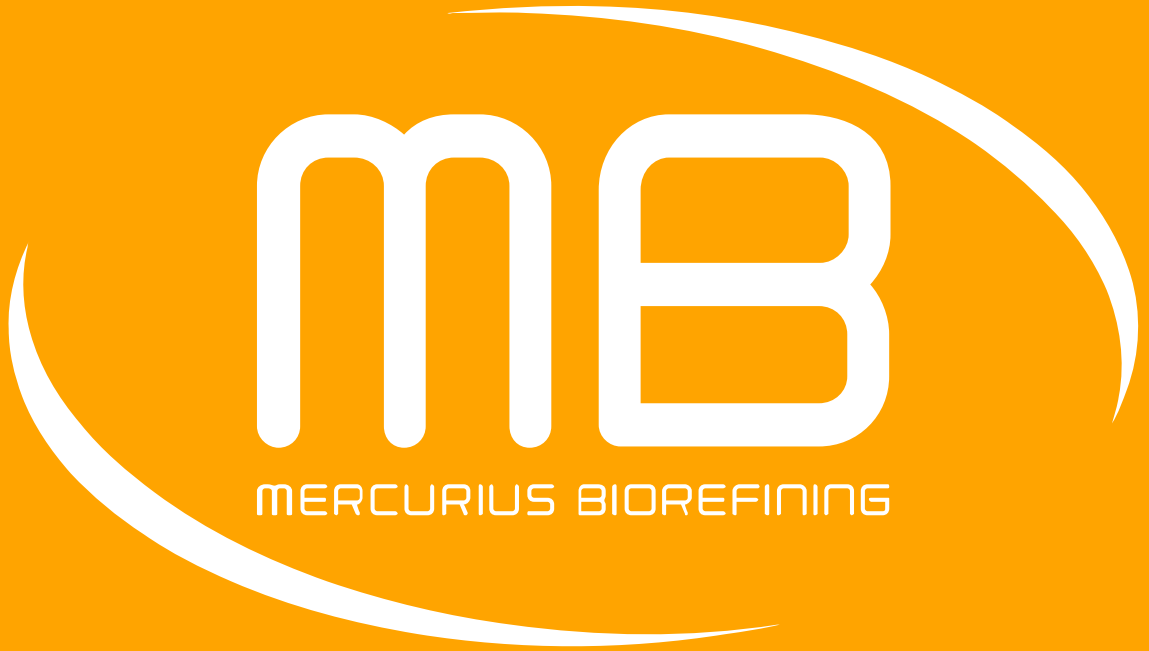

Karl Seck, CEO
March 2, 2017

Cellulosic Biofuel Technology

Liquid Phase Catalytic (LPC):

- **Low volumes with liquid phase**
- **Fast reactions and low residence times (hours)**
- ***Low temperature / pressure***
- ***Converts raw biomass***
  - *Larger particle size*
  - *High moisture*

REACH

Other Types

Thermochemical Conversion:
- Vapor phase process
- Gasification and pyrolysis
- Large equipment needed to handle vapor volumes

Biochemical Conversion:
- Fermentation to alcohols
- Requires sugars as feedstock
- Very long residence time (days)

Liquid phase:
smaller equipment

+

Catalytic:
faster process,
smaller equipment

=

Lower Capital Costs

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REACH Technology

RE — **Renewable**

Low-temperature
Low-pressure
Enzyme-free

A — **Acid-hydrolysis**

Biomass
↓
Non-sugar intermediates

CMF → other bio-products

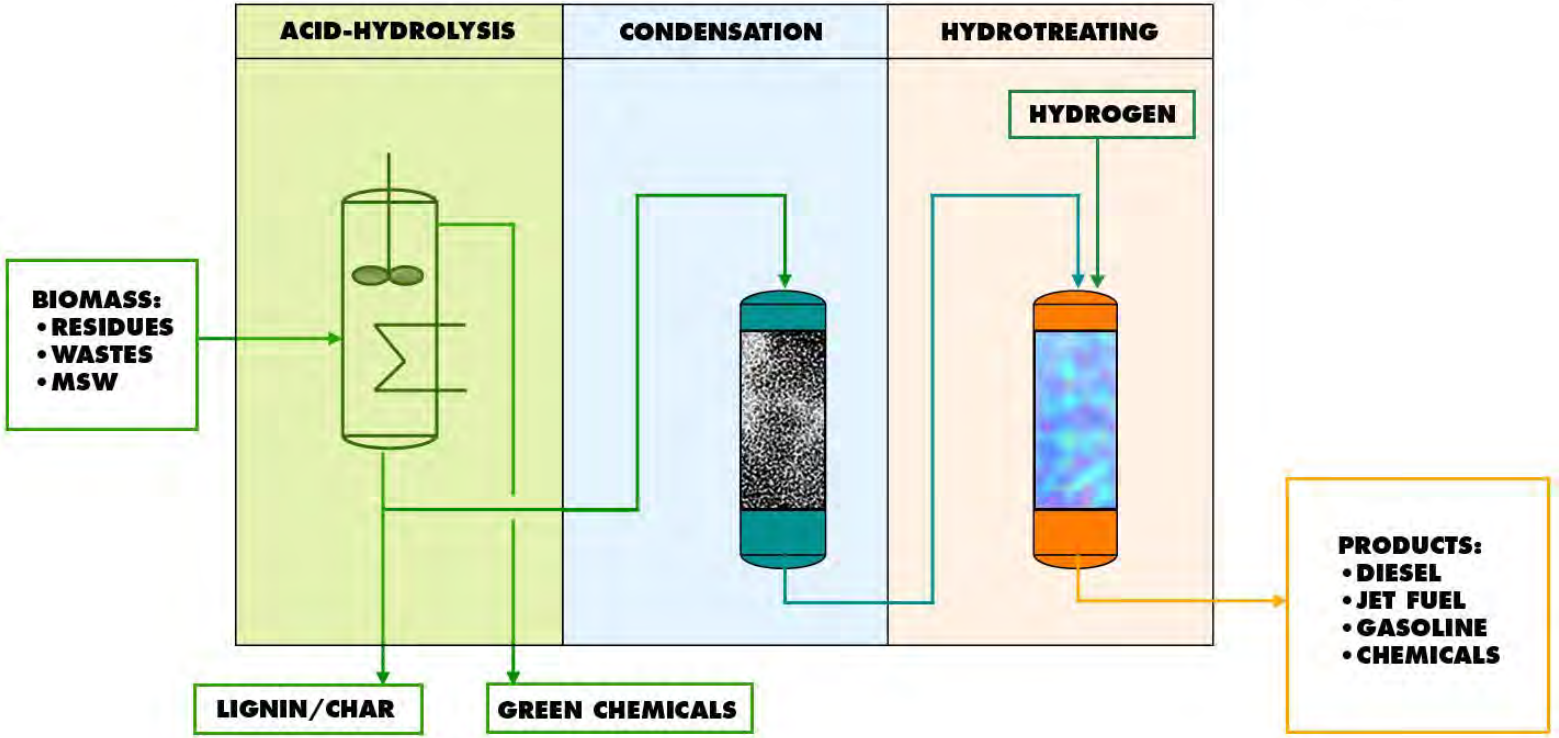
C — **Condensation**

Molecule formation:
Can customize carbon chain length for desired product

H — **Hydrotreating**

Deoxygenation:
Final drop-in hydrocarbon fuel

REnewable Acid-hydrolysis Condensation Hydrotreating (REACH) Technology



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Technology Development Advantages

- Hydrolysis similar to pulp & paper technologies
- Condensation Hydrotreating similar to petroleum refining
- Scalable, proven methodologies

- Quicker ramp-up to full capacity
- Independent of genetic research

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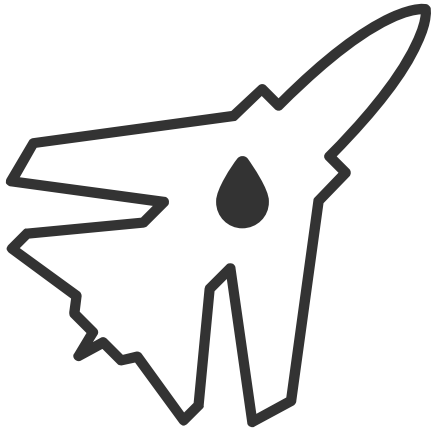
Primary Fuel Products

Drop-in Hydrocarbon Jet Fuel



Drop-in Hydrocarbon Diesel Fuel

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Valuable Chemicals & By-products

Levulinic Acid (LA)

- Plasticizers
- Solvents
- Polymers

Formic Acid

- Food safe fumigant/ animal feed supplement
- Environmentally friendly de-icer
- Fuel cell feed

Furfural

- Solvent for extraction processes
- Resin manufacturing

Lignin

- Solid Fuel
- Fertilizer / Soil Enhancer
- Hydrogen Production
- High Value Products

FDCA

- Monomer for PEF

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Cost Structure (Corn Stover)

CapEx:

$ **3–5**

/annual gal capacity

For example, a 15 mil gal plant at $4/annual gal capacity would cost $60 million

OpEx:

$ **1.06**

/gal **excluding** capital charges

$ **1.62**

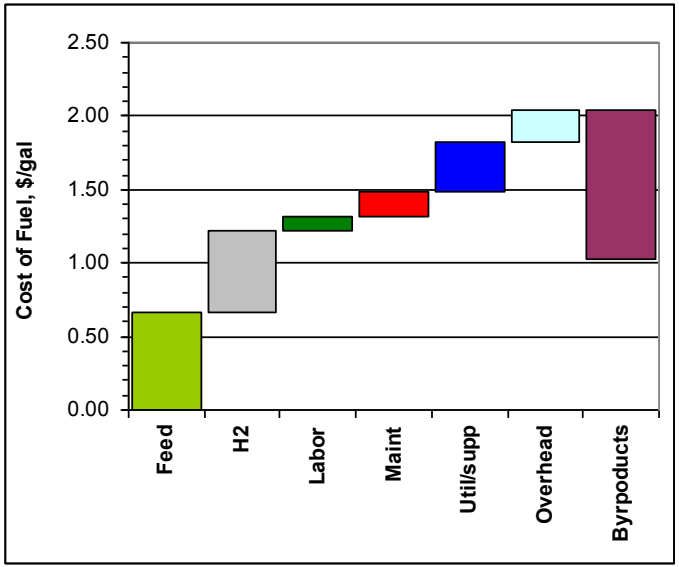
/gal **including** capital charges

Cost Breakdown

Base Case

$ 50
/dry ton feed

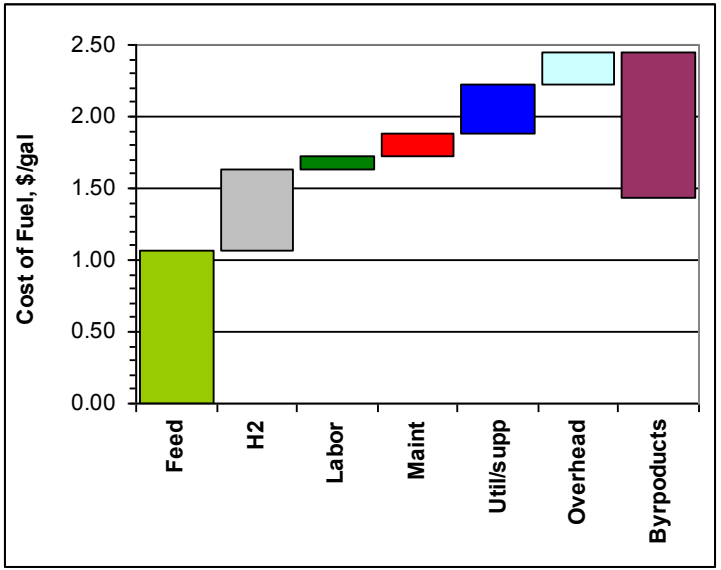
1.06
$/gal



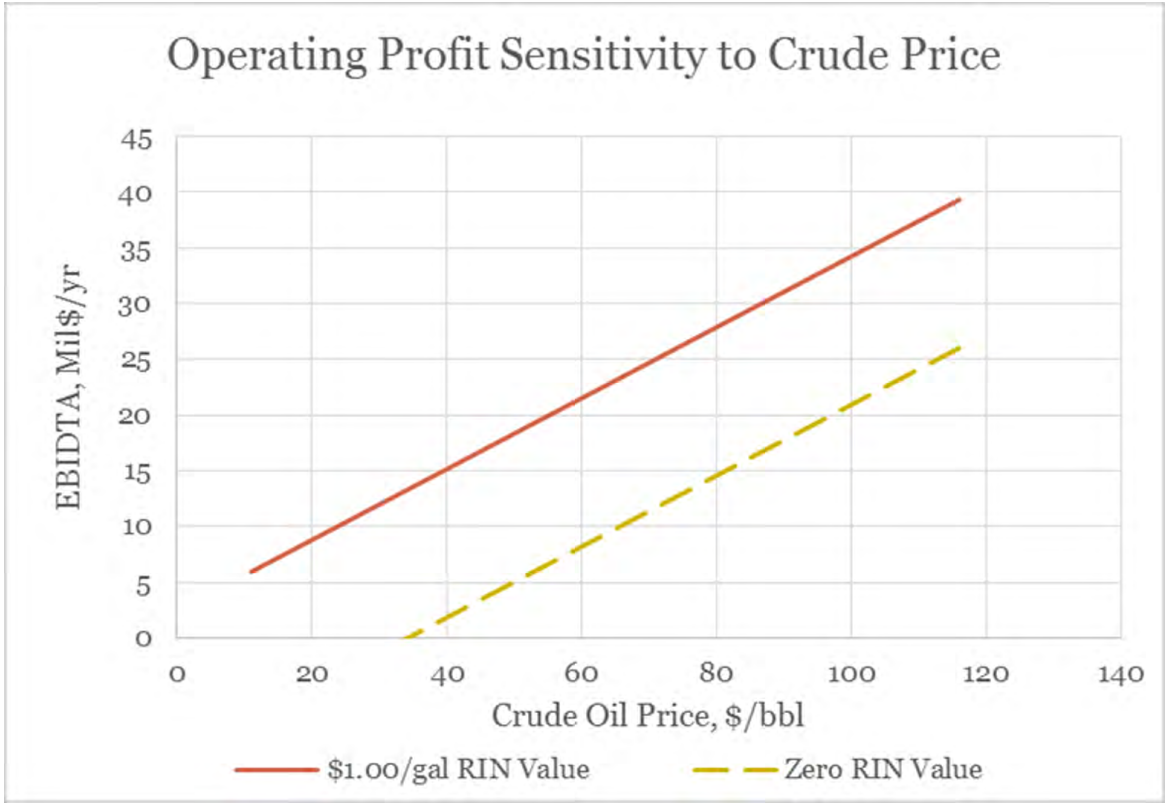
Sensitivity

$ 80
/dry ton feed

1.46
$/gal



Economics Good at Lower Crude Prices



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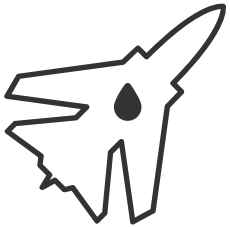
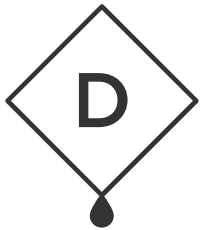
Market

U.S. liquid fuels sales in 2011 was estimated at

200+ Billion gallons



>22B
Jet Fuel



>45B
Diesel Fuel

Source: US Energy Information Association

RFS2 mandates advanced biofuels ramp up to a minimum of

21 Billion gallons annually by 2022

or

$84 Billion market for 2nd generation biofuels
assuming $4/gal

A

2%
Market Share

nearly

$2Billion
for Mercurius

Customers

The US Navy **is committed to supply 50% of its fuel** needs with non-petroleum fuels by 2020

Many airlines, including Alaska, Delta, and United have committed to **using increasing amounts of biofuels**

Diesel vehicle fleets are potential **high volume customers**

Customers for optional chemicals and by-products include **agricultural and specialty chemical companies**

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Pilot Project

- Awarded $4.6 grant from the Dept. of Energy in 2013
  - 50% matching
  - Focused on military fuels
- Current project partners:
  - Purdue University
  - University of Maine
  - Michigan State University Bioeconomy Institute (MSUBI)

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Looking Ahead > >

Fatty Acids

- Nutraceuticals
- Specialty chemicals

Lignin Products

- Unique-properties based products
- Jet fuel and diesel

Cyclic Ethers

- High cetane diesel additive
- Specialty chemicals

Polymers

- 2,5-Furandicarboxylic acid (FDCA) for PEF
- Succinic acid (SA) for BDO to PBT and PBS
- From biomass not sugar

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FDCA for PEF

PEF Advantages over PET = Better Beer Bottle!

- Superior Barrier Performance
  - ✓ O2 10x better
  - ✓ H2O 2x better
  - ✓ CO2 4x better
- Thermal Stability
  - ✓ 12C higher than PET
- Mechanical Properties
  - ✓ 1.6x better (tensile modulus)

- Renewable
- Reduced product degradation
- Lighter for lower transport costs

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Key Partners in REACH Development

CSIRO (Australia)
process optimization research

Purdue University
scientific/engineering/aviation expertise

UMaine
continuous flow optimization, engineering

MSUBI
pilot plant operations

UC Davis
Hydrolysis technology & IP

Pacific Northwest National Laboratory
past hydrotreating & catalyst development

Haldor Topsoe
catalyst / hydrotreating technology

MB
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Value Proposition

- Low cost – Capex and Opex
- Feedstock flexibility:
  - Larger-sized, high-moisture feedstock ok
  - No inhibitor issues
- Distributed model-capable
- Fuel products with increasing demand
- ~90% reduction in GHG
- High value co-products
- Co-processing options
- Patented process

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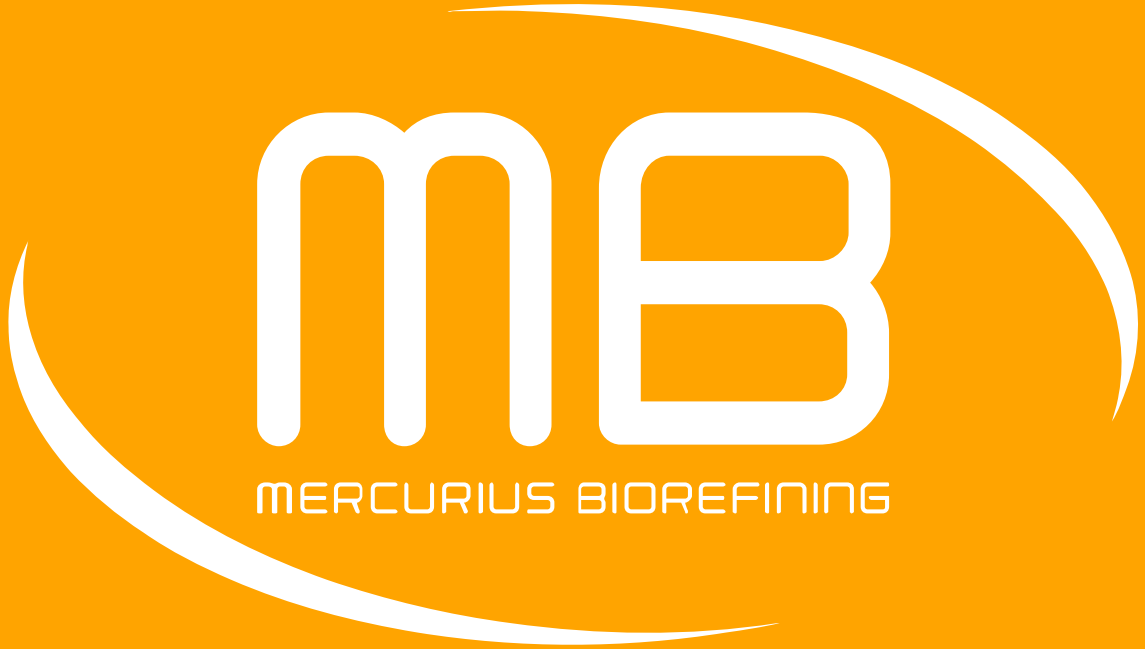

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