

# **Biofuels and Beyond: The Role for Bio-based Chemicals**



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Advanced Biofuels Markets  
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# Who We Are

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- Producer of advanced biofuels and bio-based chemicals
- Advantages:
  - Feedstock agnostic
  - Dedicated /sustainable energy crops
  - Novel integration of known processes and natural organism
  - 40% yield advantage
  - Diverse product portfolio
- Target: Compete with fossil fuel feedstocks



# Opportunity for Bio-based Chemicals vs. Biofuels

- Smaller market size but greater product diversity
- Higher value on per gallon equivalent basis
- Wider range of strategic partners
- More vulnerable to fossil fuel feedstock price volatility
- Infrastructure ready/drop into existing markets – not creating anything new



# World Markets Projected to Grow Significantly

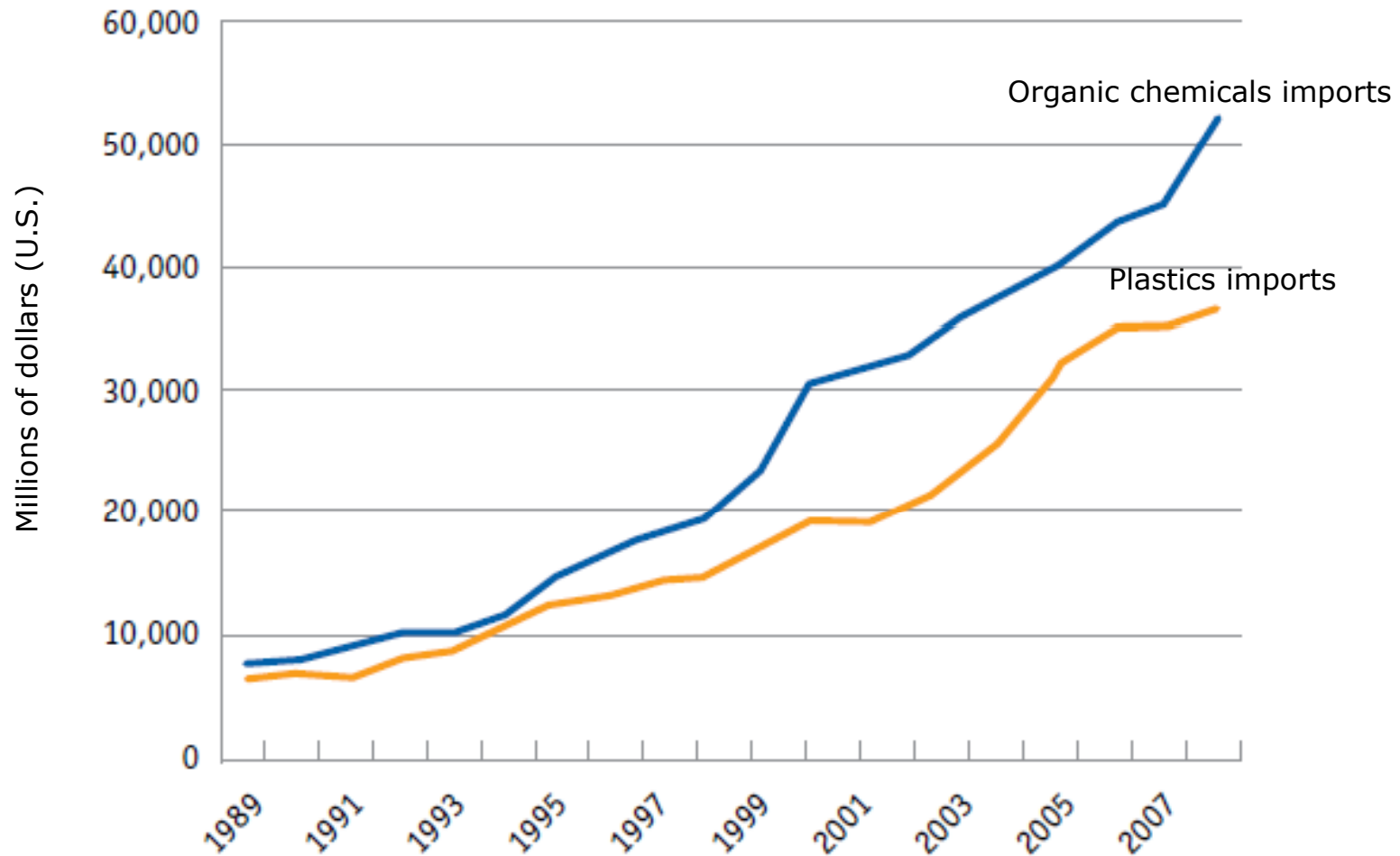
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Chemical Sector	2010	2025
Commodity Chemicals	1-2%	6-10%
Specialty Chemicals	20-25%	45-50%
Fine Chemicals	20-25%	45-50%
Polymers	5-10%	10-20%

\* The U.S. is the largest chemicals and plastics market in the world

Source: BIO, *Biobased Chemicals and Products*; chart data source: USDA, U.S. Biobased Products Market Potential and Projections Through 2025

# Significant Opportunity for U.S. Production



Source: BIO, *Biobased Chemicals and Products*; chart data source: TradeStats Express

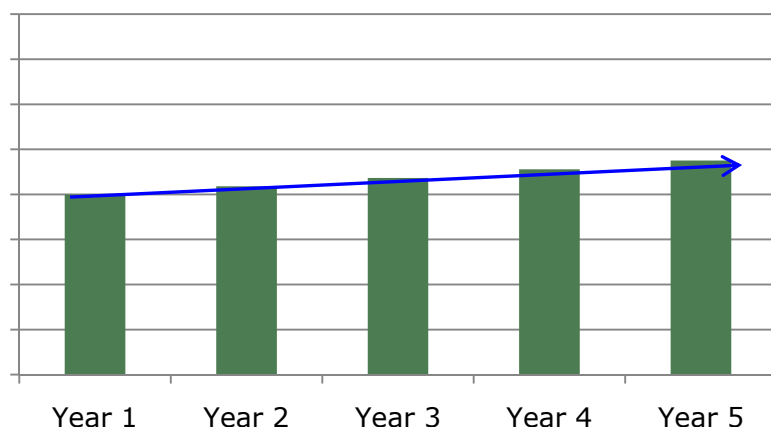


# Petroleum Feedstock vs. Energy Crops



- Crude oil price volatility more difficult for chemicals industry to absorb compared to fuels industry

## Dedicated Energy Crops



- Long-term, fixed price contracts for dedicated energy crops offers valuable price stability for chemicals industry



# Dedicated Woody Biomass Energy Crop Advantages

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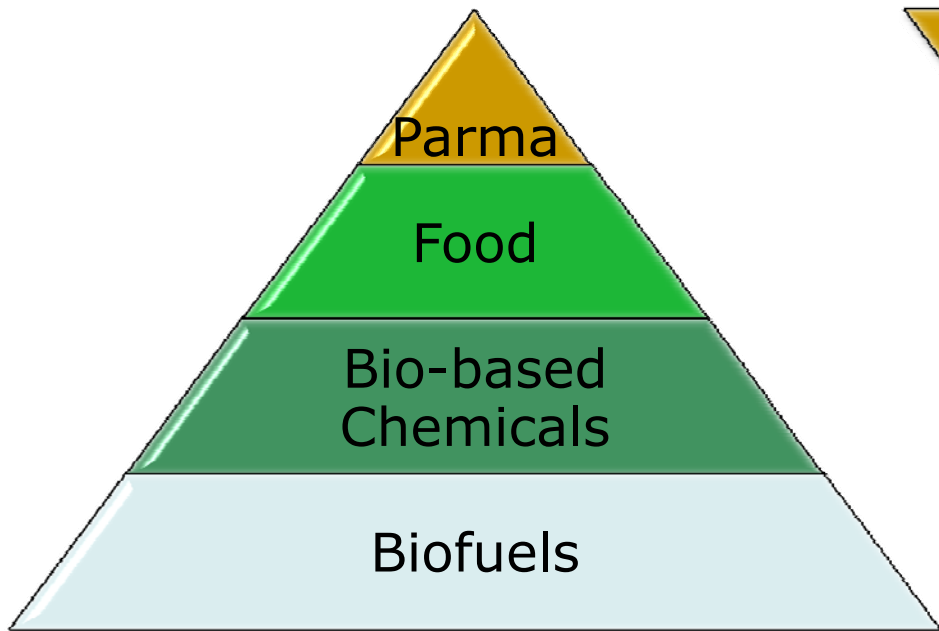
- Land aggregation
- Long-term contract
- High density
- 3-yr rotation
- Store on the stump
- 50,000 acres = 100M GPY
  - <5 mile radius



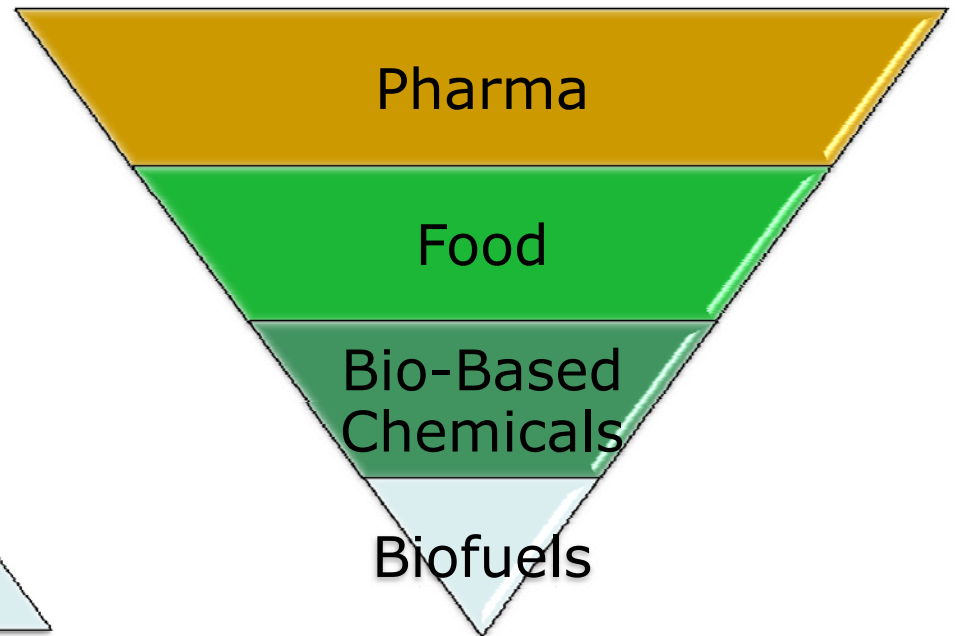
# Conundrum: Market Size vs. Product Value

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Market Size



Product Value



Highest values tend to be found in smaller markets



# Three Pathways to Bio-based Chemicals

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1. Novel processes → novel molecules



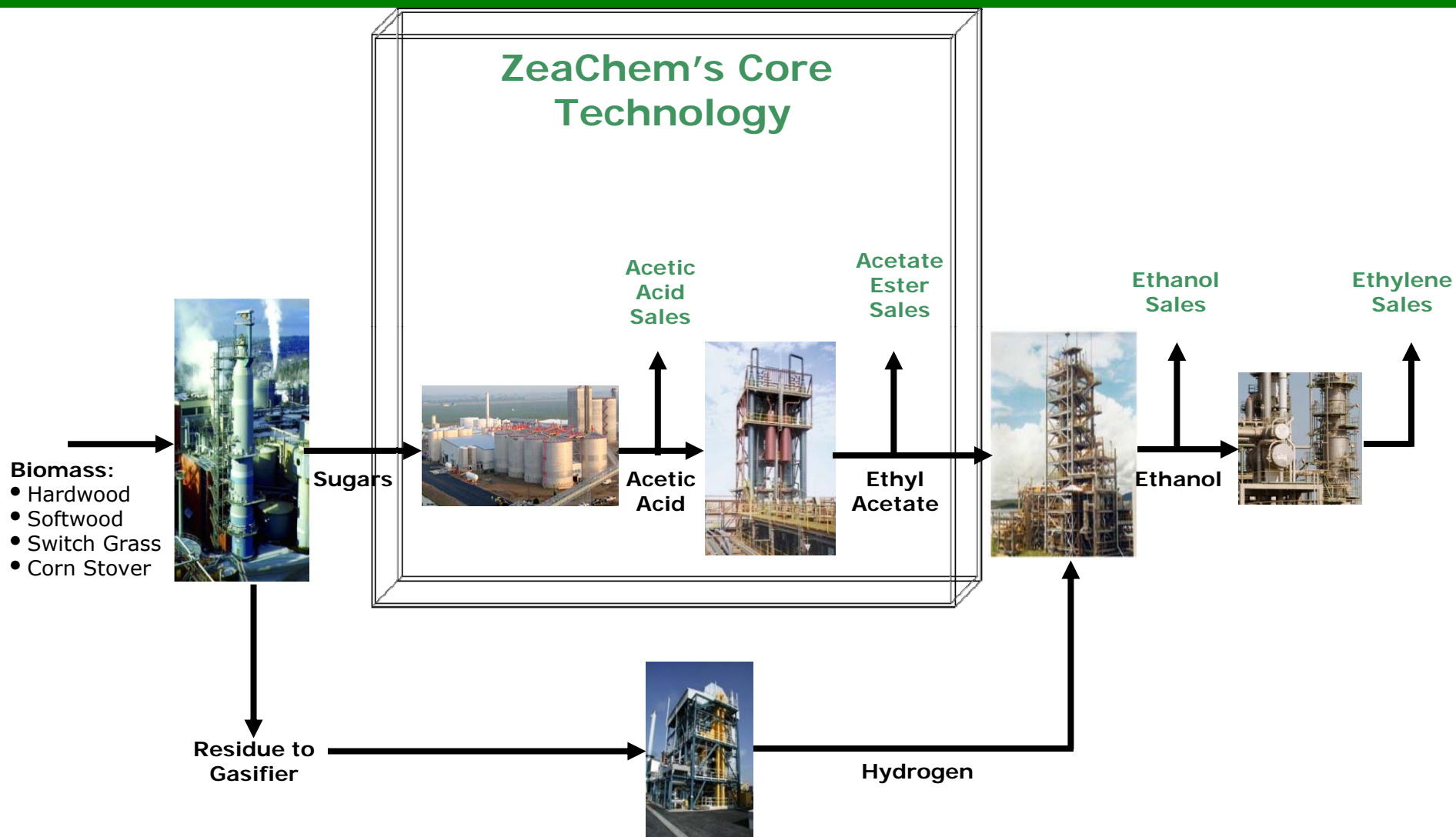
2. Novel processes → traditional molecules



3. Traditional processes → traditional molecules

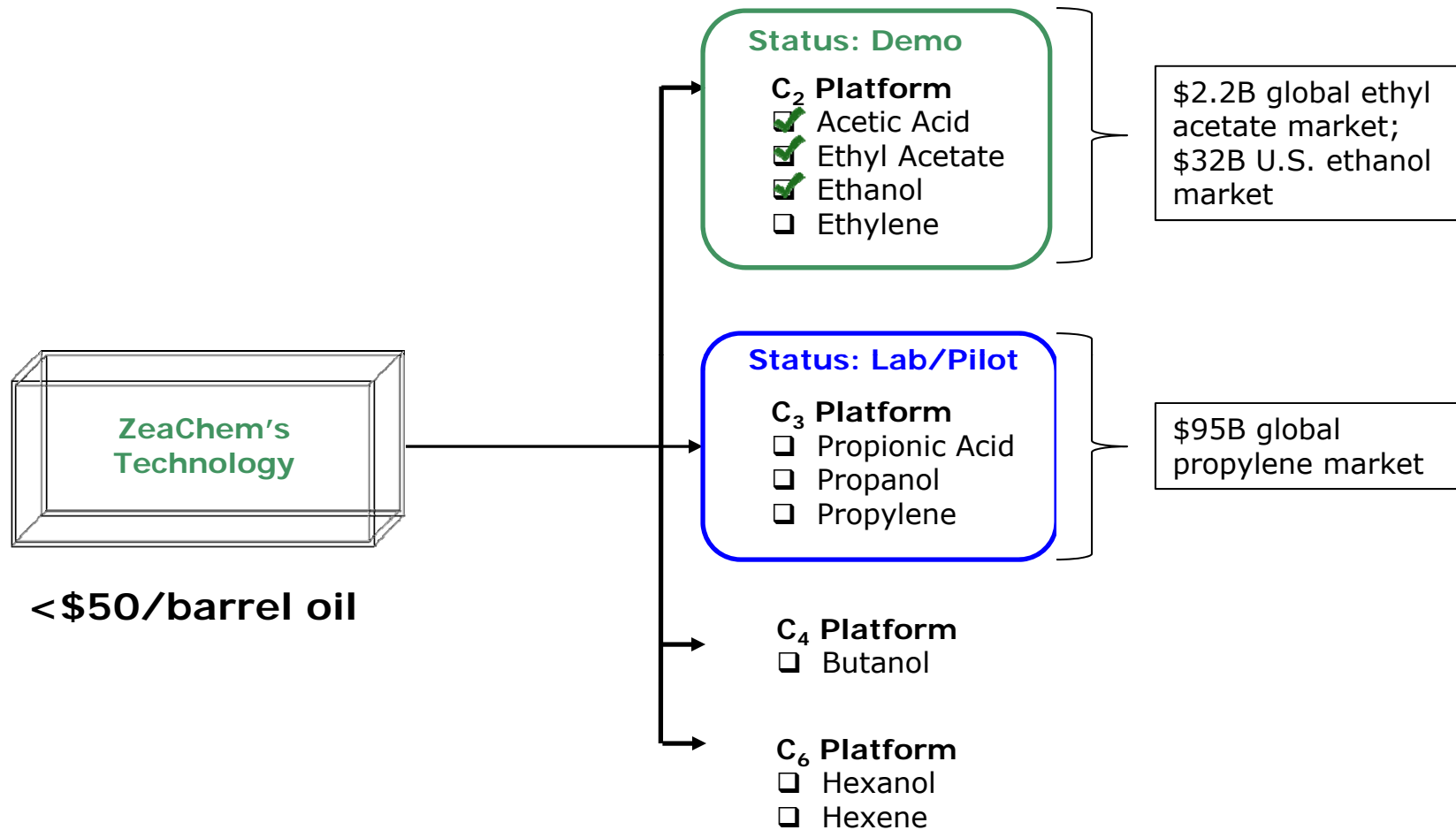


# C<sub>2</sub> Fuel and Chemical Product Platform

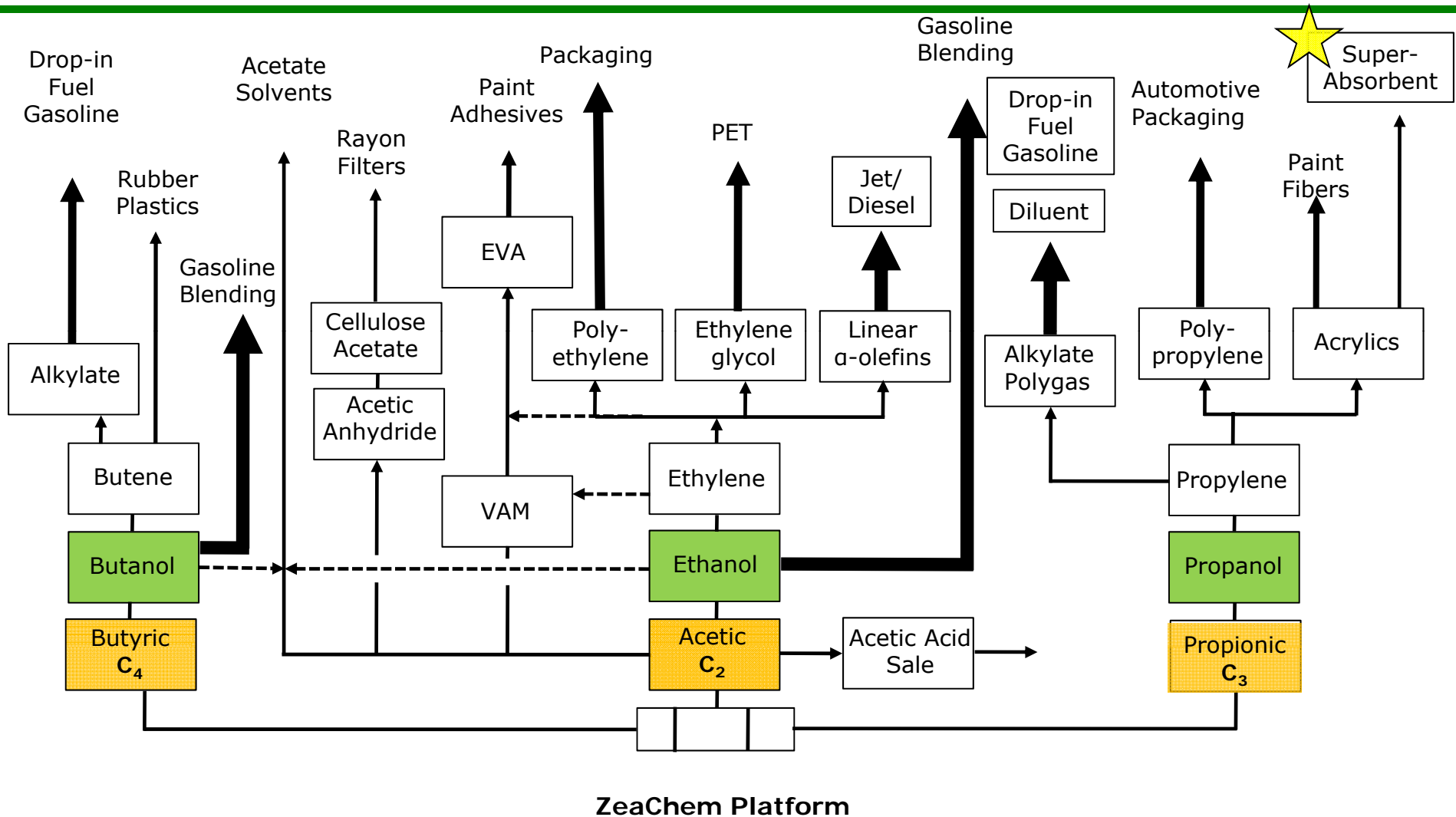


Novel integration of known processes, natural organism (no GMO)

# ZeaChem Product Platforms and Markets



# ZeaChem's Flexible Product Tree



# Technology Scale-up



Fermentation at Hazen Research Inc., Golden, Colo.

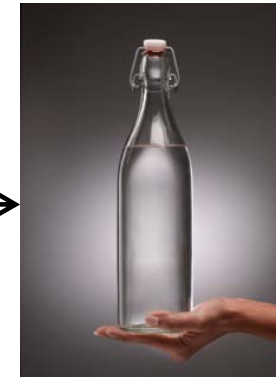
Acetic Acid



Ethyl Acetate



Ethanol



# Integrated Biorefinery in Boardman, OR



Schematic of future facility

Photo courtesy of Matt Kegler. Diagram supplied by Burns & McDonnell

- 250,000 GPY capacity
- Groundbreaking June 2010, online 2011
- Hybrid poplar + other feedstocks
- 75 construction jobs, 25+ operating jobs
- Capex and opex supported by \$25M U.S. DOE grant



# Bio-based Chemicals Success Factors

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- Highest yield, focus on efficiency
- Proven technology, natural organisms
- Feedstock flexibility
- Strategic partnerships
- Compete with fossil fuel feedstocks
- Equal product performance

**Win the Ties**



# Thank You

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