

Catchlight Energy's Biomass Liquefaction Process

U. S. Department of Energy
Biomass 2011 Conference



Presentation Topics

- Catchlight Energy (CLE) Overview
- What makes a “good biofuels process”?
- CLE’s biomass liquefaction to biofuels process
 - Technology description
 - R&D program
 - Economics
- Next steps

Catchlight Energy LLC (CLE)

A 50/50 Chevron and Weyerhaeuser joint venture.



Our Mission: To commercialize the large-scale production of liquid transportation fuels from sustainable forest-based resources



***A Unique End-to-End Value Chain Solution
Leveraging the strengths of two natural resource leaders***

Catchlight Energy (CLE) brings strengths not found elsewhere.

CLE drivers aligned with national interests to develop renewable energy platform, increase energy independence & security and promote rural development.

Catchlight Energy (CLE) – What we do

Feedstock sourcing & product integration systems

- Feedstock supply and product off-take for biofuel facilities
- Developing forest intercropping of dedicated energy crops
 - 2000 acres planted



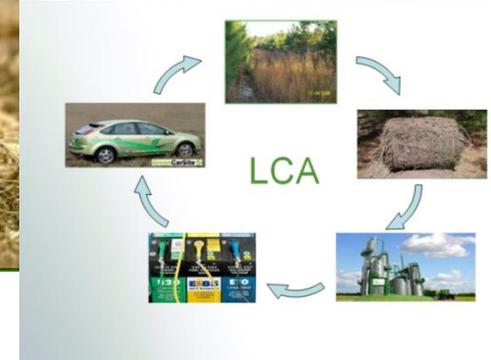
Unparalleled sustainability science

- Large-scale studies (1200 acres)
- Identifying ecosystem effects
 - Soils, nutrients, soil carbon
 - Water quality/quantity
 - Wildlife/biodiversity
 - Carbon life cycle analysis



Conversion technology

- Develop or Acquire
- Bioconversion
- **Thermochemical**



Hallmarks of a “Good Biofuels Process”



■ Historical Perspective

- **Catchlight Energy’s parent, Chevron, developed a lignin liquefaction technology in 80’s & 90’s**
 - **Successfully liquefied 500,000 lbs of Lignin in 2000**
 - **Required hydrogen and a catalyst**
- **Fast-pyrolysis biocrude is difficult to upgrade due to instability and high oxygen/water content**
- **Hydrothermal liquefaction requires a catalyst, aqueous phase separation and high pressure operation**

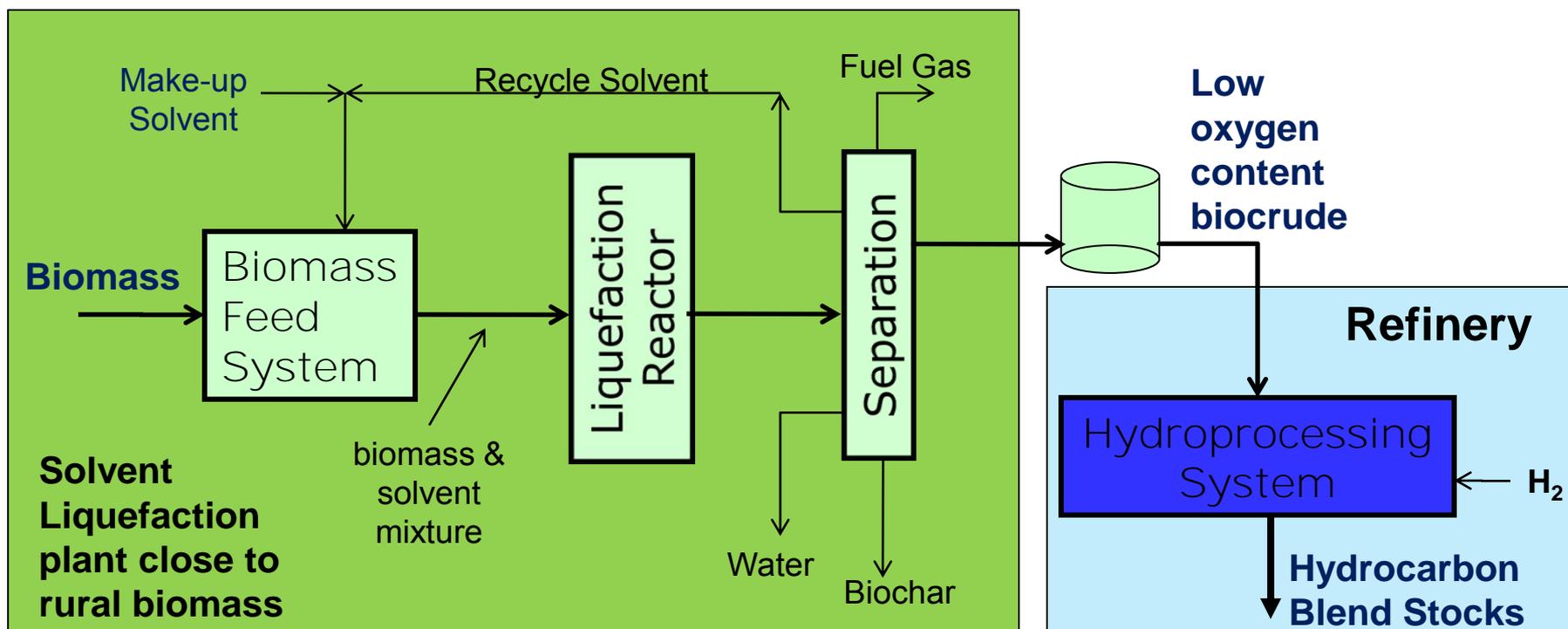
■ A “Good Biofuels Process”:

- **Minimizes footprint & complexity in the field or forest**
- **Achieves a high yield of prime product**
- **Processes whole biomass**
- **Produces low oxygen and water content biocrude at moderate pressure**

CLE Solvent Liquefaction Process

Main Process Steps

- Biomass Feed System (raise biomass pressure & temperature for reaction)
- Liquefy biomass in solvent (partially remove oxygen & stabilize oil)
- Hydroprocess liquefied-biomass to remove remaining oxygen in refinery



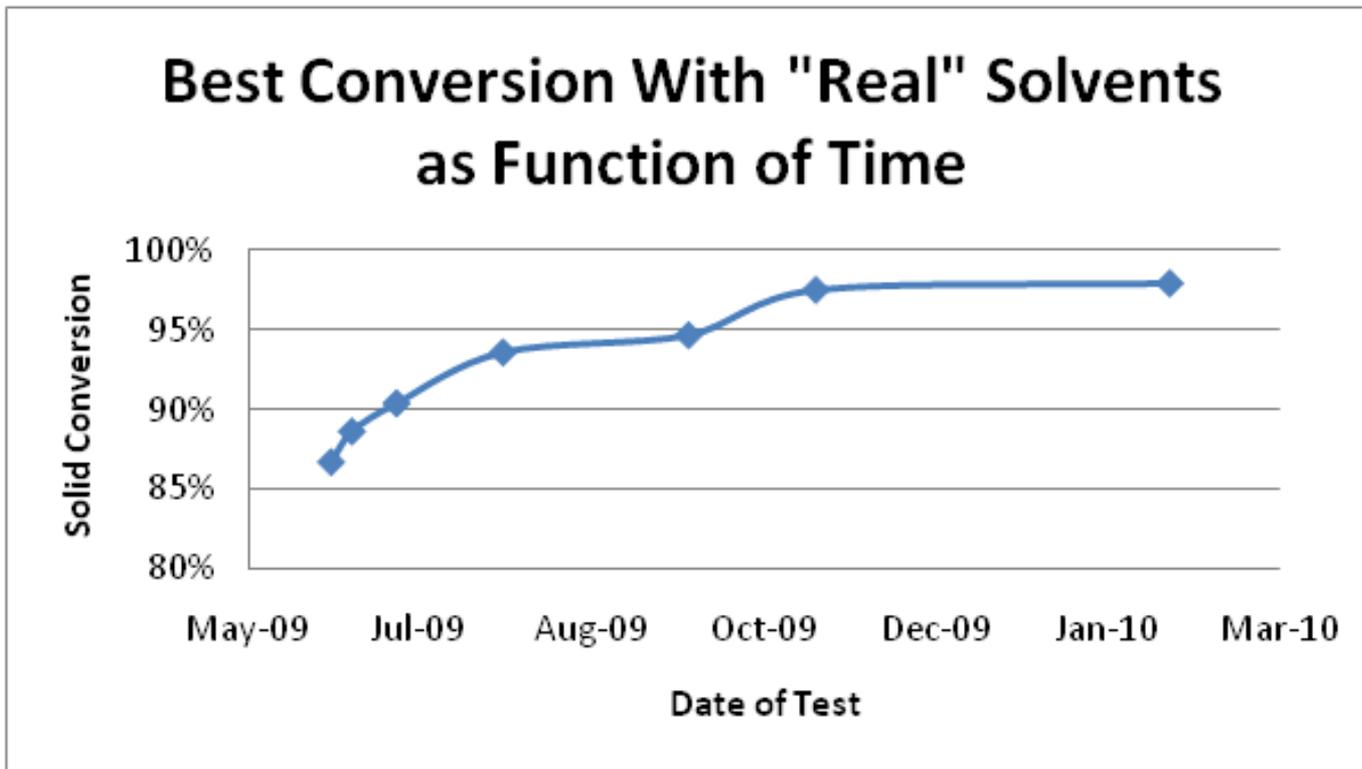
CLE Solvent Liquefaction Process

- Demonstrated process advantages:
 - High yields (>100 gal of finished HC products/BDT)
 - Low char (<6 wt%) and aqueous phase (<3%) carbon loss
 - Lower oxygen content biocrude (10-30 wt%)
 - Moderate pressure operation
 - A practical, effective and low-cost solvent system
 - Processes a wide variety of biomass

- Satisfies “Good Biofuels Process” Criteria
 - Minimizes footprint & complexity in the field or forest
 - Produces a very high yield of prime product
 - Processes whole biomass
 - Produces a low oxygen/water content biocrude
 - Meets 60% GHG reduction required to be a renewable cellulosic fuel

The Secret is in the "Sauce" (Solvent System)

- commercially-practical,
- produces low-char and high biocrude yields
- low-cost



Continuous Liquefaction Pilot Plant

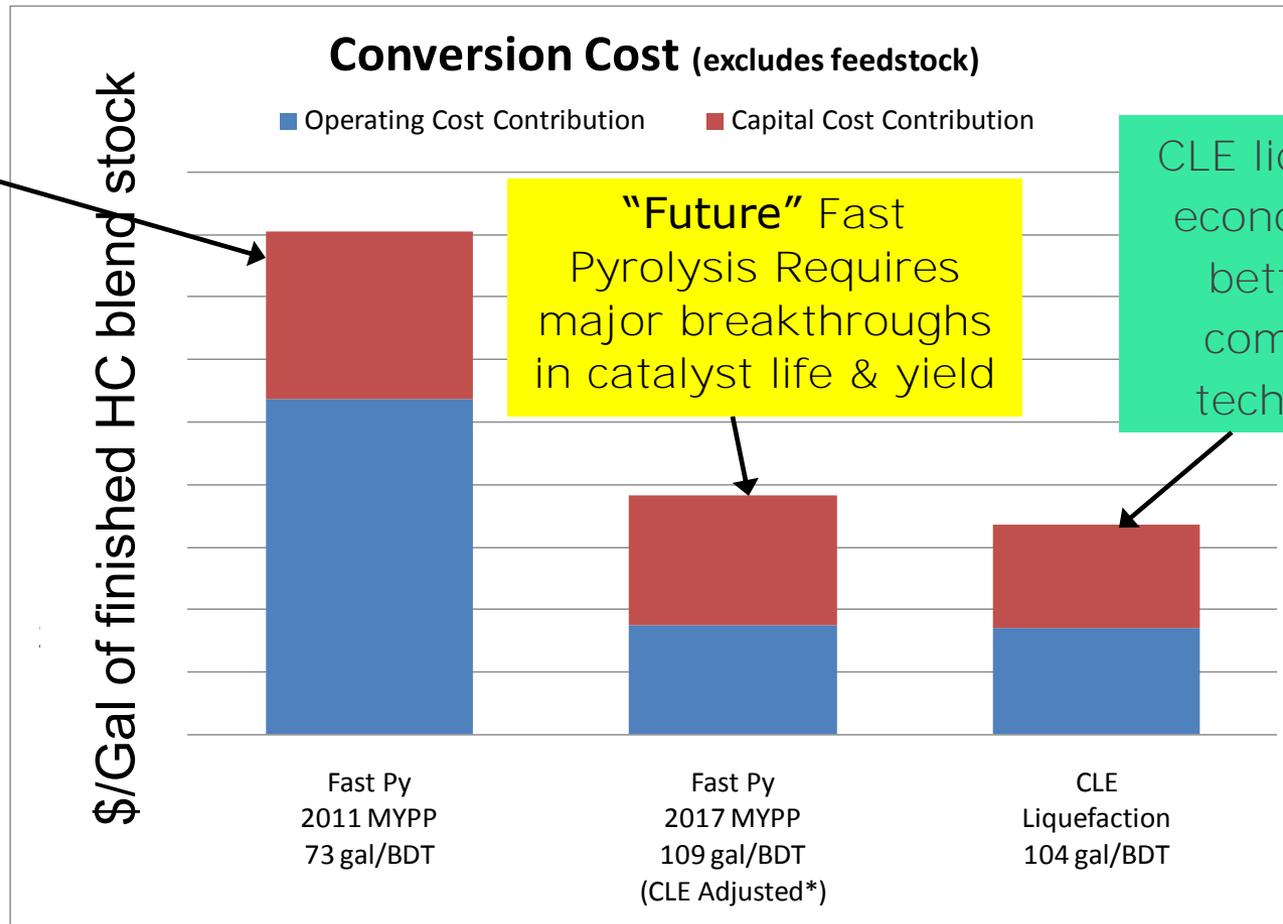


Proven
technology in
large pilot plant:
50 lbs/day

Commercially-
scalable feed
system

Commercial plant
design

Biofuels Competitive Cost



*2017 Multi-year Program Plan (MYPP) and CLE liquefaction processes based on consistent industry capital cost methodology and opex adjustments. 2011 MYPP “current” case as published by DOE.

Summary

- CLE has developed a unique, high-yield, economic biomass liquefaction process
- Further research & demonstration is needed
- CLE is pursuing value-added collaborations to:
 - Leverage our technology investment to accelerate commercialization
 - Partner with others that have complementary resources and experience