



# Biomass Program

## Pyrolysis Oil Upgrading

Biomass-derived pyrolysis oil is rich in carbon and can be refined in ways similar to crude petroleum. Coupled with its ease of transport and storage as compared to solid biomass material, pyrolysis oil (bio-oil) can serve as a potential feedstock for the production of fuels and chemicals in petroleum refineries. Pyrolysis can effectively utilize a vast majority of the projected one billion tons of biomass available in the United States.

This project is evaluating the feasibility of upgrading bio-oil in a petroleum refinery setting.

## R&D Pathway

Initial bench-scale tests of bio-oil in a batch reactor and a continuous flow reactor allowed researchers to identify target products and better understand the reaction pathways. Proof-of-principle studies demonstrated that bio-oil could be converted to gasoline with reasonable hydrogen consumption using mild hydrotreating followed by hydrocracking.

A process model was developed for use in performing economic assessments of the processing

scenarios for fuels and chemical products from bio-oil.

To better understand the linkages between the biomass feedstocks, pyrolysis oil, upgraded products, and the conversion processes, researchers will produce pyrolysis oil from several biomass feedstocks (mixed Vermont hardwood/softwood, corn stover, and dried distillers' grain). Both the feedstocks and the bio-oil will be characterized and material balance data collected from the pyrolysis process.

The bio-oil will be used in additional experiments in the batch and continuous flow reactors to evaluate product quality as a function of processing conditions, catalysts, and bio-oil properties, and their impact on process costs. The bio-oil and upgraded products will be analyzed for their chemical composition and physical characteristics.

## Thermochemical R&D

### Benefits

- Potential to replace up to 60% of transportation fuels
- Economically attractive when crude oil prices are high or if pyrolysis oil prices can be reduced

### Applications

This project will help develop a market for pyrolysis-derived bio-oils and could lead to refining of bio-oils in petroleum refineries.

### Project Participants

UOP LLC  
National Renewable Energy Laboratory (NREL)  
Pacific Northwest National Laboratory (PNNL)  
DynaMotive Energy Systems  
Ensyn Group, Inc.

### Project Period

FY 2004 – FY 2009

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