



# Renewable Petroleum™ Products & Technologies

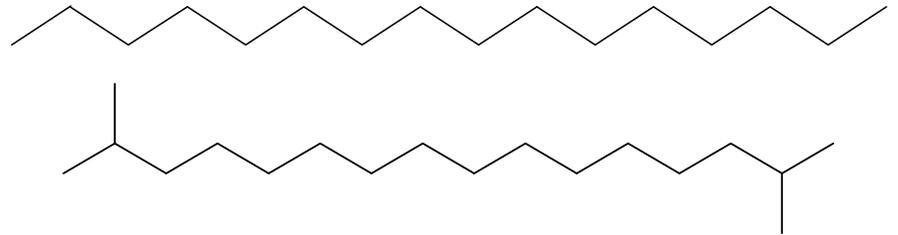
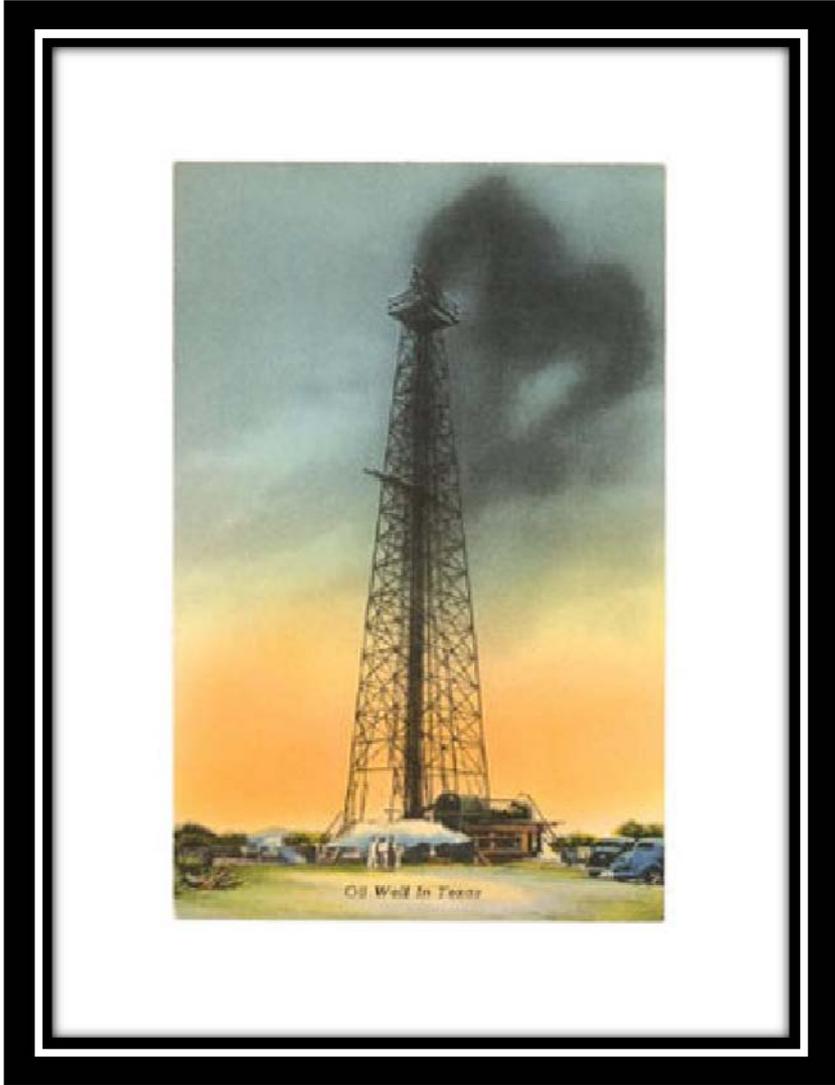
Biomass 2010  
March 30, 2010



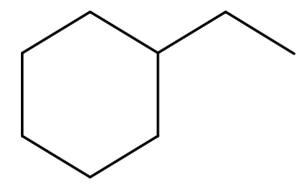
**LS9, INC.**

THE RENEWABLE  
PETROLEUM COMPANY.

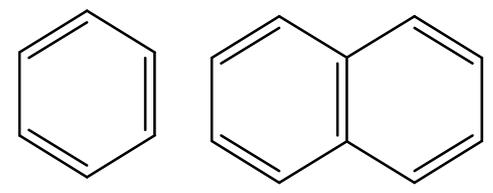
# Petroleum: If Only It Were Renewable



Paraffins

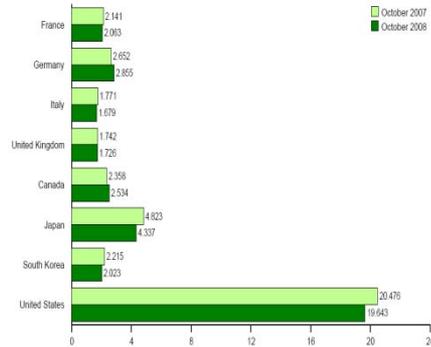


Naphtha



Aromatics

# Rapid and Widespread Transition to Renewables



- Cost competitive – profitable, without subsidy, long term.
- Scalable to meet demand
- Accessible raw materials that do not compete with food
- Compatible – distribution and consumer infrastructure
- No miracles required



## Low cost: high yield, simple, robust process

- Pricing must be competitive with petroleum without subsidy
- Raw materials ~ 70-80% COGS
  - High yielding process – low COGS
  - Simple process – lower capital, higher yield



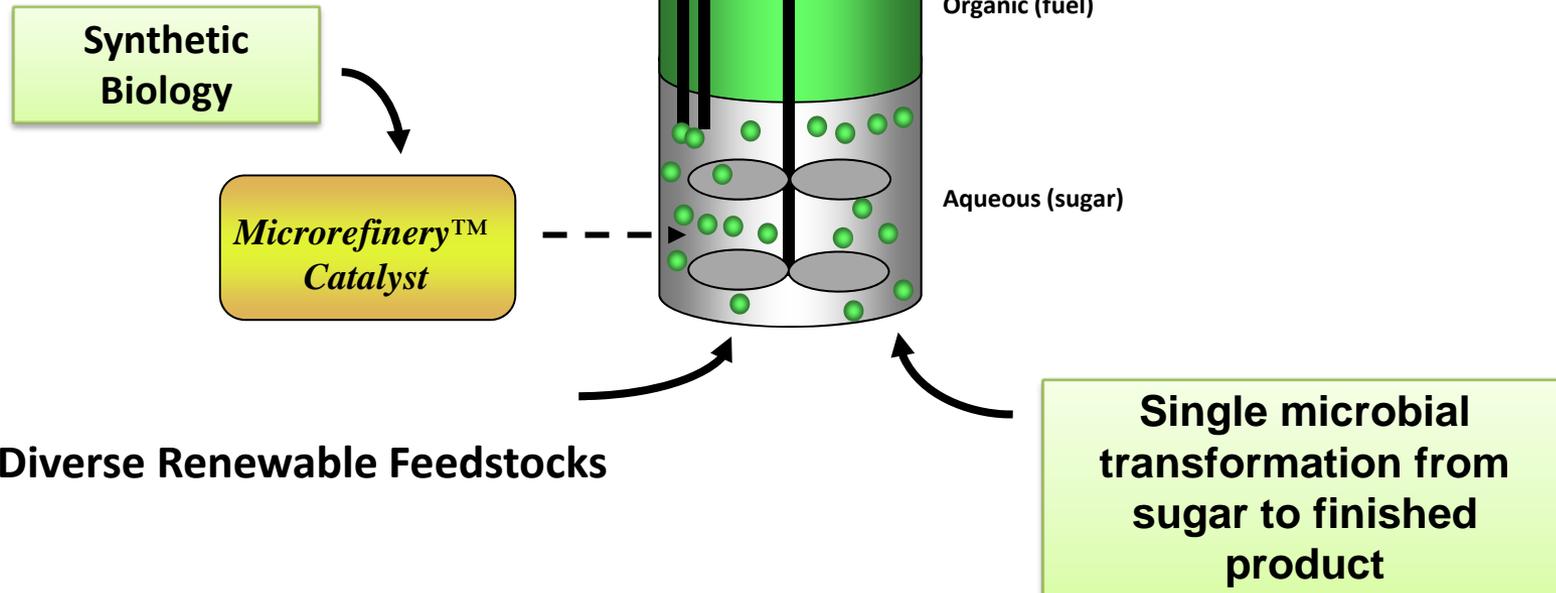
# Technology Platform

## One-Step Process & Competitive Economics



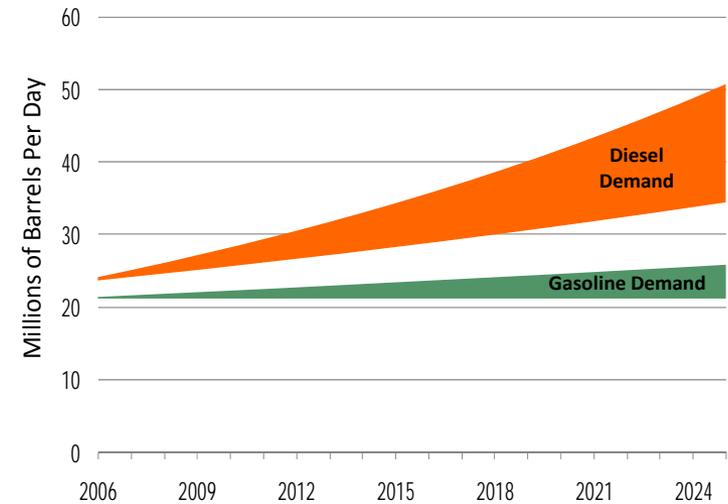
### Products

- Fuels
- Chemicals
- \$50/barrel crude oil equivalent



# Fuel: Diesel Focus

- \$1 trillion diesel market
- Globally, demand for diesel > gasoline
- Diesel is growing at 3X gasoline demand growth
- Diesel powers economies
- Need for renewable alternative



Source: EIA, ExxonMobil



# Sustainable Chemicals: Large, Growing, Multi-Billion Market

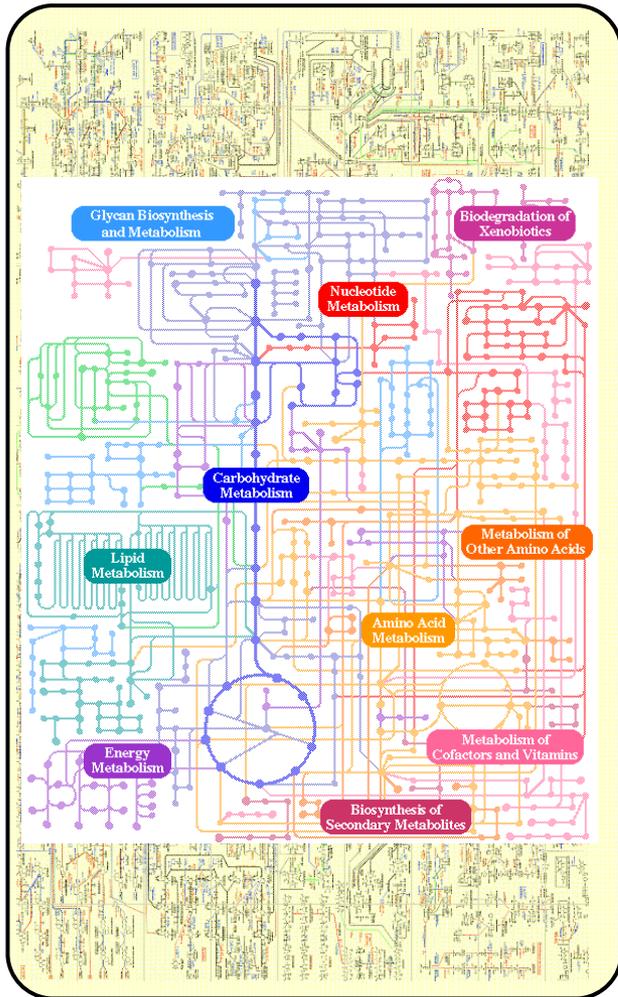
~\$45 billion global renewable chemicals market<sup>(1)</sup> growing  
at 5.3% annually with a goal of reducing petroleum dependence



<sup>(1)</sup> MarketsandMarkets forecasts.

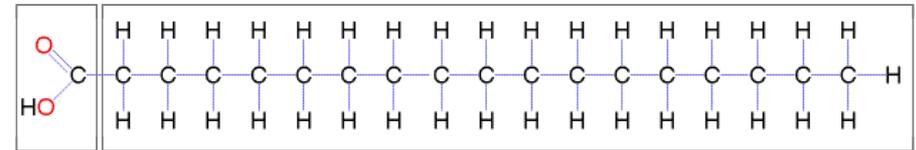
# Technology Core: Microbial Fatty Acid Metabolism

## Best Route to Hydrocarbons



### Fatty Acid Biosynthesis

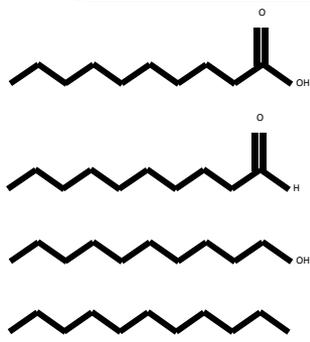
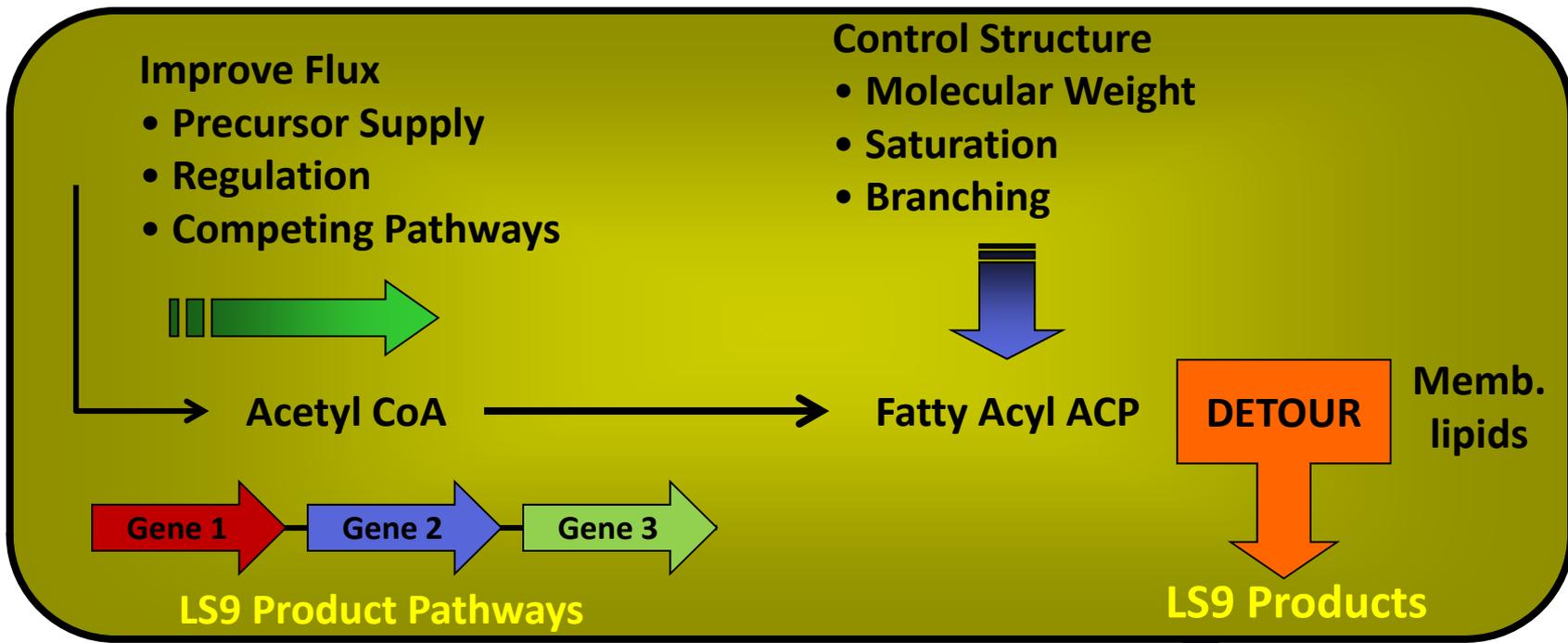
- Preferred pathway
- Highest theoretical yield
- 90% energetic efficiency
- Commercial productivity
- Well characterized
- Structurally diverse
- Immiscible



Carboxylic acid

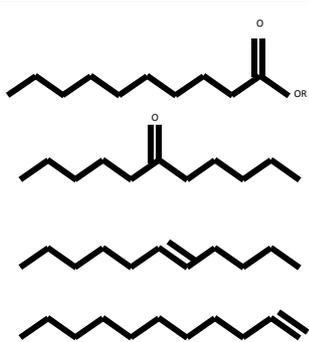
Hydrocarbon chain

# Synthetic Biology: One Pathway, Many Products



Acids  
Aldehydes  
Alcohols  
Alkanes

Esters  
Ketones  
Olefins  
 $\alpha$ -Olefins



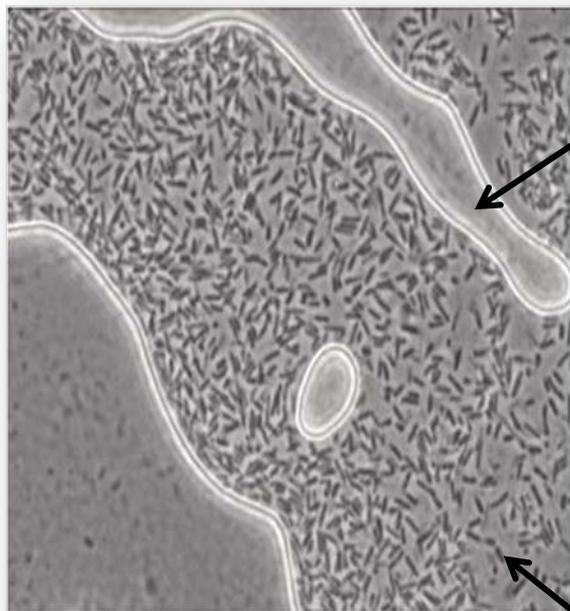
Secretion

# Product Secretion Enables Simple Biphasic Recovery

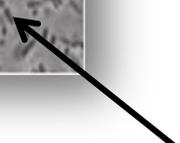
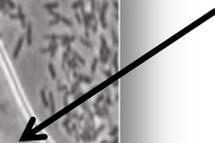


## Product Secretion

- Natural separation
- Non toxic



UltraClean™ Diesel

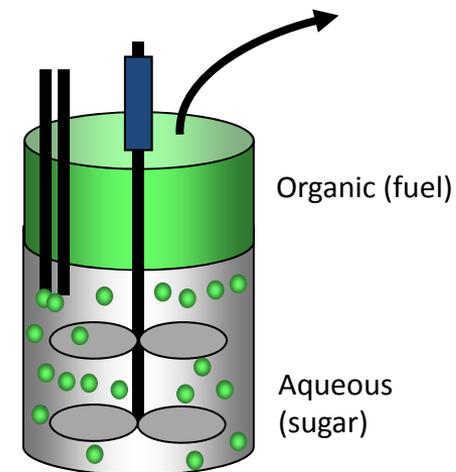


Microrefinery™ Catalyst

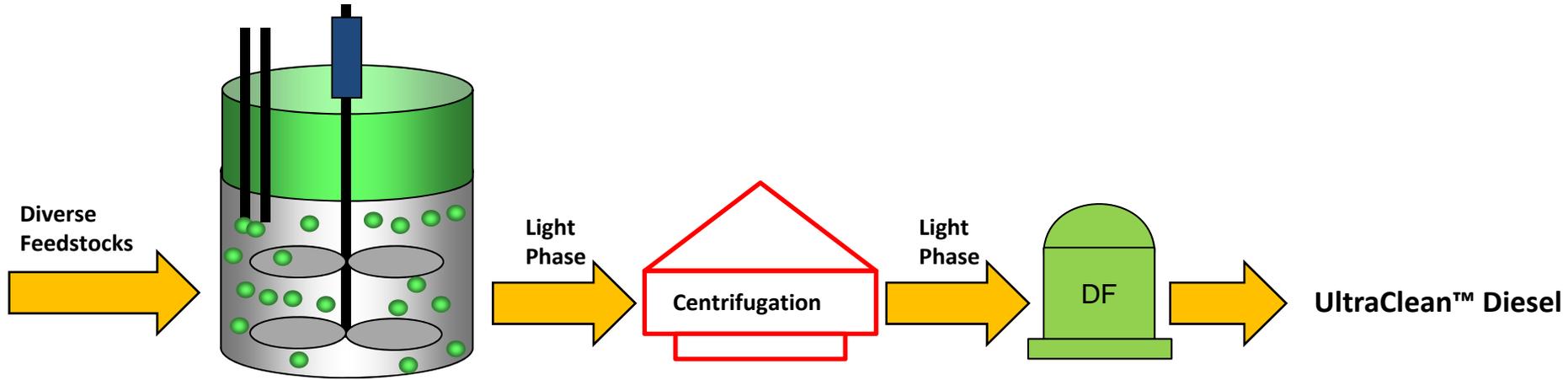
*Image Taken Under  
Microscope at LS9's  
Lab in 2008*

## Product Recovery

- Settling
- Centrifugation
- No extraction
- No distillation
- No hydrogenation



# Pilot Validation: high yield, simple process



# LS9 UltraClean™ Diesel: High Performance By Design



Key LS9 Fuel Properties Relative to Petroleum Diesel		
Fuel Property	LS9 UltraClean™ Diesel	Petroleum Diesel
Cetane	70	49
Aromatics (% volume)	N/A	10
Sulfur (ppm)	12	15



Key LS9 Fuel Properties Relative to Traditional Biodiesel Alternatives				
Fuel Property	LS9 UltraClean™ Diesel	Soy	Rapeseed	Palm
Cetane	70	53	55	60
Cloud Point (°C)	-2	+2	-2	+13
Oxidative Stability (hours)	>6	3	3	5

## Description of Properties

- **Cetane:** measurement of the combustion quality of diesel fuel (higher is preferred)
- **Cloud Point:** temperature below which wax forms in diesel, summarizes cold-flow properties (lower is preferred)
- **Oxidative Stability:** hours before product encounters stability issues related to oxidative degradation (higher is preferred)
- **Aromatics:** ring-shaped hydrocarbons including carcinogens such as benzene (lower is preferred)
- **Sulfur:** sulfur is a pollutant that tends to hamper exhaust-control devices (lower is preferred)

# Feedstock Agnostic Technology

- Today – Sugarcane
- Tomorrow – Cellulosic biomass, when available.
- Feedstock flexibility
  - Takes advantage of available technology
  - Lowest cost feedstock
  - Multiple geographies



MAKING MORE  
OF BIOMASS  
Bacterial production  
of biofuels



Biomass

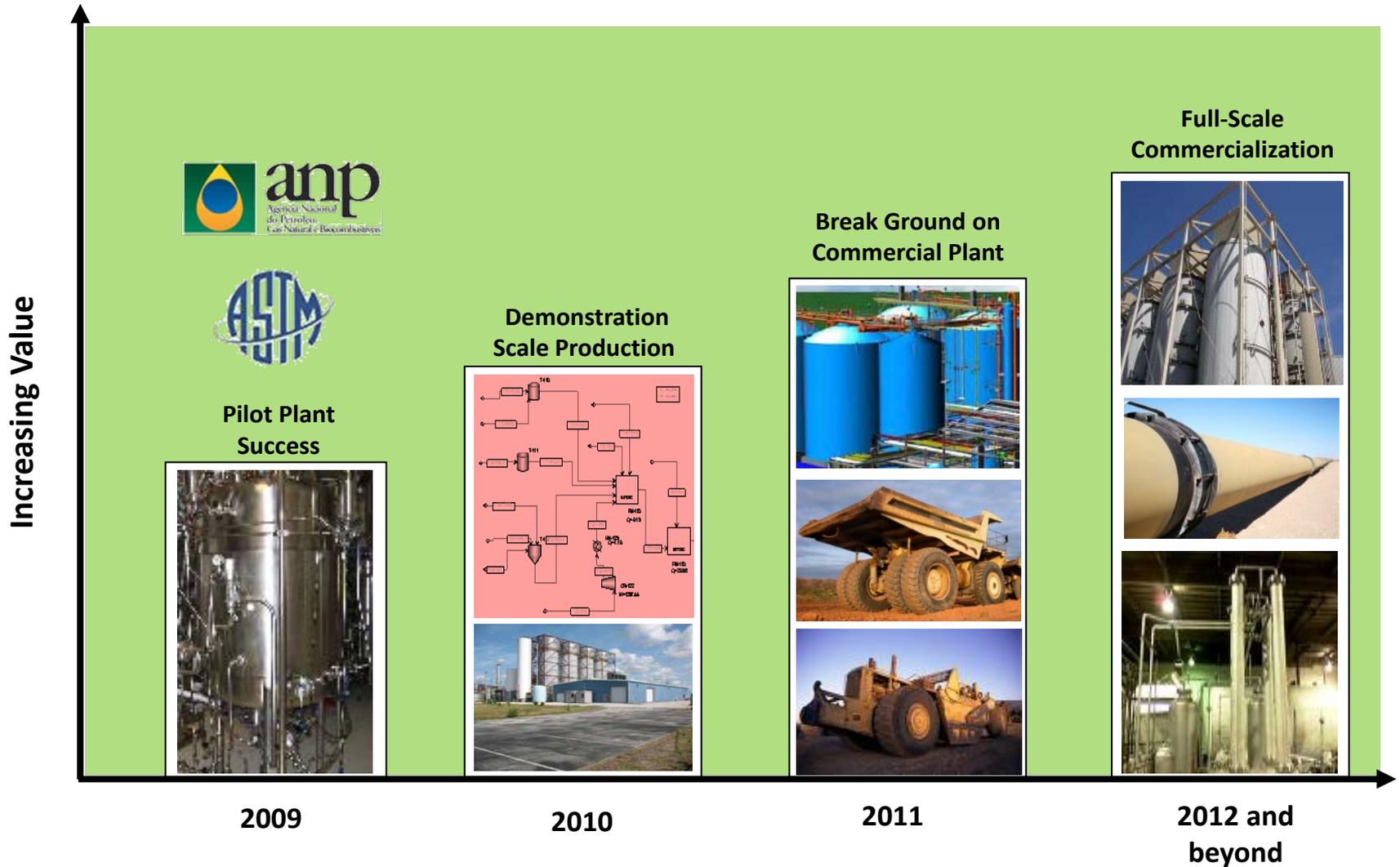


Ultraclean™ Diesel

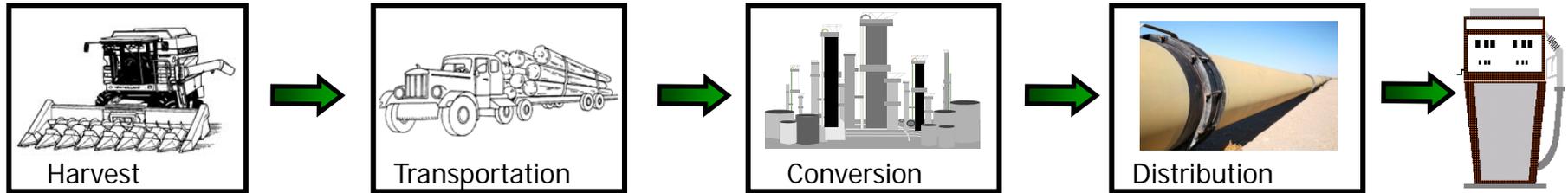
# Strategic Focus on High-Technology Components of Value Chain



# Clear Path to Commercialization



# Life Cycle Analysis



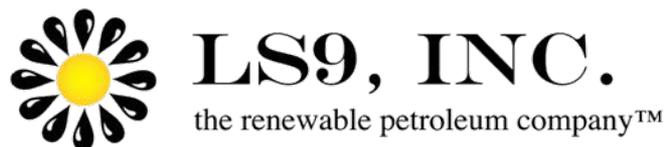
- GREET
- Assumptions for Brazilian sugar cane (M. Wang).
- Assumes no in field burning.
- Assumes tanker transport to US for combustion.
- >85% GHG decrease relative to petroleum diesel.
- Similar to decrease for EtOH relative to gasoline.

# LS9 Acquires Demo Plant; Opening Renewable Petroleum Facility in 1H'10



- Acquired production assets in Okeechobee, FL out of Chapter 7 bankruptcy
- Original installed cost of \$80 million and book value of \$20 million
- Cost to LS9 of less than 10% of book value
- Benefits to LS9:
  - Process and operational optimization
  - Commercial-scale production
  - Cellulosic technology integration

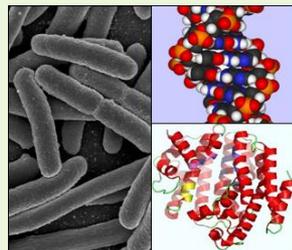
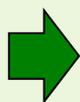




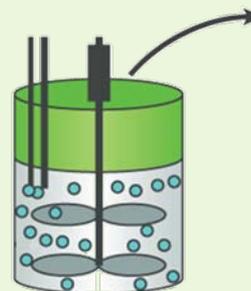
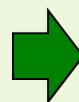
## High-quality, low-cost drop-in renewable fuels and chemicals



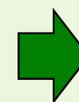
Feedstock  
agnostic



Efficient  
conversion



One-step  
process



Drop-in  
compatibility