

A horizontal banner with a green-tinted background. On the left, there is a photograph of two scientists in white lab coats, one woman in the foreground and one man behind her. A monarch butterfly is superimposed over the image. The background of the banner shows an industrial facility with large storage tanks and piping.

Biomass to Fuels and Chemicals

DOE Biomass 2012 Conference

Jacques Beaudry-Losique

July 10, 2012

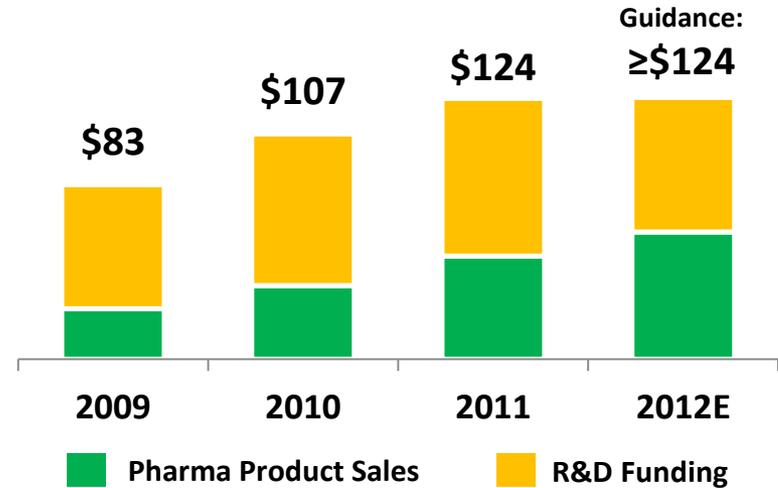


About Codexis

We develop enzymes and microorganisms that enable cost-advantaged production of biofuels, bio-based chemicals, and pharmaceuticals

- Founded 2002
- HQ in Redwood City, CA
- 340 Employees

Revenue, \$M's



Our Partners & Customers

CodeXyme™
Cellulase

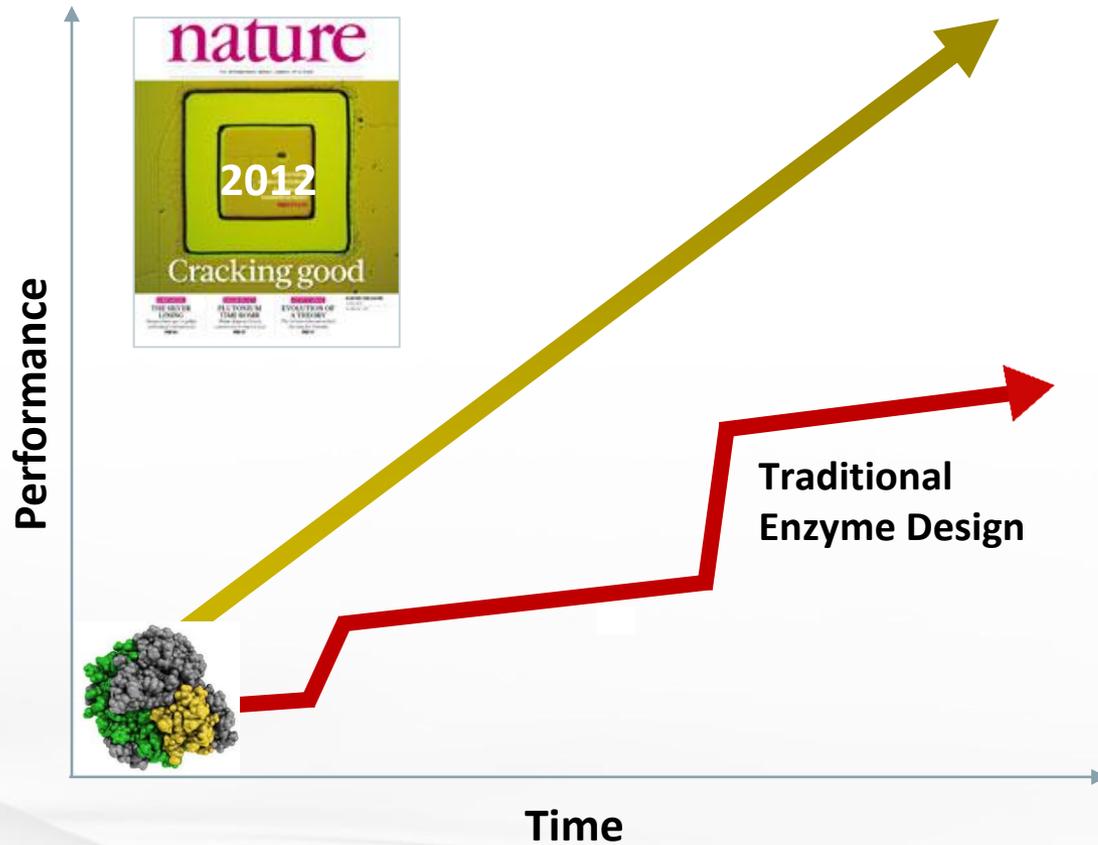
CodeXol™
Detergent Alcohol

Pharma



The CodeEvolver™ Advantage

Directed Evolution Technology Platform



Performance Improvement

- Directed DNA Sequencing + Bio-informatics
- Improved atorvastatin enzyme 4,000-fold
- Improved sitagliptin enzyme 28,000-fold



- **Economically Attractive**

- Provides high purity product in high yield
- Operates in multi-purpose plants.
- Catalyst manufacturing cost is not subject to fluctuating metal prices.

- **Environmentally benign technology**

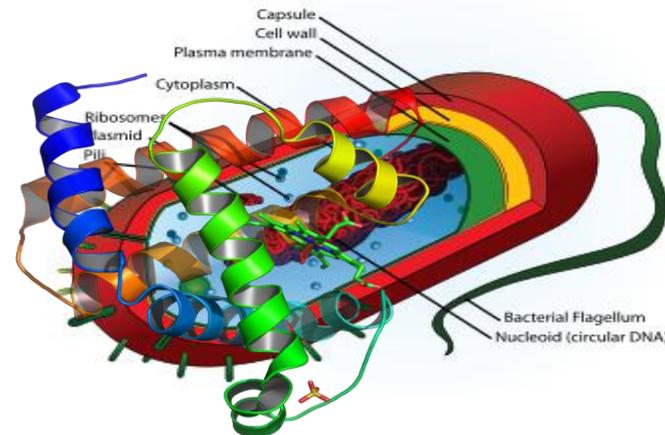
- Circumvent need for toxic reagents,
- No need for high pressure or low temperatures
- Catalysts manufactured in a fermentation process from renewable resources

- **Enabling technology**

- Reduction of steps by route re-design
- Opens access to unique synthetic sequences

- **Highly flexible/adaptable**

- Enzymes can be optimized to meet desired process parameters (as needed):
 - chemoselectivity, stability to process conditions (solvent, pH etc.)



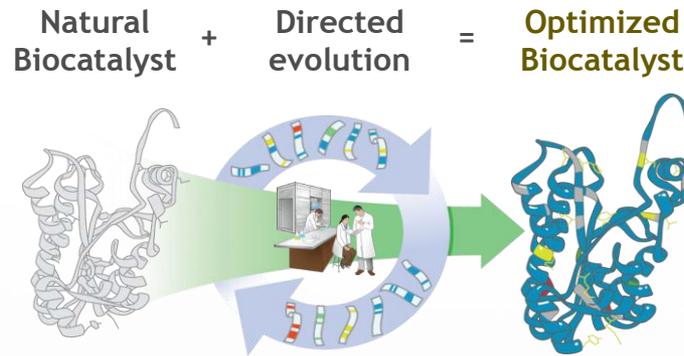


Codexis' Paradigm:

1. Conceptually design the desired catalytic process.
2. Generate the biocatalyst to enable the desired process.

Design Process

- High substrate loading
- Low biocatalyst loading
- High conversion
- High selectivity
- Avoid excess reagents
- Robust, scalable industrial process



CodeEvolver[™] Directed Evolution Technologies are the operating system of choice to generate optimized biocatalysts

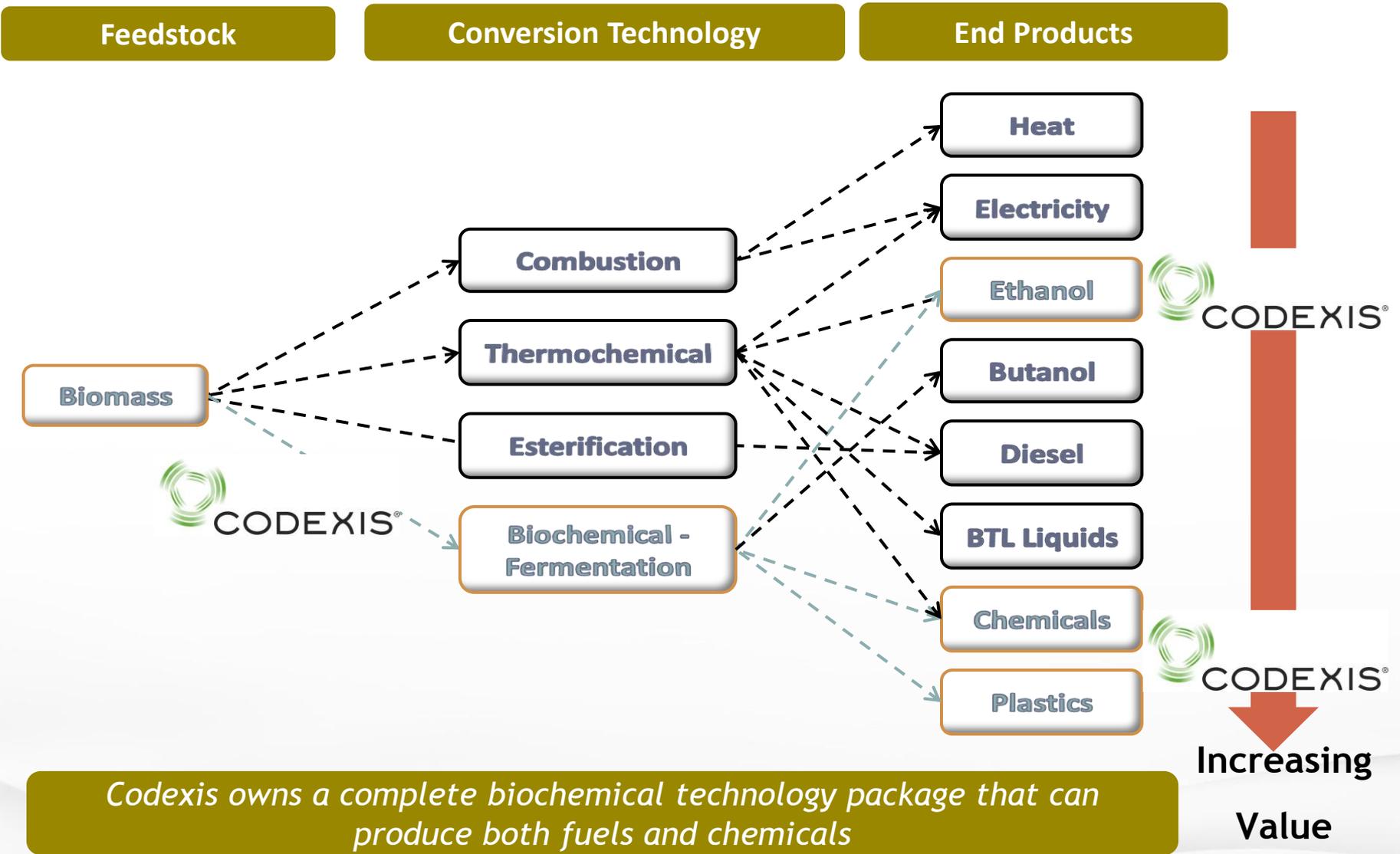


Huge Markets with World-leading Partners

Industry	Addressable Market	Commercialization	Partnerships / Customers
 Cellulase Enzymes	\$10 Billion	1-3 years	  
 Biobased Chemicals	\$150 Billion	2-3 years	
 Biofuels	\$1+ Trillion	1-3 years	 
 Pharmaceutical Intermediates	\$2 Billion	Current	   



Targeting high volume and high value products



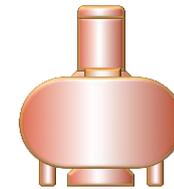
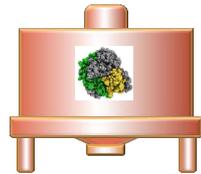
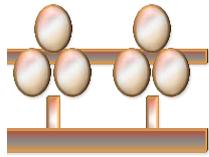
Codexis owns a complete biochemical technology package that can produce both fuels and chemicals





Non-Food Biomass → Bio-Based Fuels & Chemicals

2 Ways to Win in The New Sugar Economy



Feedstock
And
Logistics

Pre-
Treatment

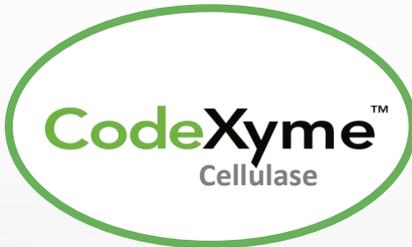
Saccharifi-
cation
Enzymes

SUGAR

Conversion
Micro-
Organism

Refining &
Finishing

Chemicals
& Fuels



Codexis is unique in providing both enzymes and microorganisms for converting biomass to fuels and chemicals



CodeXyme™
Cellulase

**Enzymes to Enable 2nd
Gen Fuels and Chemicals**



CodeXol™
Detergent Alcohol

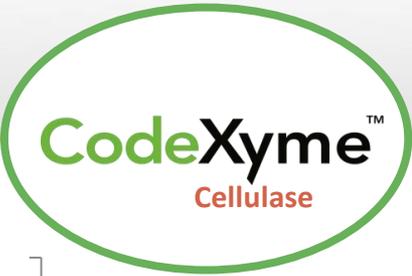
**Bio-Based Chemicals For
Consumer Products**



Pharma

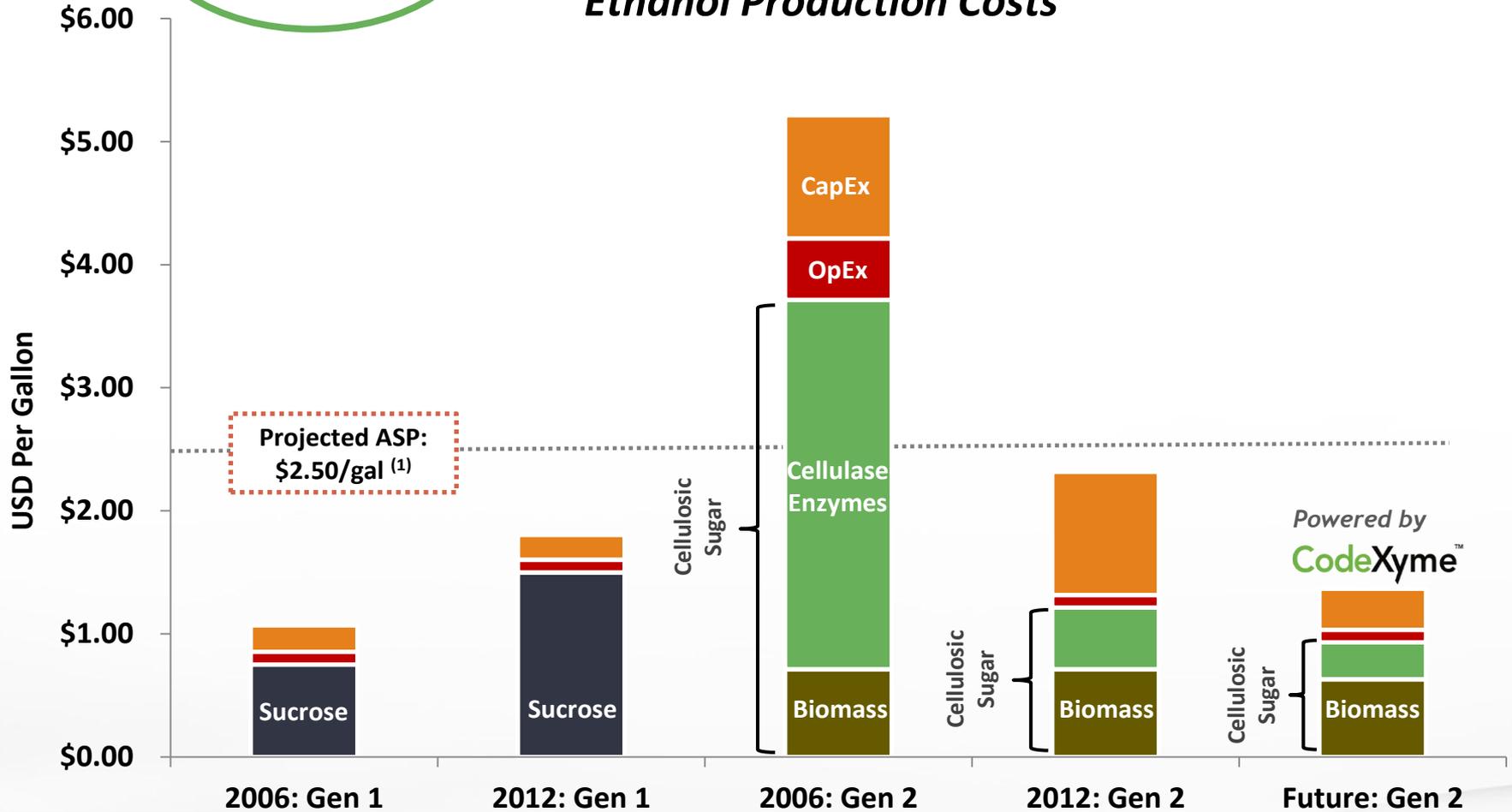
**Established, Growing
Pharma Business**





Enzymes Enable Cost Advantaged Bio-Based Fuels & Chemicals

Ethanol Production Costs

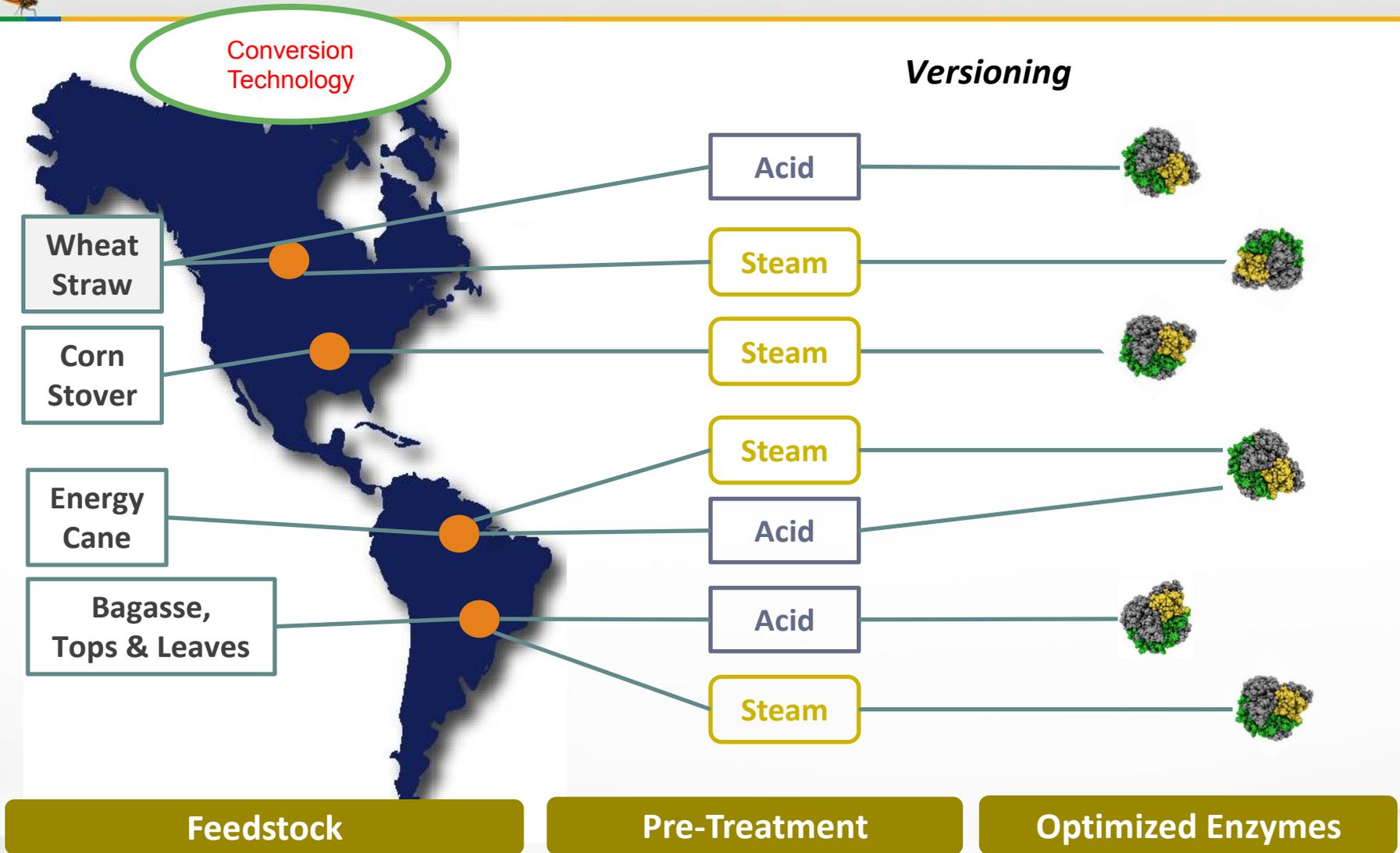


1. Associated with \$3.50/gal gasoline

Source: SRI, Codexis estimates



Optimization for Each Feedstock and Pre-Treatment Combination





Commercialization Roadmap



CodeXyme™ Cellulase Enzyme Product Development



CodeXyme™ Cellulase Enzyme Production





CodeXyme[™]
Cellulase

Enzymes to enable 2nd
Gen Fuels and Chemicals



CodeXol[™]
Detergent Alcohol

Bio-Based Chemicals For
Consumer Products



Pharma

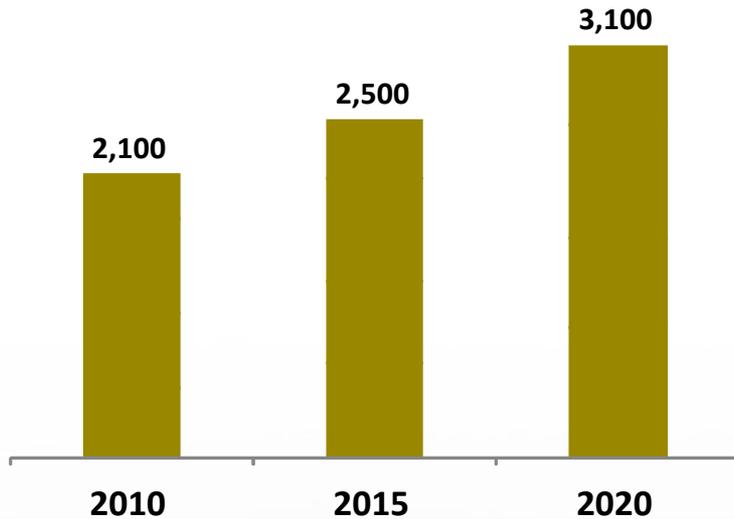
Established, Growing
Pharma Business





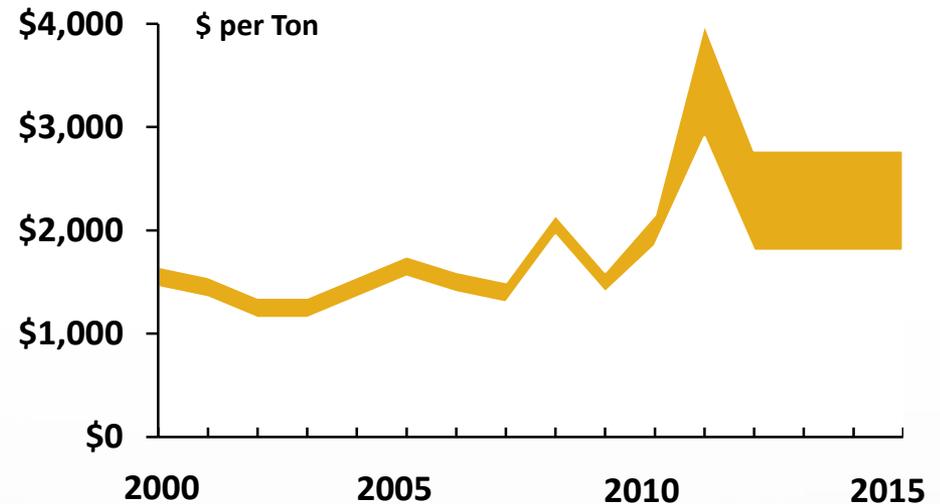
Global Detergent Alcohol Consumption

In thousands of tons



U.S. Detergent Alcohol Prices

Driven by Volatile Palm Oil & Ethylene Prices



Detergent alcohols are converted into surfactants, then formulated into household detergents and personal care products

Largest Customers:





Codexis has the potential to add value to two distinct parts of the detergent alcohol value chain: cellulosic sugar and alcohol production

Feedstock Production

Alcohol Production

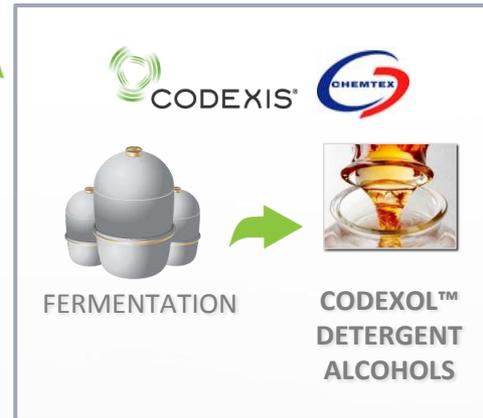
Conversion

Formulation

1ST-GEN



2ND-GEN



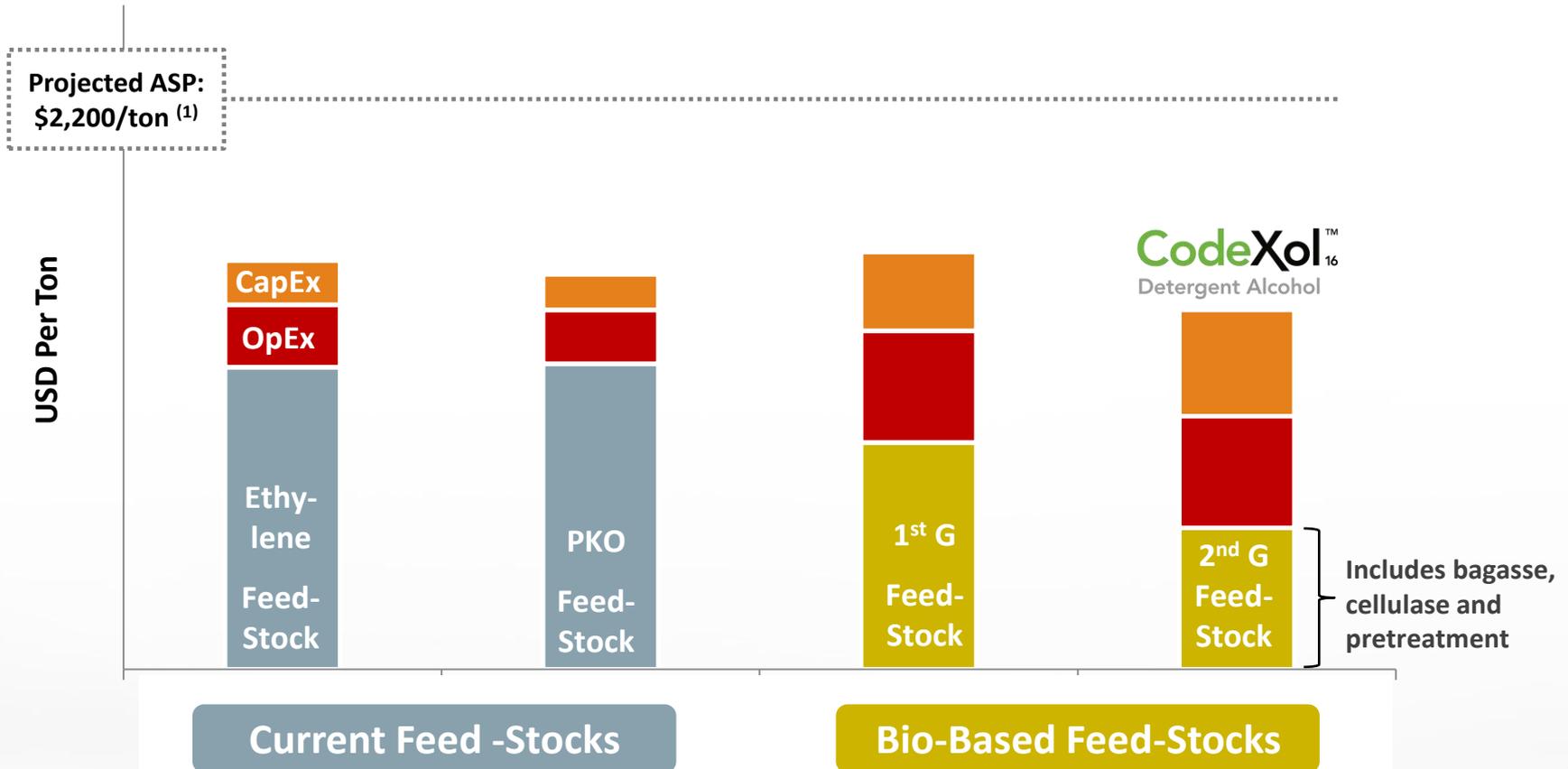
Cost Advantage with potential for Enhanced Performance



Sustainable Feedstocks => Greener Products



Detergent Alcohol Production Costs



1. Assumed to be near-to-medium term ASP for C₁₂/C₁₄ detergent alcohols, according to ICIS and industry guidance.

2. Production cost for sucrose-based route would increase ~\$500/ton if current sucrose costs were used.

Source: SRI Consulting and spot prices for ethylene and PKO routes, Codexis estimates for CodeXol™ detergent alcohol.



Production Scale-Up



Strategic Partnerships

Redwood City, CA

Rivalta

Geography Based

10 L Lab

650L Pilot

1,500 L Demo

40,000-60,000 tons p/a Cmrcl

2011

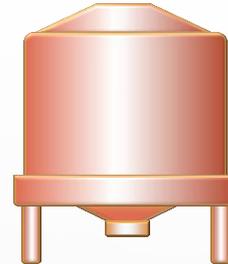
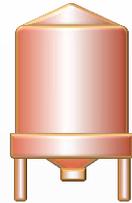


2012

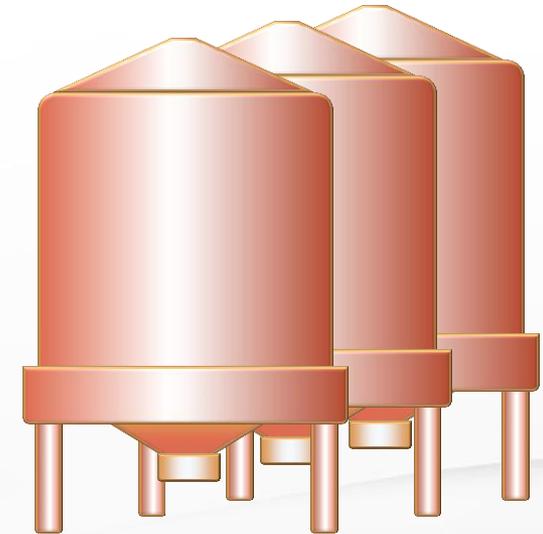


2013

2015+



Fully Integrated Unit Operations





CodeXyme™
Cellulase

Enzymes to enable 2nd
Gen Fuels and Chemicals



CodeXol™
Detergent Alcohol

Bio-Based Chemicals For
Consumer Products



Pharma

Established, Growing
Pharma Business

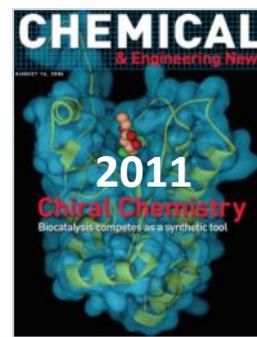




Our Science is Impacting Millions of Lives



2006: Atorvastatin (Lipitor®)
2010: Sitagliptin (Januvia®)
2012: Simvastatin



Intermediates for
the world's biggest
blockbuster



Used in the API
process for new
blockbuster



Three

2011
global
approvals

> 50

customers of
screening and
evolution

Publications highlighted above

Improving catalytic function by ProSAR-driven enzyme evolution. *Nature Biotechnology*, 25, 338 – 344 (2007)

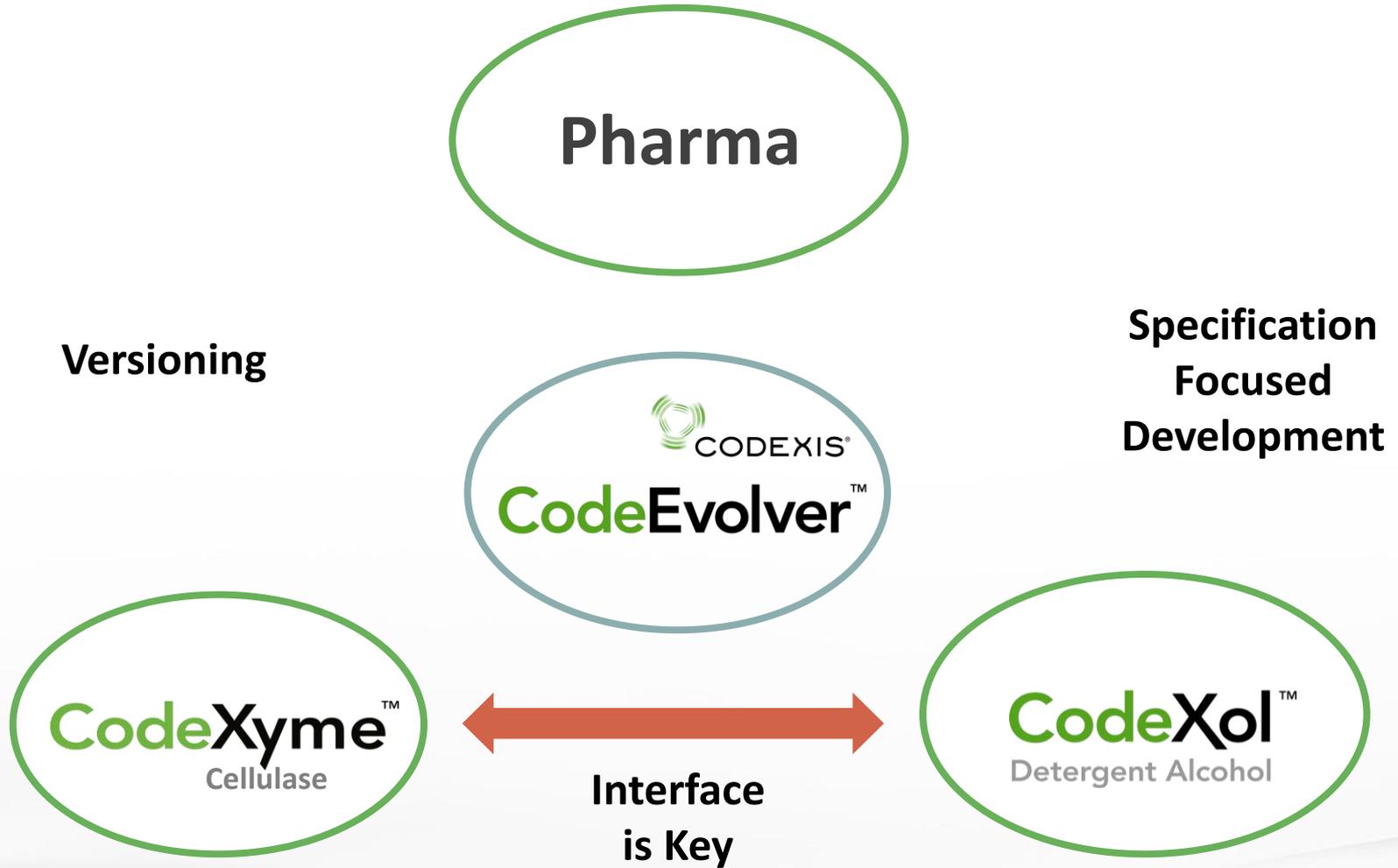
Biocatalytic Asymmetric Synthesis of Chiral Amines from Ketones Applied to Sitagliptin Manufacture. *Science*, vol 329 no. 5989, 305-309 (2010)

Twenty Years of Green Chemistry. *Chemical & Engineering News*, vol 89 no. 26, 62-65 (2011)

Engineering the Third Wave of Biocatalysis. *Nature*, 485, 185-194 (2012)



Core Assets





Codexis: Driving the New Sugar Economy™



Proprietary directed evolution platform for enzyme & microorganism development



Enzymes to enable cost-advantaged, 2nd generation bio-based fuels & chemicals



Cost-advantaged, drop-in for the \$4B detergent alcohol market (first in our pipeline of bio-based chemicals)



Established, growing business with over \$50M in sales



Parting words for DOE

- **Biomass is a highly flexible source of renewable energy**
- **Not only can it produce electrons, but also...**
 - Heat for Industrial usage
 - All grades of Fuels
 - Countless Platform Chemicals
 - Plastics
 - Tars and biochar
- **There are a myriad of biomass pathways – they can't all get funded**
 - Get the front end right:
 - ✓ feedstock, feedstock, feedstock.
 - ✓ Focus on creating large scale availability of low cost intermediates, e.g. cellulosic sugars, syngas, oils.
 - Don't be obsessed by fuels to the exclusion of everything else. Leveraging the flexibility of biomass with higher value products will lower the cost to the Treasury and enable the development of a value chain that will ultimately benefit mass production of low cost fuels.



Driving The New Sugar Economy™

