



FRP

## FOREST RESIDUES PREPARATION

Primary feedstock targets include forest residues from logging and thinning operations. We are also considering mill residues and discarded woody material from construction and demolition, in regions where these materials are under utilized.



T

## TRANSPORTATION

Feedstocks are transported from the collection site to a conversion facility. Chipping can take place at the loading or in a preprocessing facility.



PT

## PRE-TREATMENT

Wood chips are treated to make the sugar polymers (polysaccharides) accessible to degrading enzymes. These processes allow the lignin to be available for separation.



EH

## ENZYMATIC HYDROLYSIS

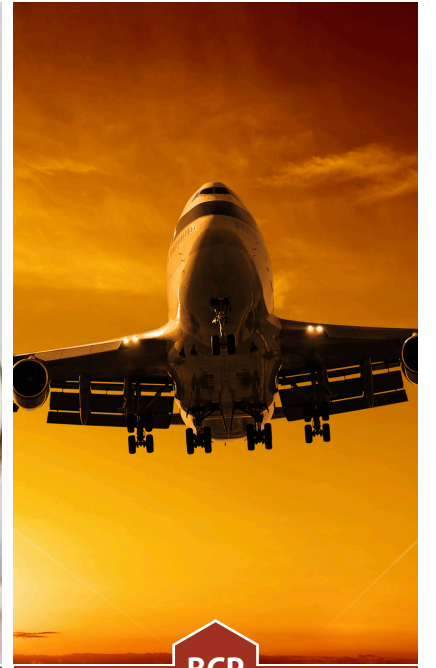
Specific enzymes are added to hydrolyze (cleave) the polysaccharides and generate simple sugars (monosaccharides).



F

## FERMENTATION

Specialized yeast convert the monosaccharides into isobutanol.



BCP

## BIOJET & CO-PRODUCTS

Aviation fuels can be generated from the platform molecules derived from wood sugars. Lignin can be used to generate co-products such as epoxies, structural materials and bio-based plastics. As an alternative, lignin can be burned to produce renewable energy.

**ONE** BONE DRY **TON** WOODY BIOMASS

+

DIESEL

+

HEAT, WATER, & CHEMICALS

=

**~600** POUNDS LIGNIN

AND

**~59** GALLONS ISOBUTANOL

OR

**~42** GALLONS BIOJET

**RALPH CAVALIERI, NARA Project Director**  
Associate Vice President for Alternative Energy  
Washington State University  
cavalieri@wsu.edu • 509-335-5581

**MICHAEL WOLCOTT, NARA Project Co-Director**  
Director, Institute for Sustainable Design  
Washington State University  
wolcott@wsu.edu • 509-335-6392

NARA is led by Washington State University and supported by the Agriculture and Food Research Initiative Competitive Grant no. 2011-68005-30416 from the USDA National Institute of Food and Agriculture.

