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Renewable Energy—Role of Biomass

A BRIEF LOOK AT HYDROCARBONS FOR FUELS AND CHEMICALS

RICK ORTH

Presented at The Northwest Bioenergy Research Symposium

November 13, 2012

Biomass in the Energy Sector

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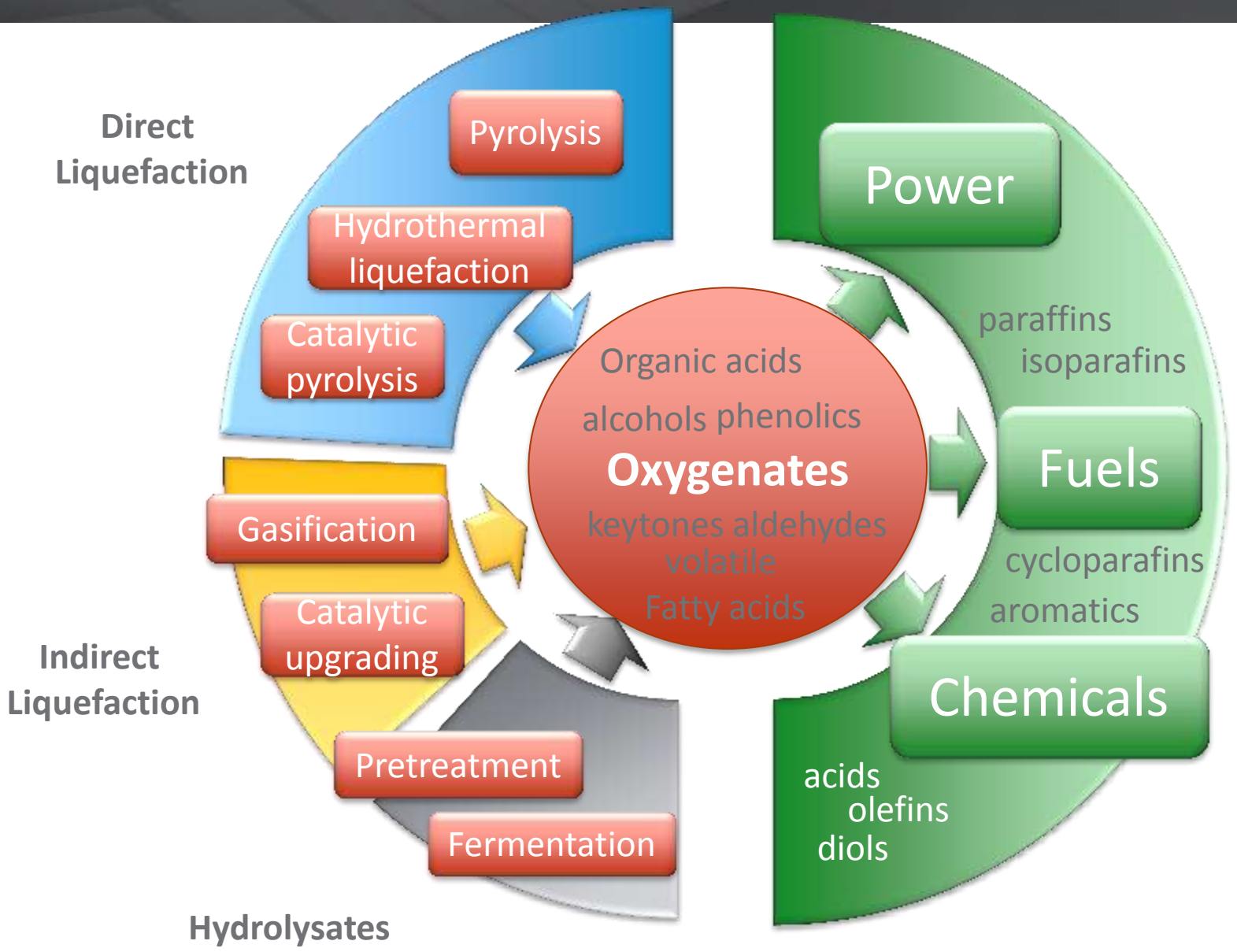

PNNL Strategic Emphasis

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Whole Biomass

Terrestrial
Lignocellulosics
- agricul. residues
- woody residues
- purpose-grown

Aquatic
- algae
- cyanobacteria
- sea weed
- duck weed

Deconstruction (higher temps)

Liquefied Biomass
- Pyrolysis oils
- Liquefaction oils
- Lipids
- Indirect liquefaction

Deconstruction (moderate temps)

Sugar Derived Compounds
- Sugars
- Alcohols
- Organic acids (or diacids)
- Mixed oxygenates
  - ketones, aldehydes, polyols, cyclics
- Other Fermentation products
  - Isoprenoids, polyketides, fatty acids

Phenolics
- Lignin and lignin degradation products

Other
- Lipids
- Proteins

Catalytic Upgrading
- Hydrotreating
- Hydrocracking

Catalytic upgrading
- Hydrogenations
- Condensations
- Dehydrations
- Others

Products (Fuels/Chemicals)

Fuels
Hydrocarbons
- paraffins
- isoparaffins
- aromatics/cyclics

Chemicals
- oxygenated compounds
- olefins
- aromatics

Emphasis-diesel/jet distillates

Alcohol to Jet Hybrid Technologies

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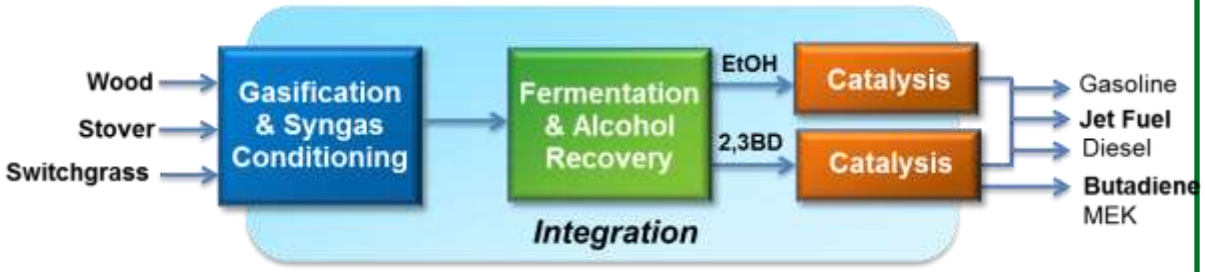
Fermentation and Catalytic Conversion



Example Hybrid Process

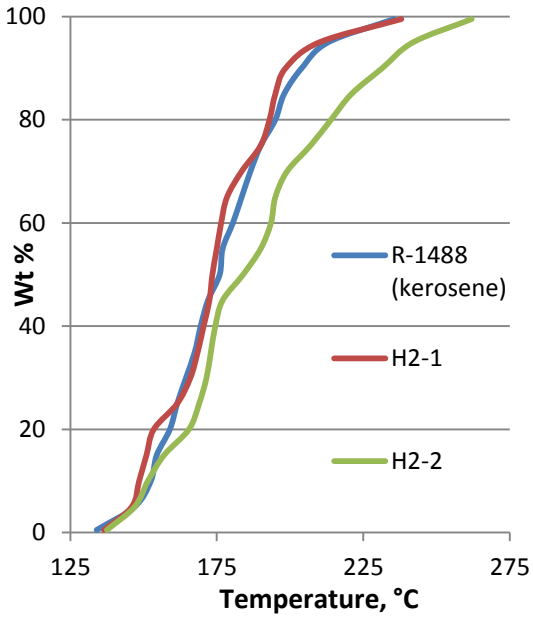
Upgrading of Oxygenated Intermediates

Imperium Aviation Fuels

Jet range hydrocarbon product

Impact

New Catalytic process to produce sustainable aviation fuels



LanzaTech
MichiganTech
NREL
BOEING

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WASHINGTON STATE UNIVERSITY

World Class. Face to Face.

Bioproducts, Sciences and Engineering Laboratory (BSEL)

- Partnership with Washington State University, located on the WSU-Tri-Cities Campus in Richland Washington
- BSEL Houses Approximately 50 PNNL and 45 WSU Staff
  - The combinatorial Catalysis research laboratory for catalyst discovery and development
  - High-pressure catalytic reactor rooms for catalyst testing and process development
  - Bioprocessing labs for development and engineering of fungal fermentations
  - Biomass pretreatment technologies and capabilities
  - Process engineering research and development
  - Collaborations with WSU-TC, WSU-Pullman and WSU-Prosser and others, including NW industry
    - Projects
      - Examples – Energy crop assessment (WSU-Prosser), catalysis, National Advanced Biofuels Consortium (WSU-Pullman), hybrid biochemical/thermochemical approach, National Advanced Biofuels Consortium (WSU-Tri-Cities)
    - Joint appointments and Adjunct faculty
    - Summer interns

Session B3 – Conversion to Drop-in Fuels

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- *Improving the Economics of Lignocellulose Conversion to Transportation Fuels*, Patricia Irving, Innova Tech
- *Northwest Efforts Toward Producing Aviation Fuels using Hybrid Approaches*, John Holladay, Pacific Northwest National Laboratory
- *Thermochemical and Hydrothermal Conversion Processes*, Fernando Resende, University of Washington
- *Catalytic Upgrading of Intermediate Products*, Rich Hallen, Pacific Northwest National Laboratory