

Karl Seck, CEO  
November, 2018

# Why Are We Doing This?

## Climate Change!

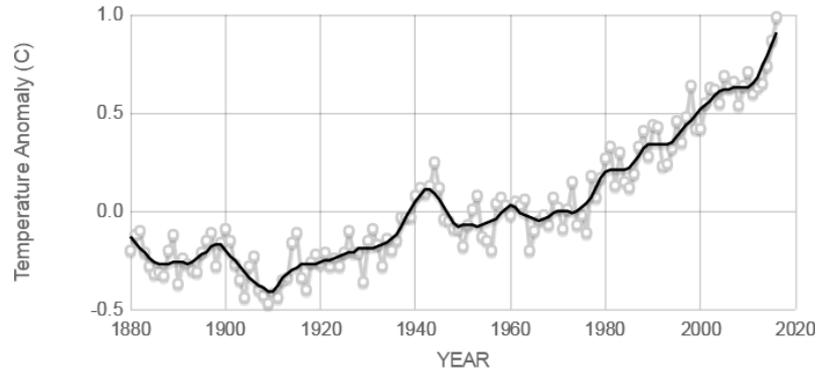
- It's REAL!
- Biofuels for transportation GHG mitigation.
  - Renewable electrification for passenger vehicles.
  - Jet fuel, diesel, and marine will rely on biofuels.
- Drives value.

## US Energy Security

- Shale gas and oil have changed this equation.
- US is still net importer of oil for transportation fuels.

## Rural Redevelopment

- Agricultural areas.
- Pulp and Paper mill towns



Source: climate.nasa.gov



# Cellulosic Biofuel Technology

## Liquid Phase Catalytic (LPC):

- ❖ Low volumes with liquid phase
- ❖ Fast reactions and low residence times (hours)
- ❖ *Low temperature / pressure compared to HTL*
- ❖ *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**





# 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*



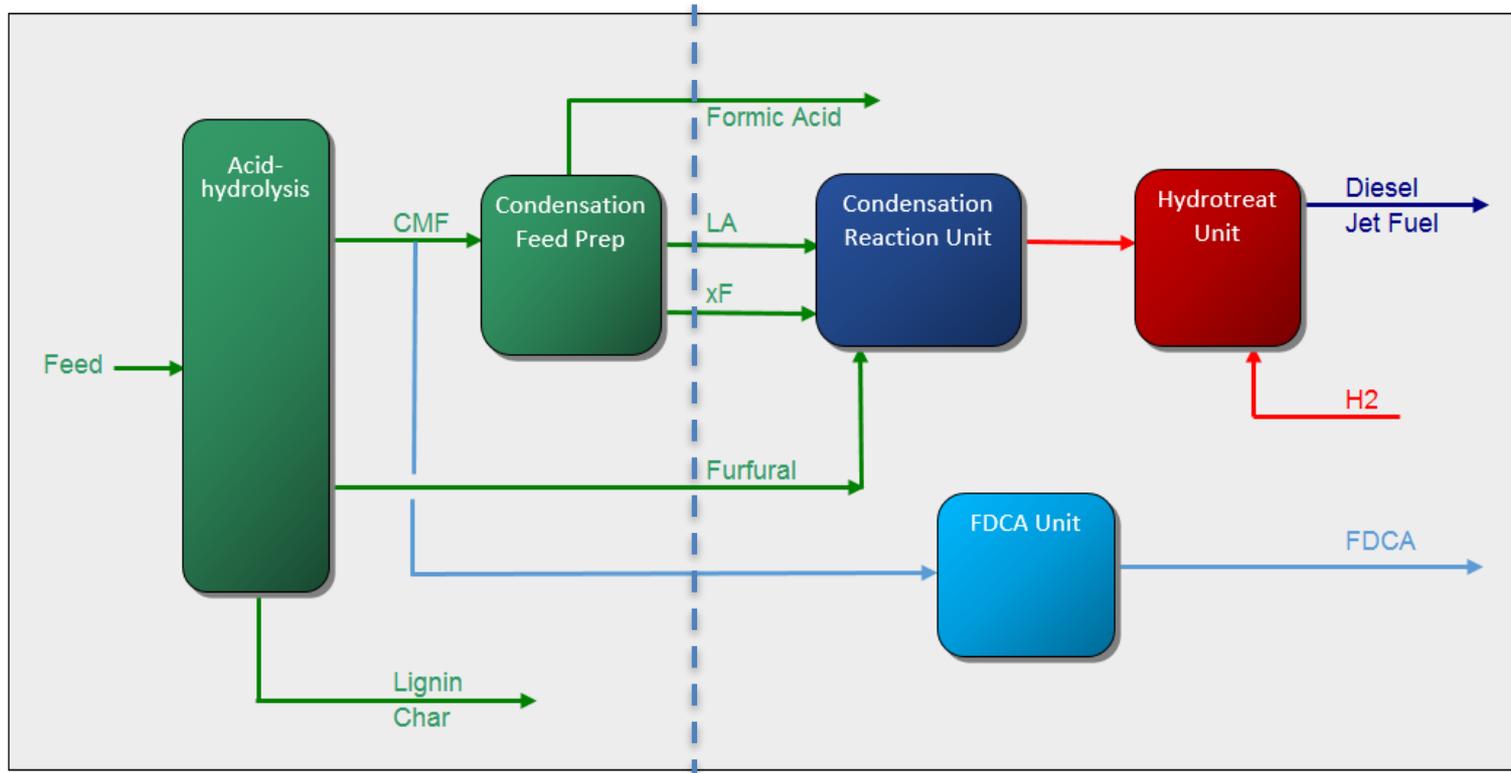
H

Hydrotreating

*Deoxygenation: Final  
drop-in hydrocarbon  
fuel*



# REACH Block Flow



Distributed Model: Local Processing | Central Processing

# Technology Development Advantages



Hydrolysis  
similar to pulp &  
paper  
technologies



Condensation  
Hydrotreating  
similar to petroleum  
refining



Scalable, proven  
methodologies



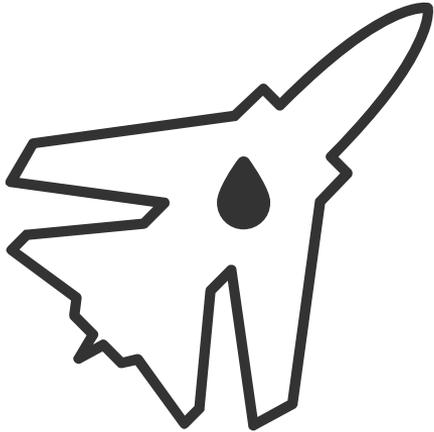
Quicker  
ramp-up to  
full capacity



Independent  
of genetic  
research

# Primary Fuel Products

**Drop-in  
Hydrocarbon  
Jet Fuel**



**Drop-in  
Hydrocarbon  
Diesel Fuel**



# 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

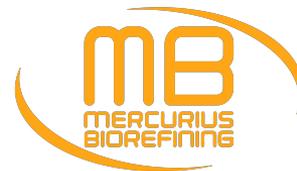
## OpEx:

\$ **1.06**

/gal **excluding** capital charges

\$ **1.62**

/gal **including** capital charges



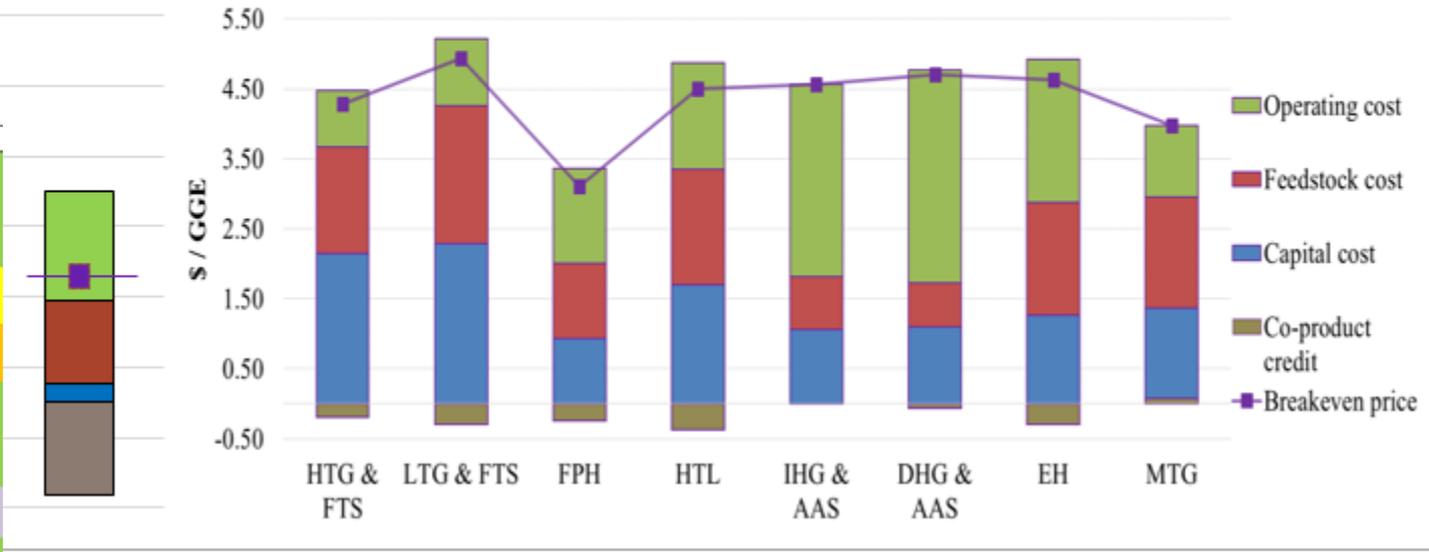
# TEA Compared to Other Technologies

Stochastic Techno-economic Evaluation of Cellulosic Biofuel Pathways,  
by: Xin Zhao, Purdue University

REACH  
estimate

Pathways	Abbreviations
High temperature gasification & Fischer-Tropsch synthesis	HTG & FTS
Low temperature gasification & Fischer-Tropsch synthesis	LTG & FTS
Fast pyrolysis & hydroprocessing	FPH
Hydrothermal liquefaction	HTL
Indirectly-heated gasification & acetic acid synthesis	IHG & AAS
Directly-heated gasification & acetic acid synthesis	DHG & AAS
Enzymatic hydrolysis & fermentation	EH
Gasification & methanol-to-gasoline	MTG

REACH - Liquid Phase Catalytic REACH



# Cost Breakdown

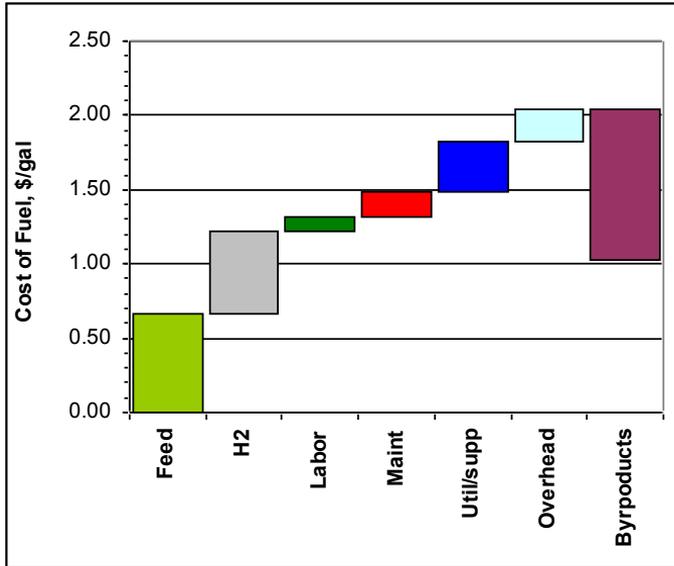
## Base Case

\$ **50**

/dry ton feed

**1.06**

\$/gal



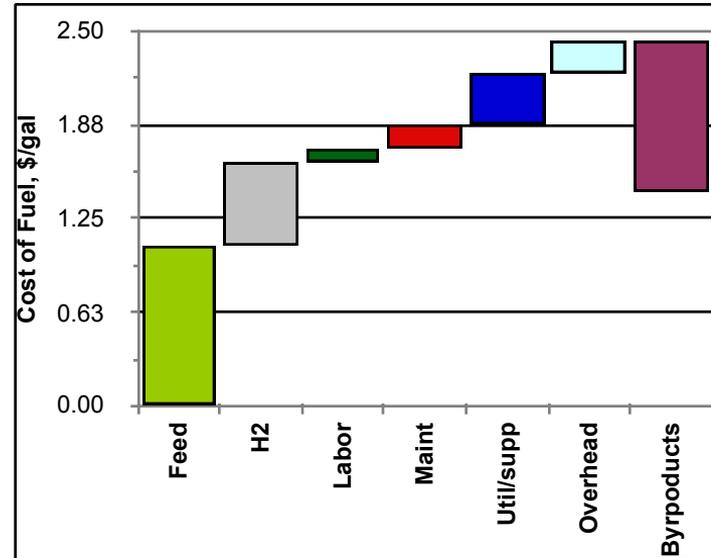
## Sensitivity

\$ **80**

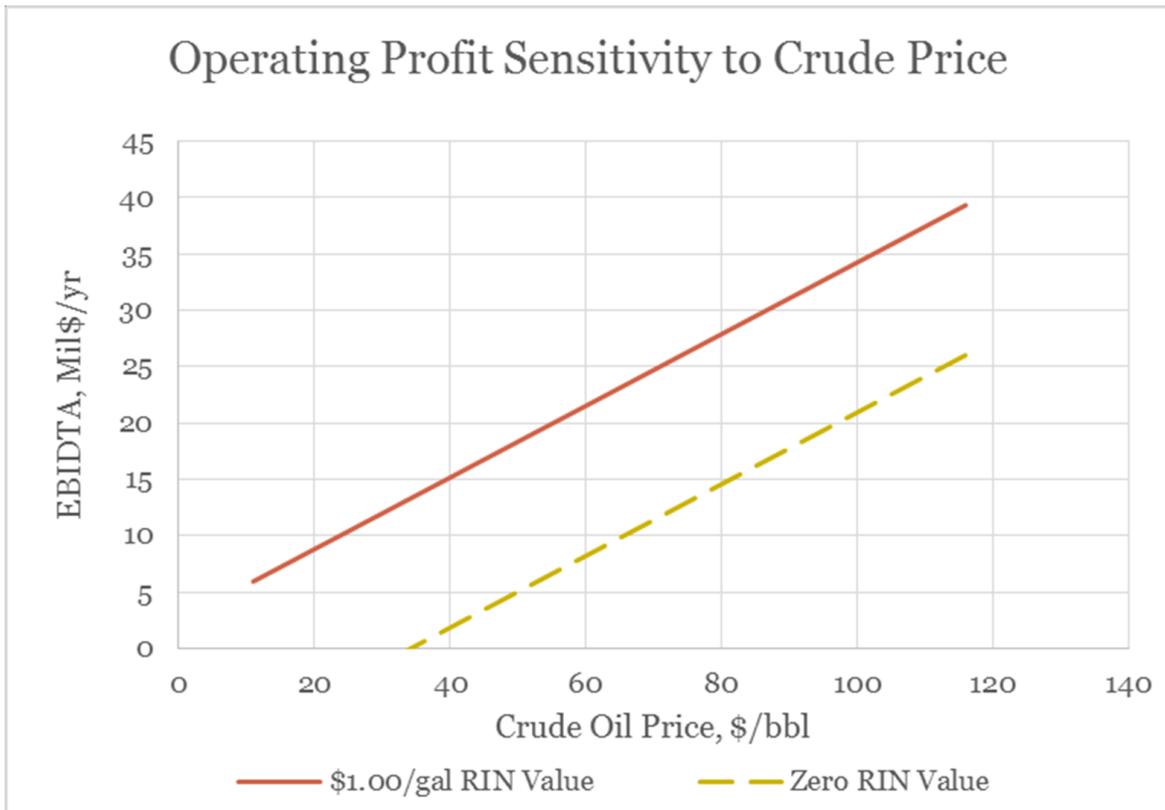
/dry ton feed

**1.46**

\$/gal



# Economics Good at Lower Crude Prices



Current  
Calculation:

	<u>\$/</u>
gal	
RIN Adj.	1.60
LCFS	
<u>0.90</u>	
total	
2.50	



# Mercurius REACH – R&D Completed

## University of California, Davis

- CMF and FDCA technology.

## University of North Dakota, EERC

- Condensation reactions and hydrotreating.

## Purdue University

- CMF production @ 1L scale, fuel testing, condensation reactions.

## Commonwealth Scientific and Industrial Research Organization (CSIRO)

- R&D = CMF production, condensation reactions

## University of Maine

- Process engineering, hydrotreating, condensation reactions, pilot plant located at TRC.

## Michigan State University Bioeconomy Institute (MSUBI)

- CMF production scale-up (400L) and condensation products analysis.

## Queensland University of Technology (QUT).

- CMF production, feed prep, condensation reactions, hydrotreating.

## Southern Oil Refining (SOR)

- Hydrotreating and fuel testing.



# QUT Optimization

## Queensland University of Technology (QUT).

- CMF production, feed prep, condensation reactions, hydrotreating.

## Southern Oil Refining (SOR)

- Hydrotreating and fuel testing.



# Pilot Project

## Seeking State support

- Rural economic development
- Drop-in biofuels
- High performance bioproducts

## Project partners:

- Queensland University of Technology (QUT)
  - Chemistry and engineering support
  - Pilot plant site in Mackay Qld
- Southern Oil Refining (SOR), Gladstone Qld
  - Hydrotreating pilot facilities
  - Fuel testing lab



# Pilot Details

## Located at existing QUT pilot facility

- Designed for fermentation
- Limited modifications for REACH
- On-site of Mackay Sugar Mill

## Modifications for REACH

- Acid hydrolysis step and intermediates
- Acid clean-up and recycle
- Solvent recycle
- Condensation and Hydrotreating at SOR facility

**Feedstock – bagasse, hardwood, rice straw...**



# Valuable Chemicals & By-products

## Levulinic Acid (LA)

- Plasticizers
- Solvents
- Polymers

## Formic Acid

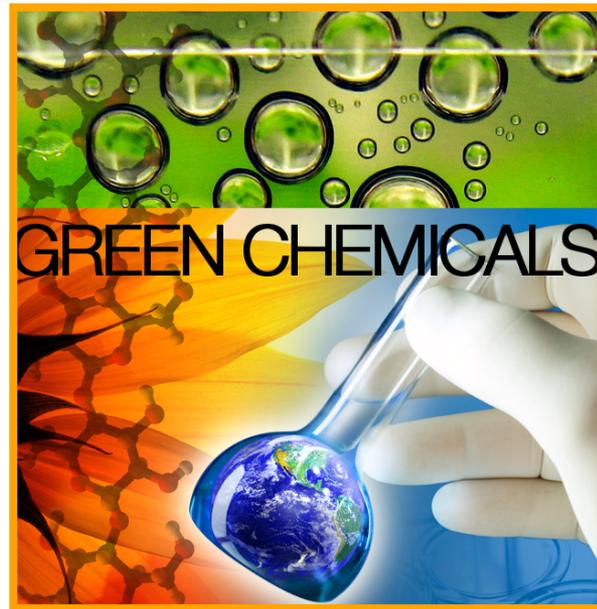
- Food safe fumigant/ animal feed supplement
- Environmentally friendly de-icer
- Fuel cell feed

## Furfural

- Solvent for extraction processes
- Resin manufacturing

## Lignin

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



# Looking Ahead >>

## Fatty Acids

- Nutraceuticals
- Specialty chemicals

## Cyclic Ethers

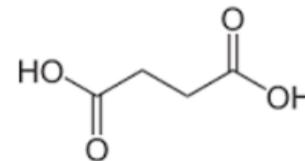
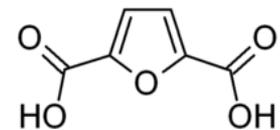
- High cetane diesel additive
- Specialty chemicals

## Lignin Products

- Unique-properties based products
- Jet fuel and diesel

## Polymers

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



# FDCA for PEF

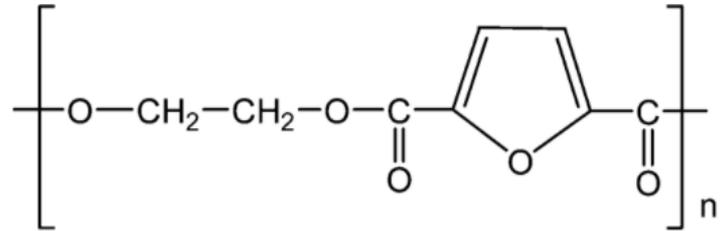
## PEF Advantages over PET

- Superior Barrier Performance
  - ✓ O<sub>2</sub> 10x better
  - ✓ H<sub>2</sub>O 2x better
  - ✓ CO<sub>2</sub> 4x better
- Thermal Stability
  - ✓ 12C higher than PET
- Mechanical Properties
  - ✓ 1.6x better (tensile modulus)

=

## Better Beer Bottle!

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



# Key Partners in REACH Development

## CSIRO (Australia)

process optimization research

## Purdue University

scientific/engineering/aviation expertise

## UMaine

continuous flow optimization, engineering

## QUT

chemistry, engineering, pilot plant operations



## UC Davis

hydrolysis technology & IP

## Pacific Northwest National Laboratory

past hydrotreating & catalyst development

## Haldor Topsoe

catalyst / hydrotreating technology



# 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

# Management Team

K.S.

**Karl Seck**

**President & CEO**

Karl has nearly 30 years experience as a process engineer in the petroleum industry. He has a Bachelor of Science in Chemical Engineering from the University of Kansas.

M.V.

**Michael Vevera**

**Chief Financial Officer**

Michael has started-up and run successful companies in Japan and Australia. He has a degree in International Finance from Oregon State and a Masters in International Marketing from University of Technology, Sydney.

K.B.

**Knud Balslev**

**VP of Business**

**Development**

Knud has 25+ years of international business development experience. He has a BSC in Electronics from the Danish Technical University



# Advisors

MM

## Mark Mascali

**Professor of Chemistry,  
University of California–Davis**

Mark received his PhD from the University of London, Imperial College and was a Postdoctoral Fellow at the University of Strasbourg, France.

CW

## Clayton Wheeler

**Assistant Professor of Chemical  
& Biological Engineering,  
University of Maine.**

Clay received his BS, MS and PhD degrees from the University of Texas at Austin.

P  
K

## Pete Kitzman

**Sr. Manager: Risk Management &  
Procurement, The Kellogg Company**

Pete has over 30 years of experience in risk management, strategic project management, biofuel co-product dev. & agriculture production. He has a BS in Agriculture from Iowa State University



# Funding Needs

## Series A 2018

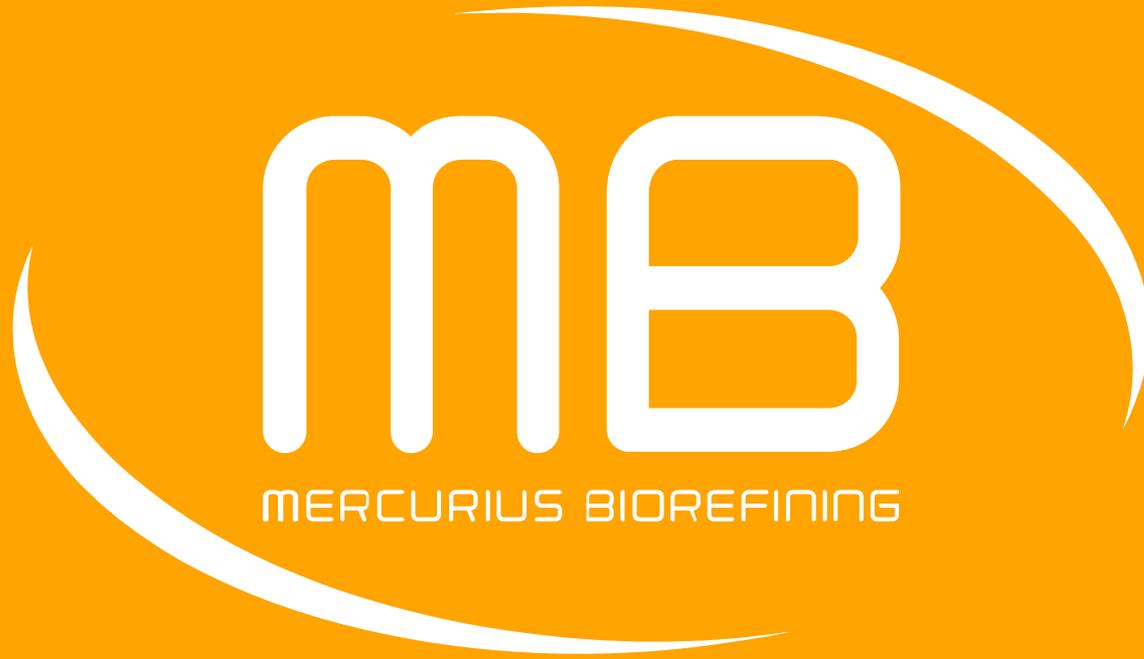
**Seeking \$0.5-\$1.5  
million**

of equity funding to use as matching funds along side the grants and tax credits of ~\$0.8 million to complete the Pilot Plant Project

## Series B 2019-20

**Seeking \$3-5 million**  
of equity funding to use along with \$5 million of grants to build the 20 MTPD Demonstration Plant





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