendments. 40 pots were used for this experiment. Plant length, the best indicator for Teff, was measured once a week. At the end of the experiment, the plant material will be dried and weighed for comparison.

Project Schedule

<table>
<thead>
<tr>
<th>Task</th>
<th>% Complete</th>
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<tbody>
<tr>
<td>1. Upgrade Biomax15 Unit</td>
<td>100%</td>
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<tr>
<td>2. Characterize Syngas</td>
<td>15%</td>
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<tr>
<td>3. Mass and Energy Balance</td>
<td>25%</td>
</tr>
<tr>
<td>4. Characterize Biochar</td>
<td>50%</td>
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<tr>
<td>5. Project Management</td>
<td>25%</td>
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