

The logo for LYGOS, featuring the letters L, Y, G, and S in a bold, black, sans-serif font. The letter O is replaced by a green rounded square containing a white diagonal shape that resembles a stylized 'O' or a drop. A thick blue horizontal line is positioned above the logo, and a black horizontal line with circular end caps is positioned below it.

LYGOS

*Specialty chemicals made naturally
with industrial biotechnology*

Company overview

Founded

2010

Employees

12

Location

Emeryville, CA

\$6.5MM in
Current Financing

Private Financing
4 DOE Grants
3 USDA Grants
2 NSF Grants



Eric Steen
Chief Science Officer



Jay Keasling
Co-Founder; Science Advisor



Jeffrey Dietrich
Chief Technology Officer

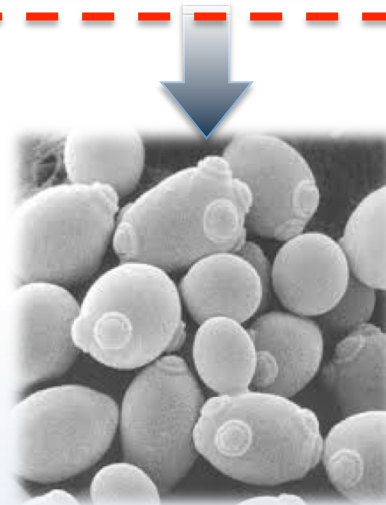
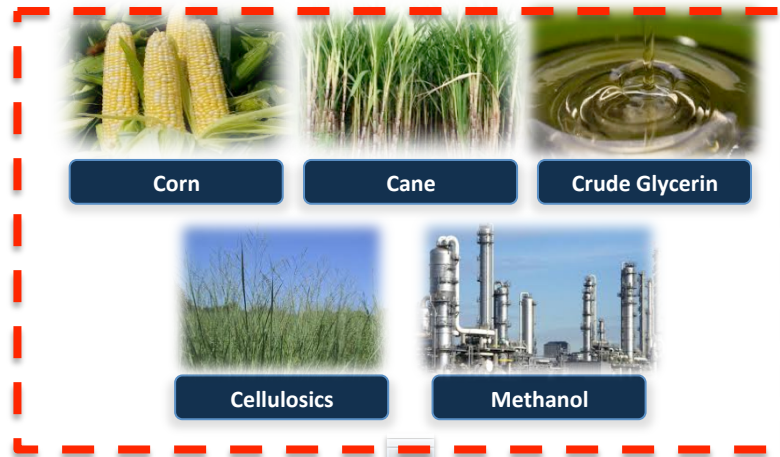


Leonard Katz
Co-Founder; Science Advisor



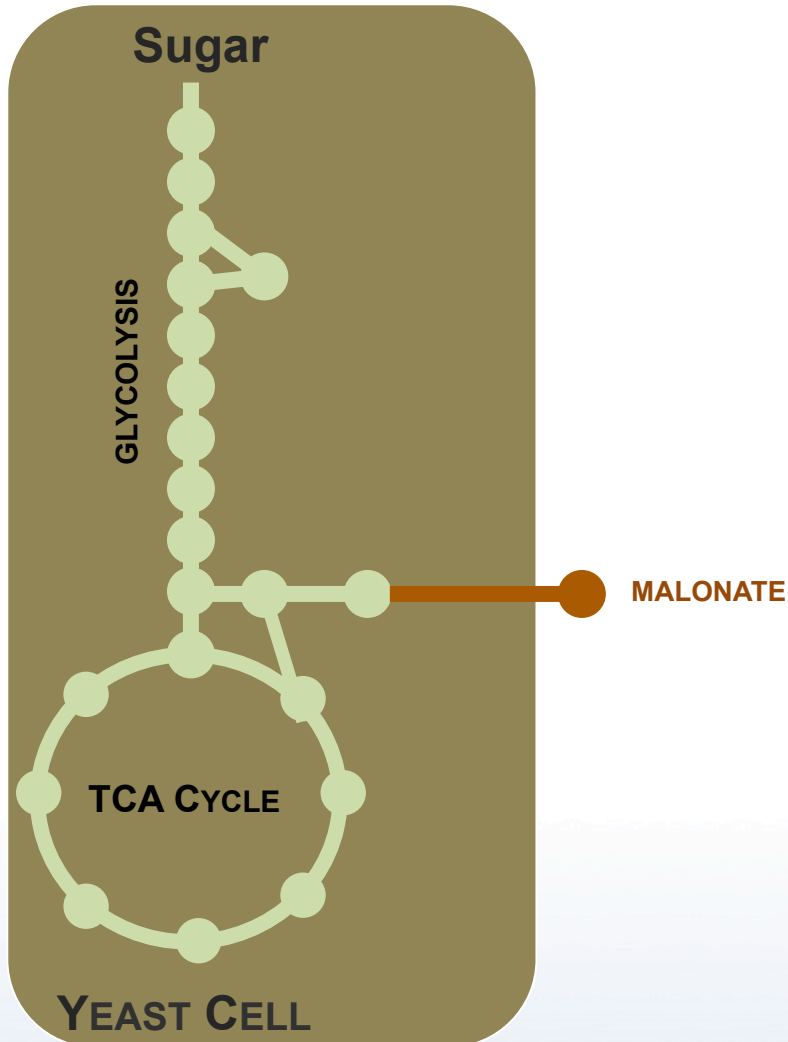
Technology overview: fermentative conversion of sugars

Convert low-cost renewable carbon into high-value fuels and chemicals



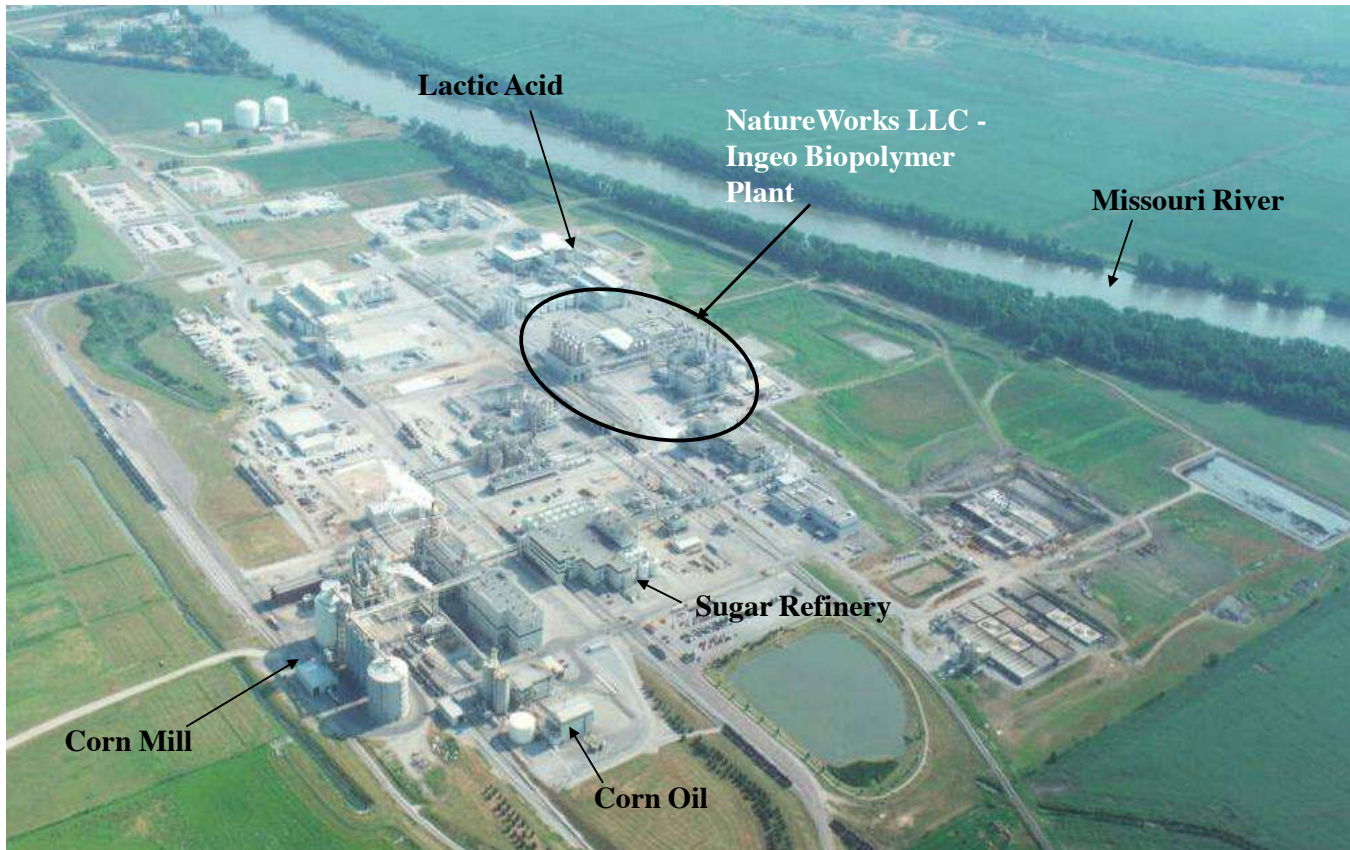
Engineered Yeast

Lygos produces bio-advantaged chemicals



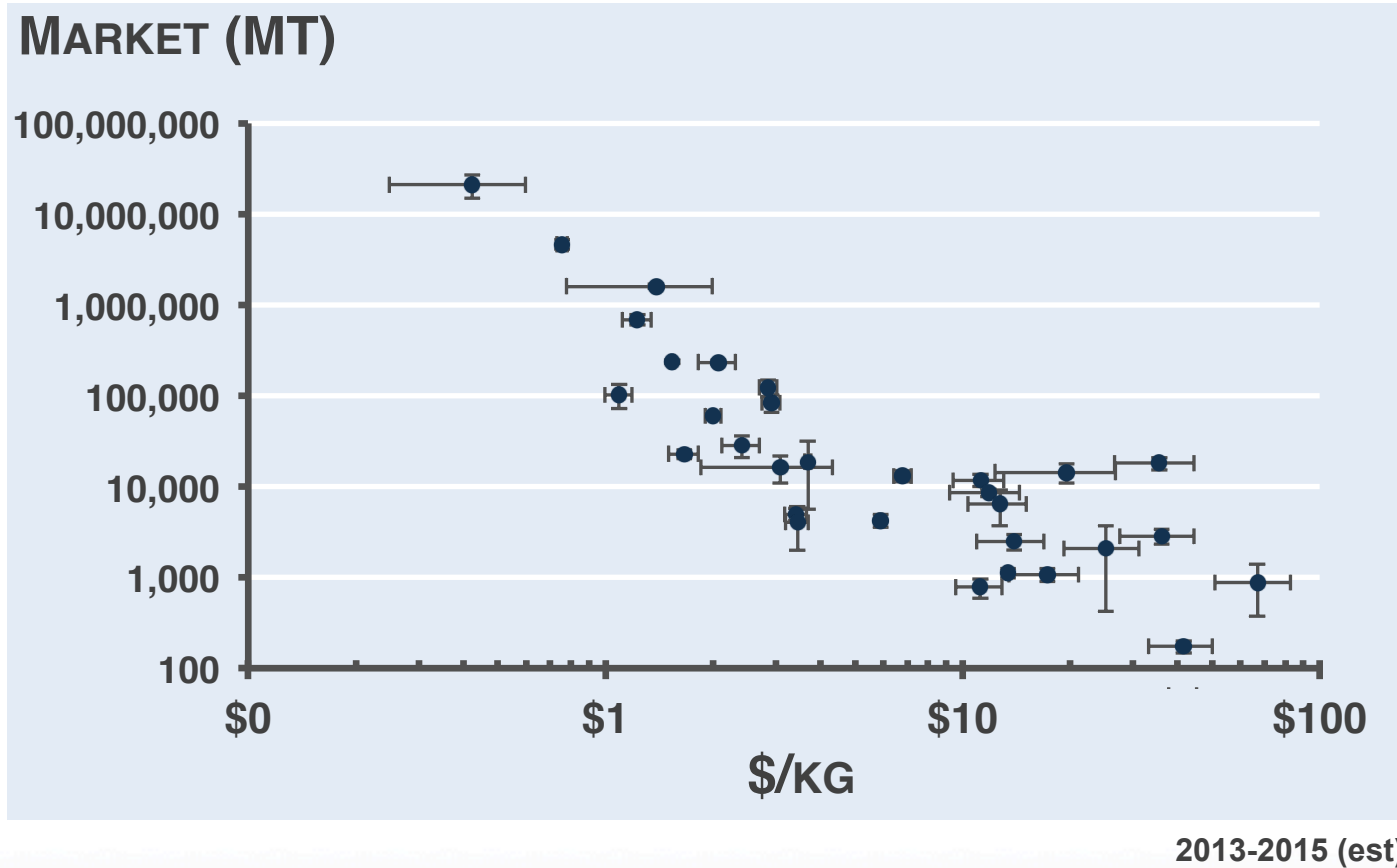
- **Chemicals of Interest**
 - C3 & C4 molecules
 - Carboxylic & amino acids
 - 2-3 steps from acetyl-CoA
 - 2-3 steps from reductive TCA cycle
- **Pathway characteristics**
 - Theor. yield: >100% g/g-glucose
 - Theor. productivity: > 3 g/l/hr
 - Redox balanced
- **Intellectual Property Strategy**
 - Engineered enzymes
 - Genetically modified strains
 - Fermentation process
 - Purification process

Lactic acid, a model bio-advantaged chemical



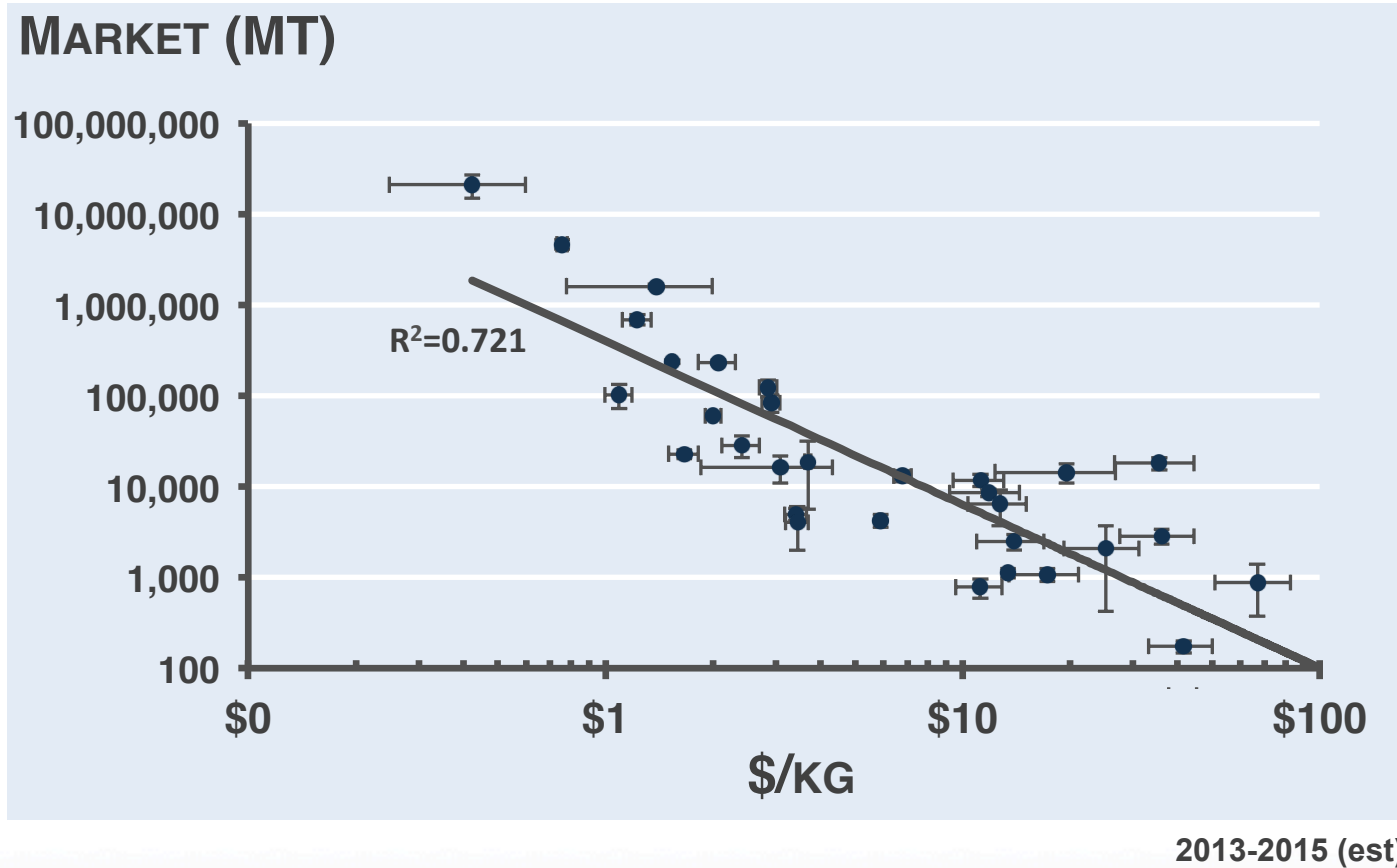
Lactic acid market 1997: ca. 60K MT
Lactic acid market 2015: ca. 500K MT

Identifying market opportunities



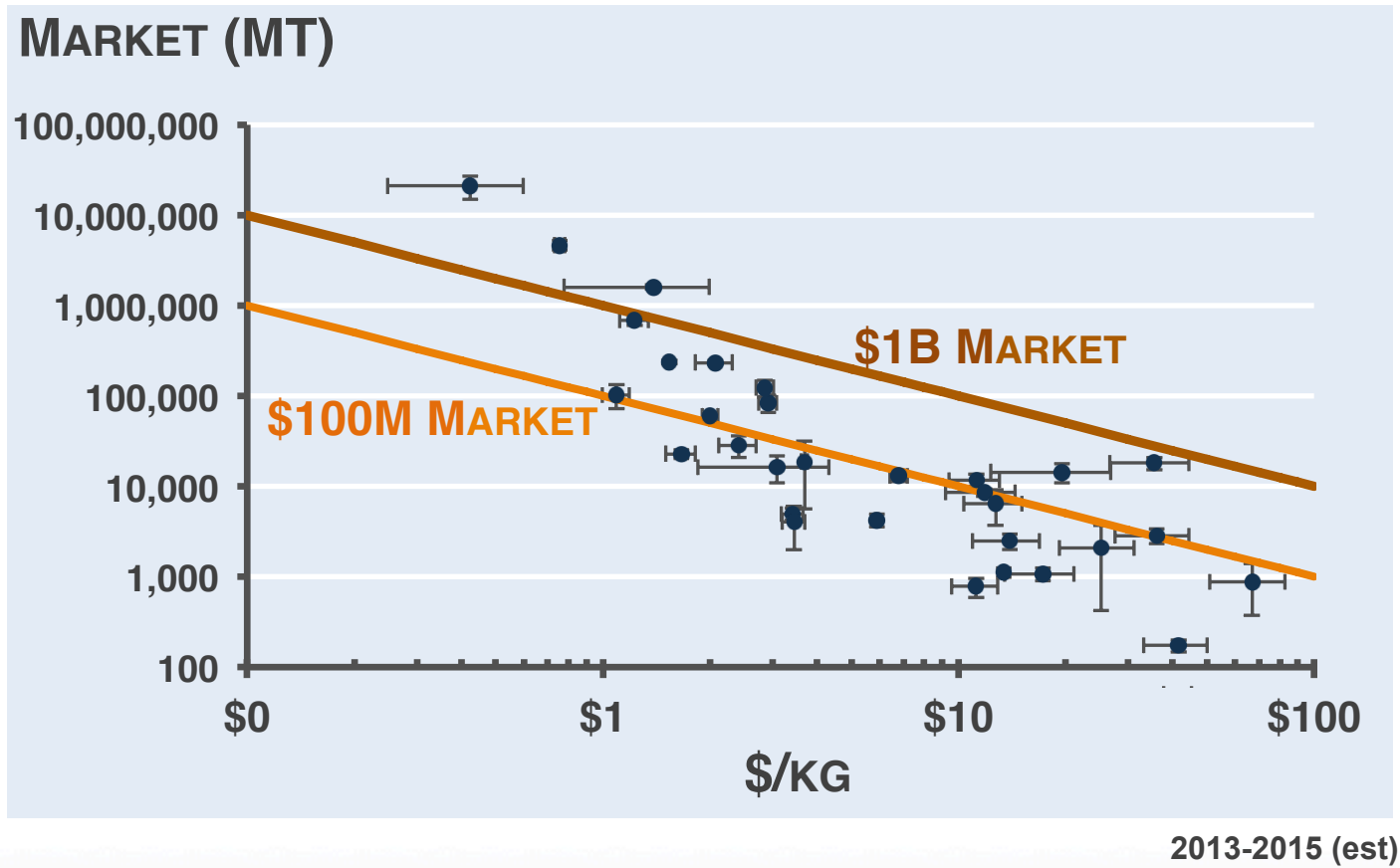
- Good correlation between import volume and selling price
- Range in price of oil (2013-2015): \$45-\$110/bbl

Identifying market opportunities

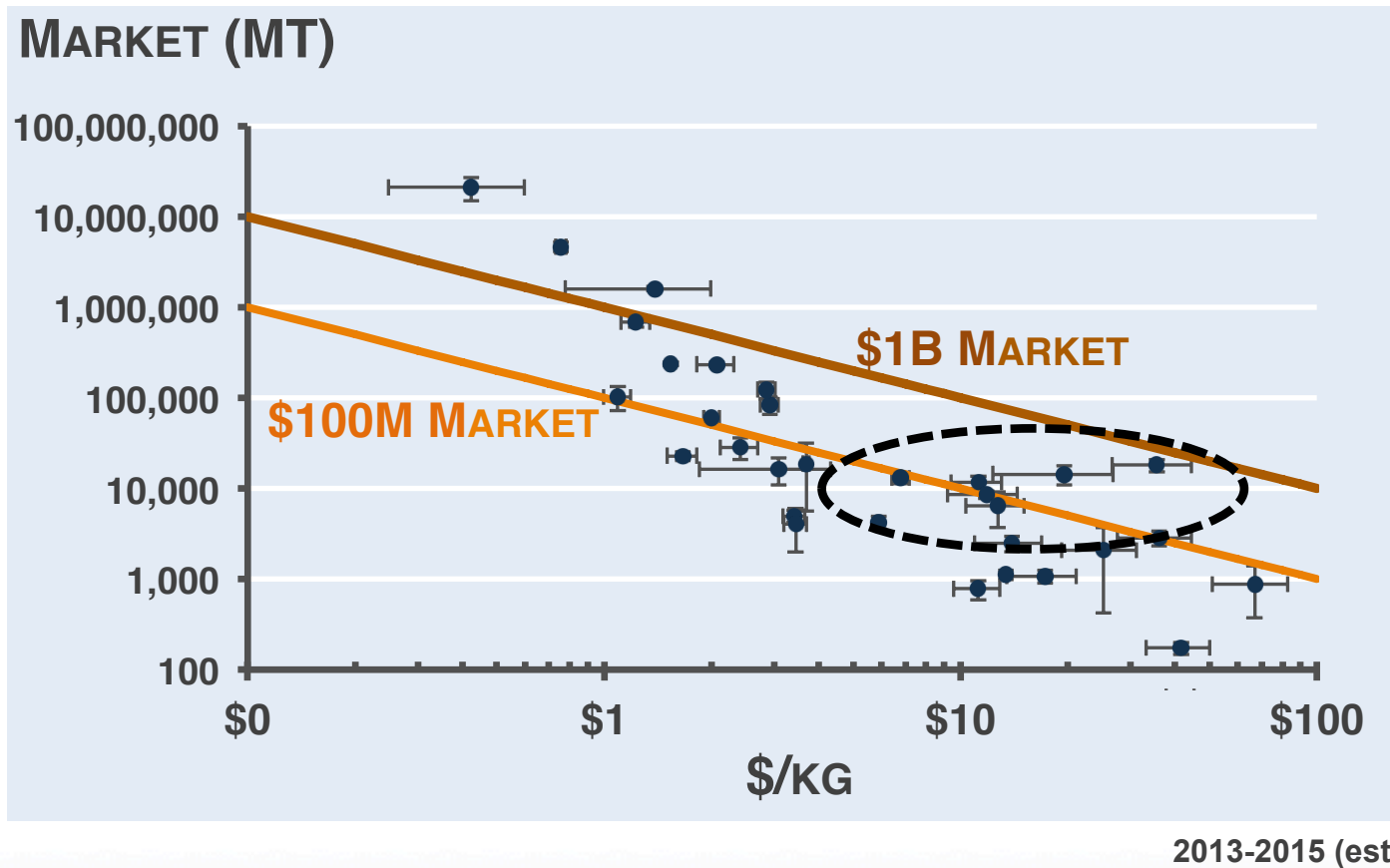


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Lygos produces bio-advantaged chemicals

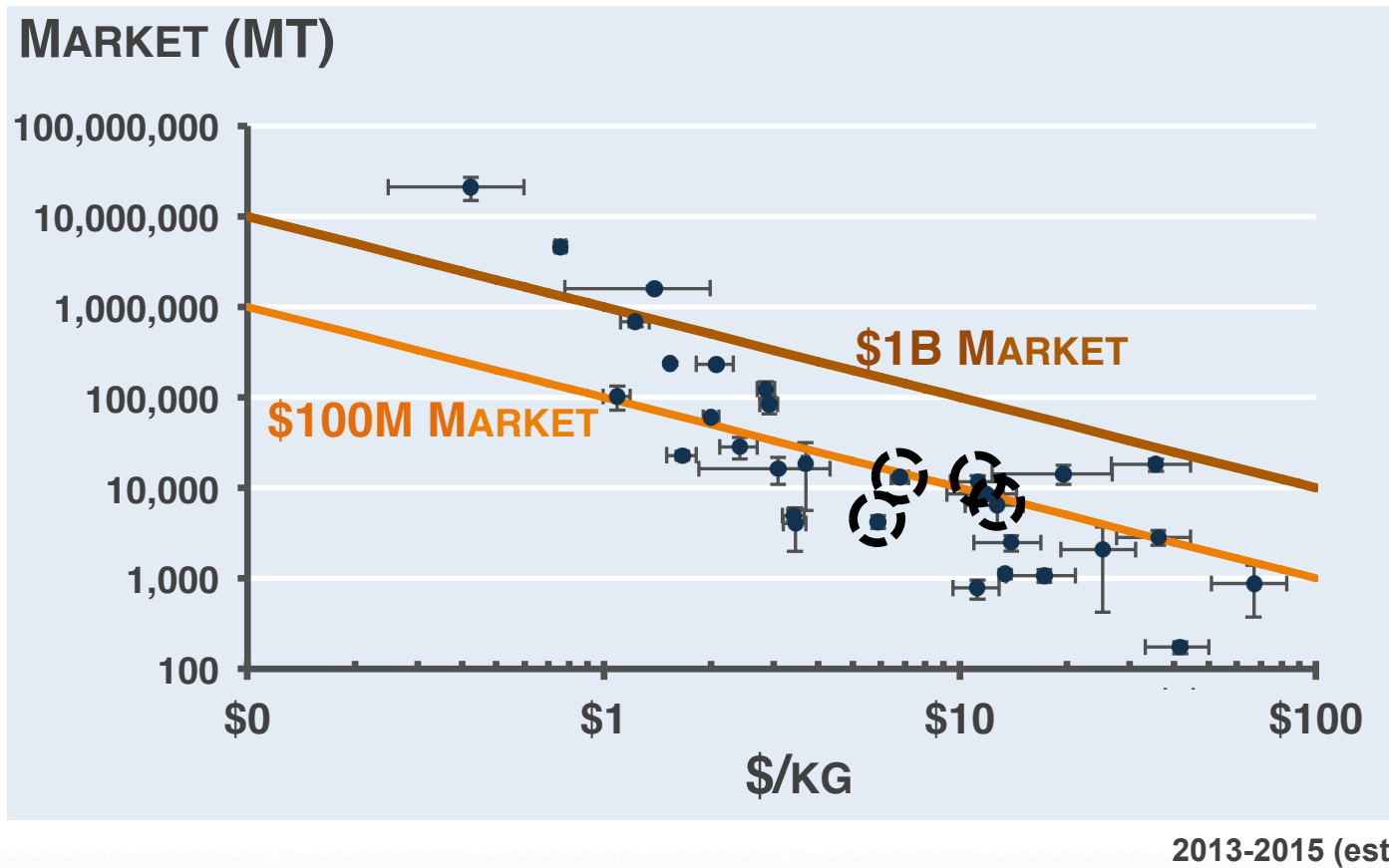


Lygos produces bio-advantaged chemicals



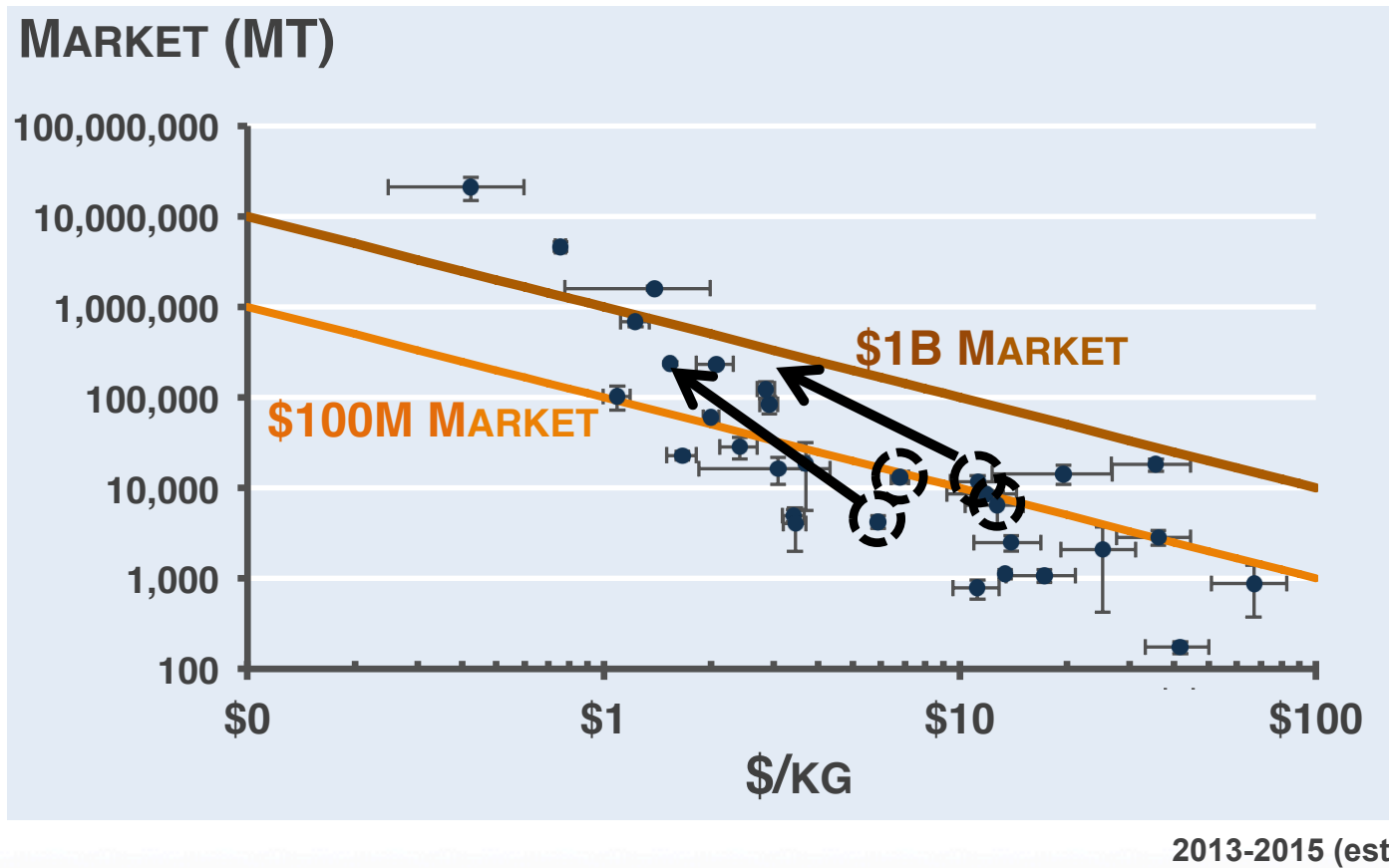
1. Identify chemicals $> \$3/\text{kg}$ (\$75-\$250MM markets)

Lygos produces bio-advantaged chemicals



1. Identify chemicals $> \$3/\text{kg}$ (\$75-\$250MM markets)
2. Identify those where biotech is advantaged over petrotech

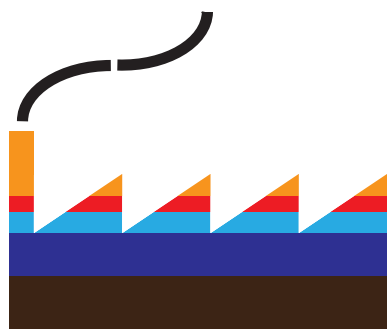
Lygos produces bio-advantaged chemicals



1. Identify chemicals $> \$3/\text{kg}$ (\$75-\$250MM markets)
2. Identify those where biotech is advantaged over petrotech
3. Commercialize those with large market opportunities

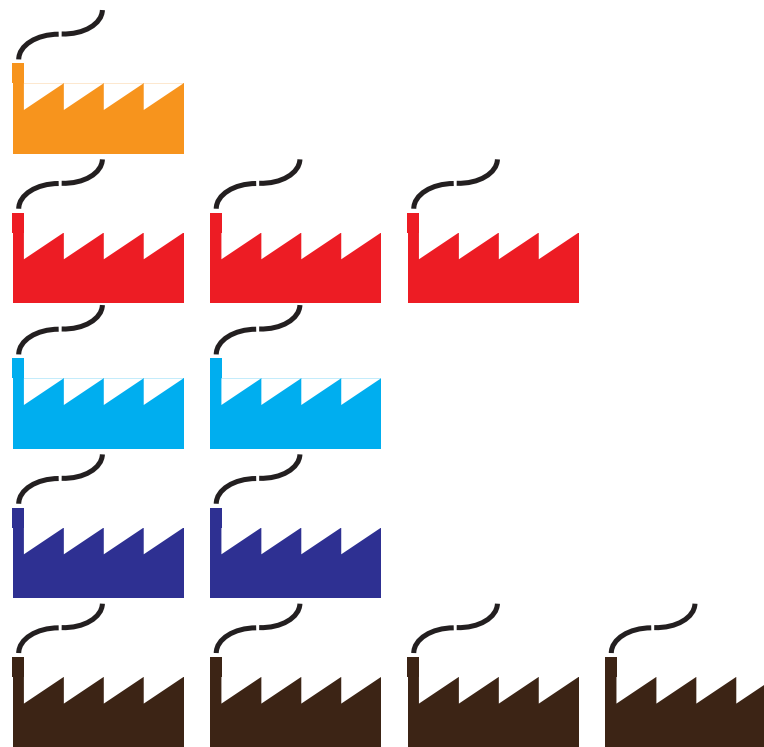
Looking at alternative commercial models

MULTI-PRODUCT PLANT



10K MT facility
\$3/kg min. selling price

EXPANSION INTO DEDICATED PLANTS



- ID chemicals cost-competitive in 2K MT/yr capacity plants
- Economies of scale rt 1: 10K MT, multi-product plant
- Economies of scale rt 2: Large-scale, dedicated plants

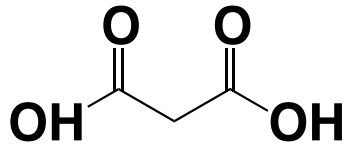
Product #1: malonic acid

Lygos' Industrial Biotech Process



**SUGAR
CO₂**

Lead Product
Malonic Acid



Conventional Oil-Based Process

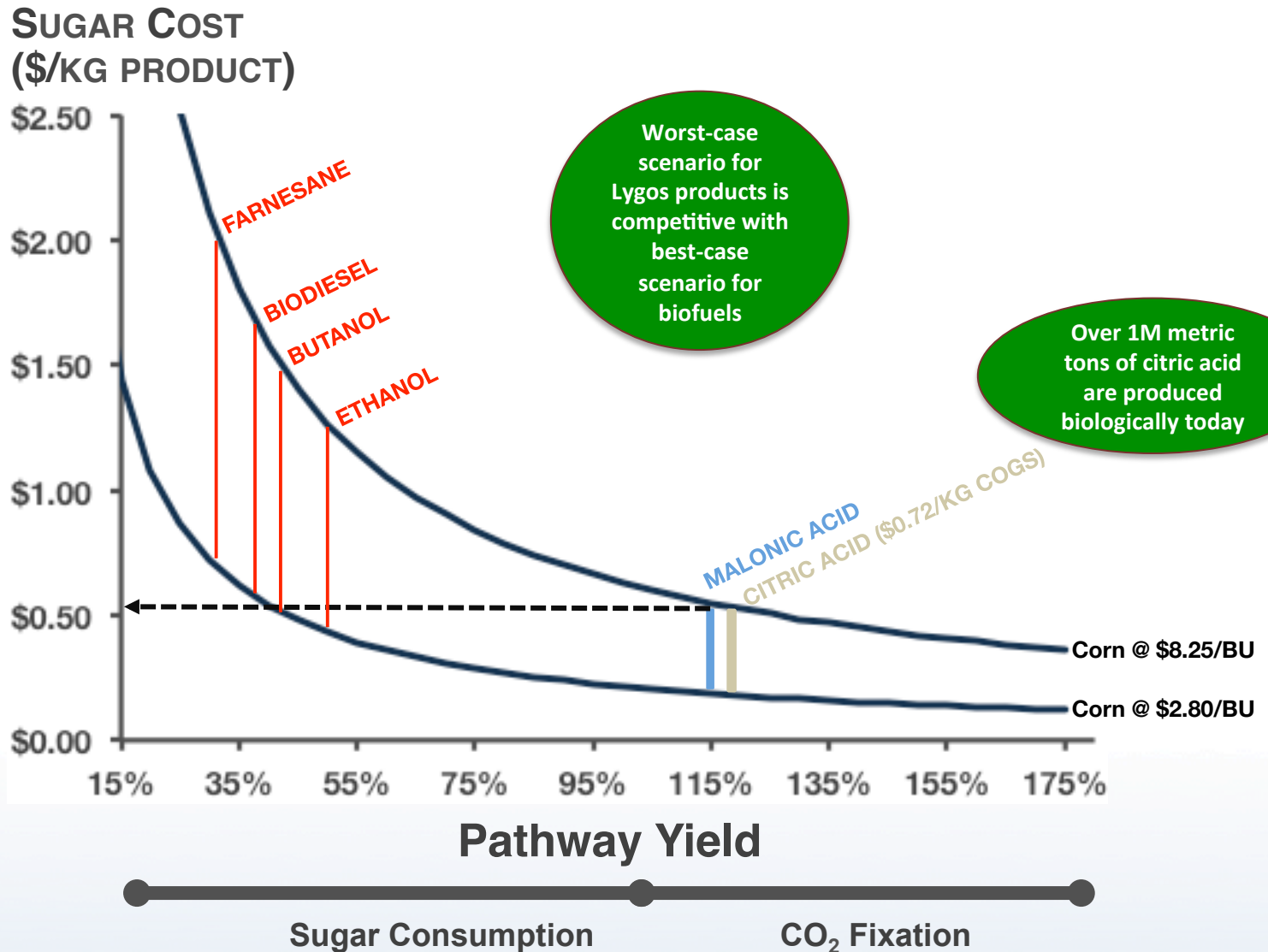


**PETROLEUM
SODIUM CYANIDE**

- *Bio-tech is less expensive than petro raw materials cost*
- *Bio-tech is safer than petro processes*

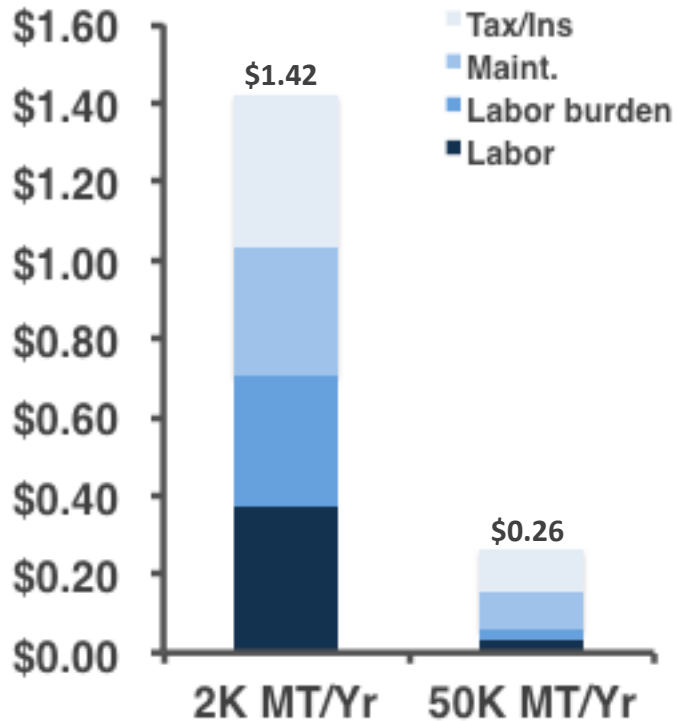
Lygos advantages: cheaper, cleaner, proprietary

OPEX analysis – importance of yield



Fixed cost

\$/KG-MALONATE



	2K MT/Yr	50K MT/Yr
Employee count	16	39
Labor burden	90%	90%
Maintenance	2.5% DFC	2.5% DFC
Taxes/Insurance	3% DFC	3% DFC

DFC: direct fixed capital

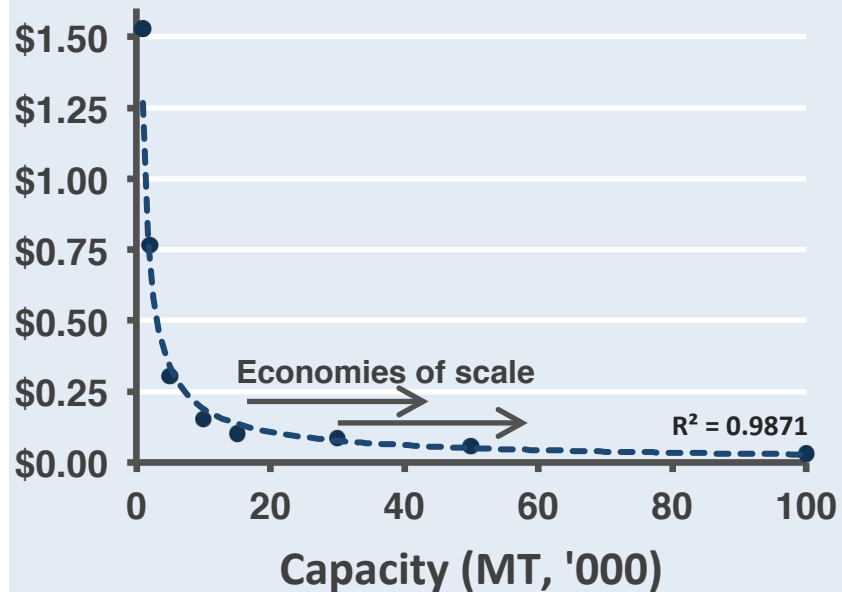
- **Midwest salaries (Glassdoor.com)**
- **Assume salaries are comparable to ethanol industry**

82% decrease in fixed cost moving to larger plant

Fixed cost: Labor

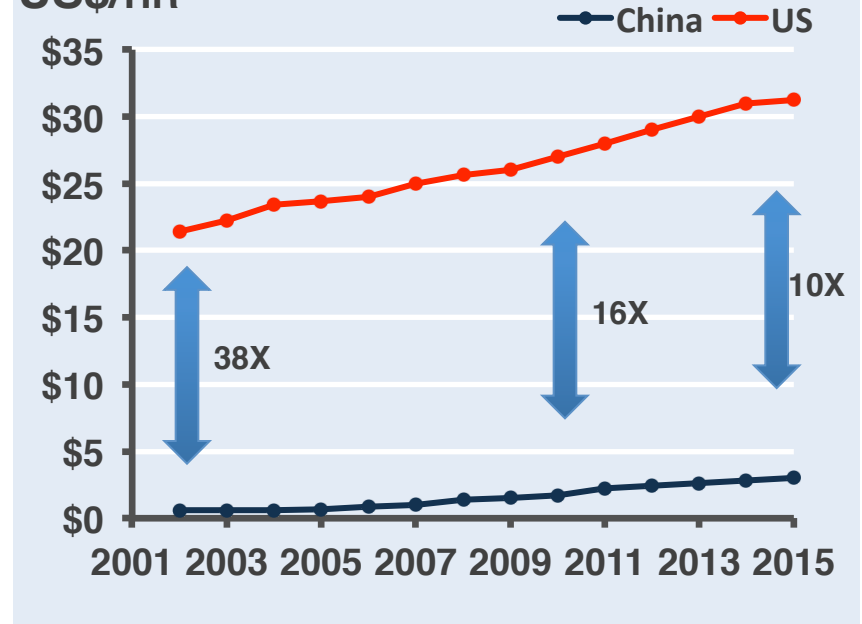
LABOR COST VS. PLANT SIZE

\$/KG-PRODUCT



US VS. CHINA LABOR COST

US\$/HR



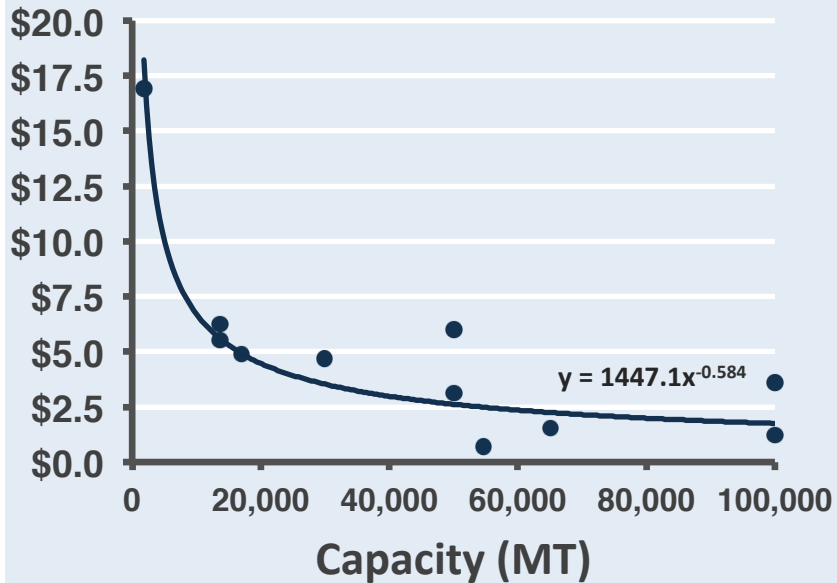
Bureau of Labor Stat.; KKR Global Macro and Asset Allocation

- Economy of scale benefits occur at ~10K MT/Yr plant size
- Labor costs remain significantly cheaper in China as compared to US:
 - 2K MT/Yr scale: China advantage of ca. \$0.70/kg
 - 50K MT/Yr scale: China advantage of ca. \$0.05/kg

CAPEX

EMPIRICAL FACILITY COSTS

FACILITY CAPITAL COST (\$/KG)



	2K MT/Yr	50K MT/Yr
Total Capital Cost	\$29MM	\$150MM
Facility Cap Cost (\$/kg)	\$14.5	\$0.26
Depr. cost (\$/kg)*	\$0.96	\$0.20

* 15 yr straight-line

- Economy of scale benefits occur at ~10K MT/Yr plant size
- 80% depreciation cost savings between 2K and 50K MT/yr plants

Plant Financing: DOE Loan Guarantee

	2K MT/Yr	50K MT/Yr
Loan Amount	\$23.2MM	\$120MM
Phase I App Fee	\$50K	\$50K
Phase II App Fee	\$100K	\$350K
Facility Fee	\$232K	\$1.2MM
Indpt. Consultant Fee	\$250K	\$500K
Maint. Fee (\$/Yr)	\$0.5MM	\$0.5MM

- \$632K fees for 2K MT/yr plant
- \$1.2MM fees for 50K MT/yr plant

\$0.01/kg

\$0.25/kg (equiv. to 2.1% interest rate)

Plant financing: DOE loan guarantee

	2K MT/Yr	50K MT/Yr
Loan Amount	\$23.2MM	\$120MM
Phase I App Fee	\$50K	\$50K
Phase II App Fee	\$100K	\$350K
Facility Fee	\$230K	\$700K
Indpt. Consultant Fee	\$250K	\$750K
Maint. Fee (\$/Yr)	\$0.5M	\$1.5M

- \$632K fees for 2K MT/yr plant
- \$1.2MM fees for 50K MT/yr plant

