Thermal Conversion of Biomass to Fuels

A cooperative program by:

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Introduction

DRI is partnering with the University of Nevada, Reno (UNR), the Renewable Energy Institute International (REII), the Gas Technology Institute (GTI) and Changing World Technologies (CWT) to demonstrate the viability of a hydrothermal pre-treatment method to convert lignocellulosic biomass into a uniform, densified feedstock that could be easily fed into a thermo-chemical conversion process to produce syngas or bio-oil. DRI is focused on materials available in the State of Nevada, and is also conducting a biomass resource assessment within the State.

Nevada Biomass Resource Assessment

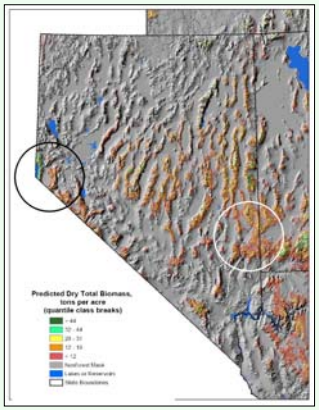

Figure 1: Biomass resources in Nevada. Resources are primarily Pinion/ Juniper centered around Carson City and Panaca.

Nevada is typically viewed as a desert landscape with minimal biomass resources. To support commercial deployment of biomass conversion technologies, adequate sustainable resources within and nearby Nevada must be identified. DRI and REII are assessing potential resources by:

- Performing an inventory of current and future feedstocks in Nevada and nearby areas
- Assessing the accessibility of these feedstocks
- Evaluating harvesting and transportation options

Project Participants

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Biomass Pre-Treatment

Biomass feedstocks include a wide variety of materials with significant differences in handling characteristics, energy content and recalcitrance to conversion -- all factors that must be accommodated within a biorefinery context.

HYDROTHERMAL PRETREATMENT

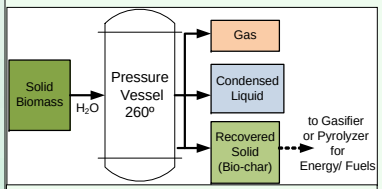

Figure 2. Hydrothermal Pretreatment Process

Hydrothermal pretreatment transforms lignocellulosic biomass into a more friable solid with less mass and higher energy density that can be easily fed for pyrolysis or gasification.

Approach: Treat biomass in water at temperatures around 260°C and equilibrium pressures (~680 psig) for 2-5 minutes to produce a solid that is easily dried and pelletized.

Technical Accomplishments:

- The O content is lowered, but the C content is increased.
- The process takes less time than conventional torrefaction.
- The mass of the feedstock decreases while its energy content is mostly retained.

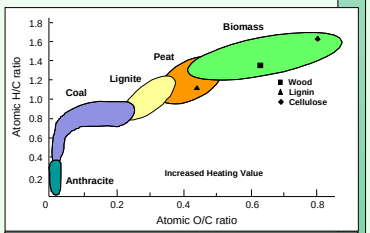

Figure 3: HP lowers O_2 content and increases C content, making biomass more similar to coal.

PROCESS OPTIMIZATION

DRI is collecting all products of the HP process including:

- The pre-treated biomass or "bio-char"
- The condensed liquid
- Gases

Figure 4: Loblolly pine chips before and after pre-treatment

Through a comprehensive set of laboratory analysis, we will perform complete mass and energy balances of the pre-treatment process.

Table 1: Ultimate analysis of three feedstocks shows a decrease in O and increase in C and energy content of three different feedstocks.

Ultimate and Proximate Analysis	Loblolly Pine		Corn Stover		Rice Hulls	
	Feedstock	Pre-treated Solid	Feedstock	Pre-treated Solid	Feedstock	Pre-treated Solid
C	51.4	**68.3**	43.1	**48.7**	39.0	**43.2**
H	5.9	**5.1**	5.3	**4.7**	4.8	**4.0**
N	0.23	**0.37**	0.75	**0.94**	0.26	**0.40**
S	0.04	**0.03**	0.09	**0.10**	0.06	**0.05**
O	42.1	**25.9**	40.1	**30.7**	35.6	**24.0**
Ash	0.39	**0.27**	10.9	**14.7**	20.4	**27.9**
Dry (Btu/lb)	8511	**11793**	7207	**8239**	6650	**7328**

Gasification and Deployment in Nevada

To demonstrate the viability of the pre-treatment process, we intend to use the bio-char to run a gasifier. DRI is partnering with UNR's College of Agriculture, which has acquired a Biomax 15, a commercial gasifier/ power generation system.

BIOMAX 15

The Biomax 15, manufactured by Community Power Corporation (CPC), produces syngas by gasification of wood-chips. The syngas is then combusted in an engine/generator set to produce 15 kW of power and provide available heat. We intend to run the Biomax using pre-treated, Nevada-specific biomass.

Figure 8: The Biomax 15 produces 15 kW of electrical power by burning syngas from gasification of biomass in a generator.

SYNGAS CHARACTERIZATION

Dilution sampling will be used to collect syngas from:

- raw wood feedstock
- hydrothermally pre-treated feedstock
- conventionally torrified feedstock

Techno-economic Assessment

A techno-economic analysis of the pre-treatment process is being conducted to determine the viability of building a full-scale facility in Nevada.

- This analysis incorporates results of the resource assessment, and the mass and energy balances of the pre-treatment process.
- Hydrothermal pre-treatment will be coupled with gasification (for syngas production) or pyrolysis (for bio-oil production).
- Based upon results of the Nevada biomass resource assessment, the facility would be located in Eastern Nevada.