



# ***Breaking the Sugar Cost Barrier***

**Biomass 2012  
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***Proterro makes low cost sucrose that unlocks economical production of biofuels and chemicals***

## Not Crop-Based / Not Cellulosic

- Avoids pricing volatility associated with corn and other feedstock markets
- Predictable, reliable source of production

## Fermentation-Ready

- Drop-in replacement for current sugar feedstock
- No further processing required for fermentation
- Easily scalable

## Clean

- Just sucrose (no other sugars)
- Sucrose sampled to potential partners and validated
- Requires little water

# ...While Others Try to Extract Sugar

## Technology Landscape

	Technology Type	Overview	Drawbacks	Players
1st Gen		<ul style="list-style-type: none"> <li>Utilize edible parts of food crops – mainly corn &amp; sugarcane – as carbon feedstock</li> </ul>	<ul style="list-style-type: none"> <li>Subject to substantial volatility in corn, sugarcane, and other feedstock prices</li> <li>Reliant on inherently inefficient feedstock extraction and processing techniques (sugarcane only ~16% sugar)</li> <li>Generally not profitable at today's cost structures – large group of idle plants and spare capacity in the market</li> </ul>	      
2nd Gen		<ul style="list-style-type: none"> <li>Capture agricultural residues and ligno-cellulosic inputs as carbon feedstock</li> </ul>	<ul style="list-style-type: none"> <li>Subject to milder but still significant swings in feedstock prices</li> <li>Very low sugar content</li> <li>Challenging to access sugar: enzymatic / acid hydrolysis or thermochemical techniques involve significant opex</li> <li>Working with multiple types of sugar inputs requires sophisticated pre-treatment and other processing equipment, which translates into greater capital-intensity</li> </ul>	    

***Proterro offers a unique concept: directly make sugar***  
***Others develop engineered bugs or processes to access sugar in nature***

# Converting Sunlight to Fuels & Chemicals



CO<sub>2</sub> + H<sub>2</sub>O  
+  
Nutrients



## Sugarcane, Corn, Cellulose



Growth  
\$



Harvest  
\$



Logistics  
\$



Process  
\$

- Complex; Labor, capital & energy intensive



Refine



Fuels &  
Chemicals

CO<sub>2</sub> + H<sub>2</sub>O  
+  
Nutrients



- Significantly higher productivity per acre

## Proterro Sucrose

- Lower cost than sugarcane, corn or cellulose



Alcohols

Oils

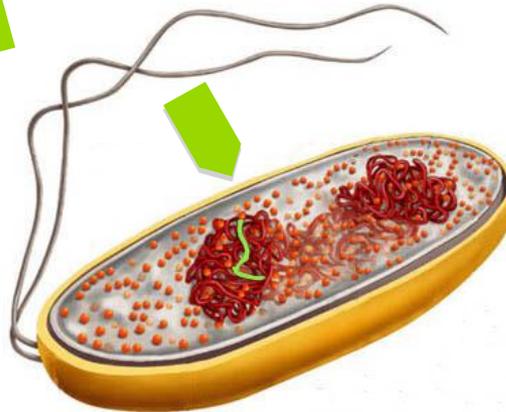
Hydrocarbons

Organic Acids

# Breakthrough Sucrose Producing Organism



**Natural System**  
*Cyanobacteria*  
+ salt = sucrose



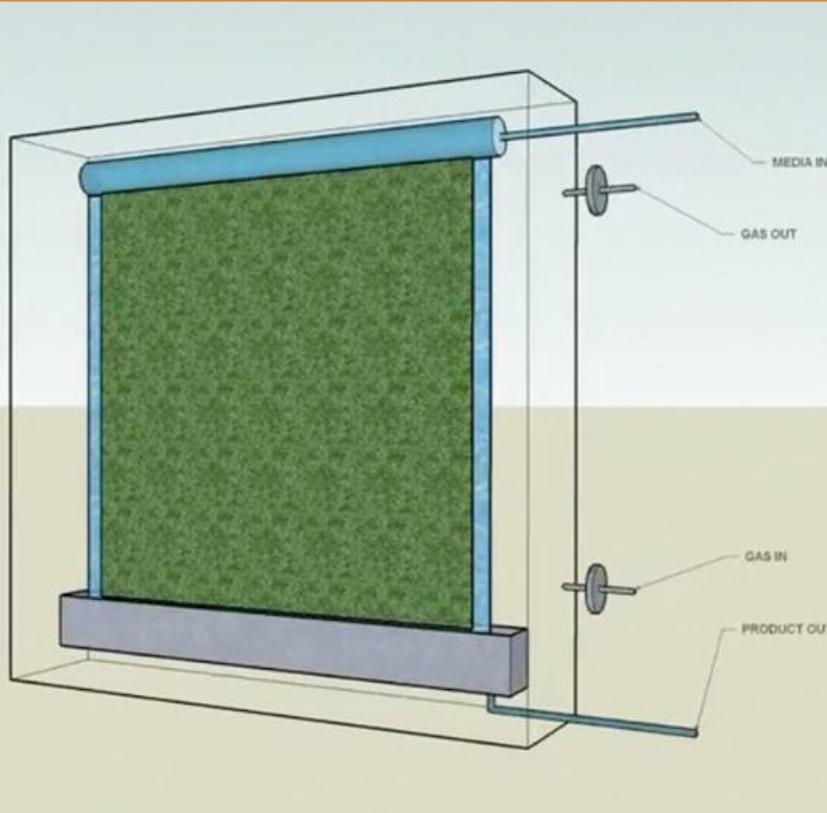
**DNA Manipulation**



**Production strain:**  
*continuous sucrose*  
*production*

# Disruptive Bioreactor and Plant Design

## Solid-State Photo-Bioreactor

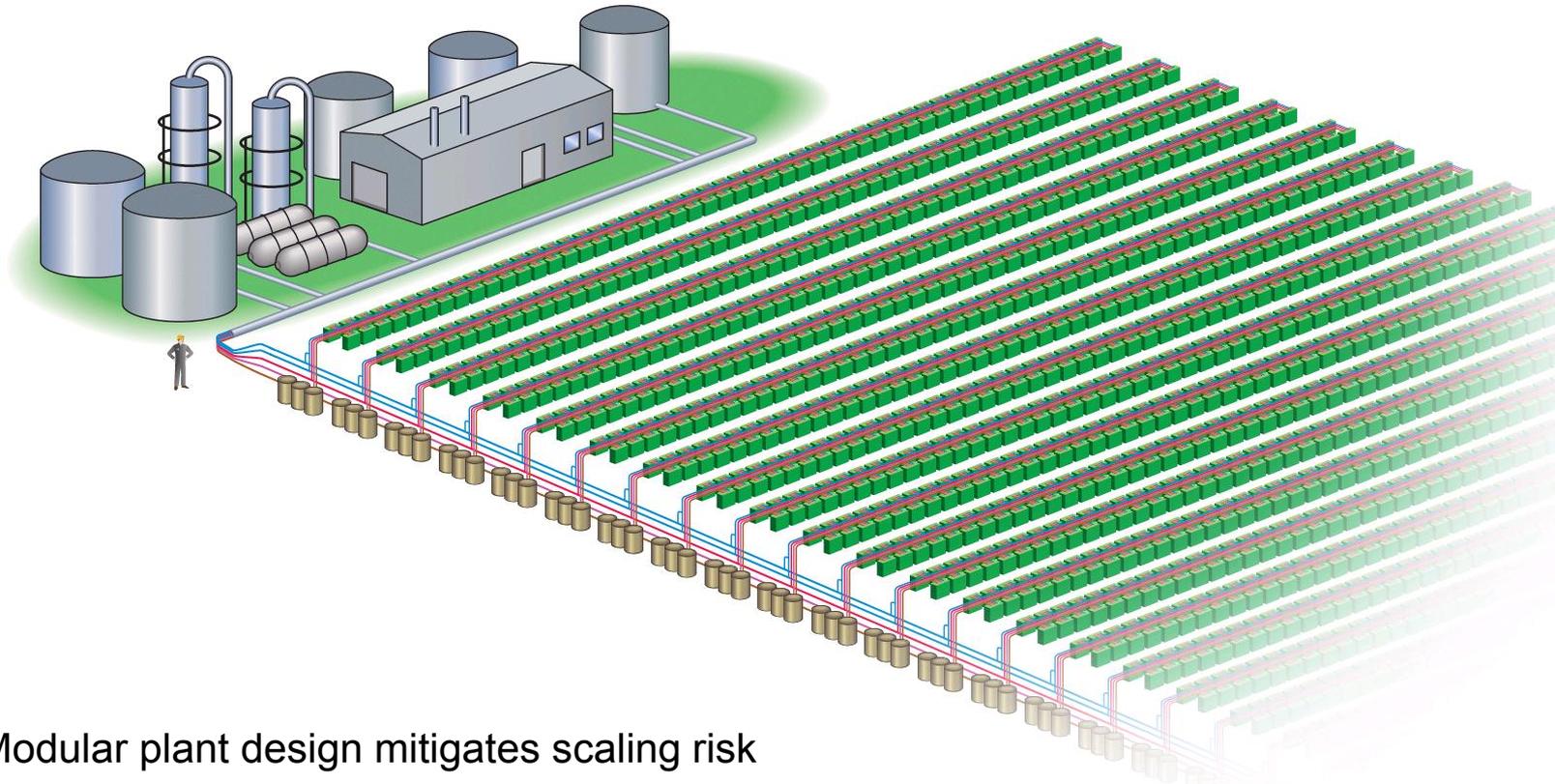


## Advantages

- ▲ Preliminary plant design developed with Battelle and chemical engineering consultant
- ▲ Nothing exotic or elaborate (no high pressure / high temperature equipment)
- ▲ Efficient CO<sub>2</sub> and water use
- ▲ Modular system
- ▲ Minimal scale-up risk (just add bioreactors), de-risking commercialization process
- ▲ Incremental \$3.40/gallon ethanol capex

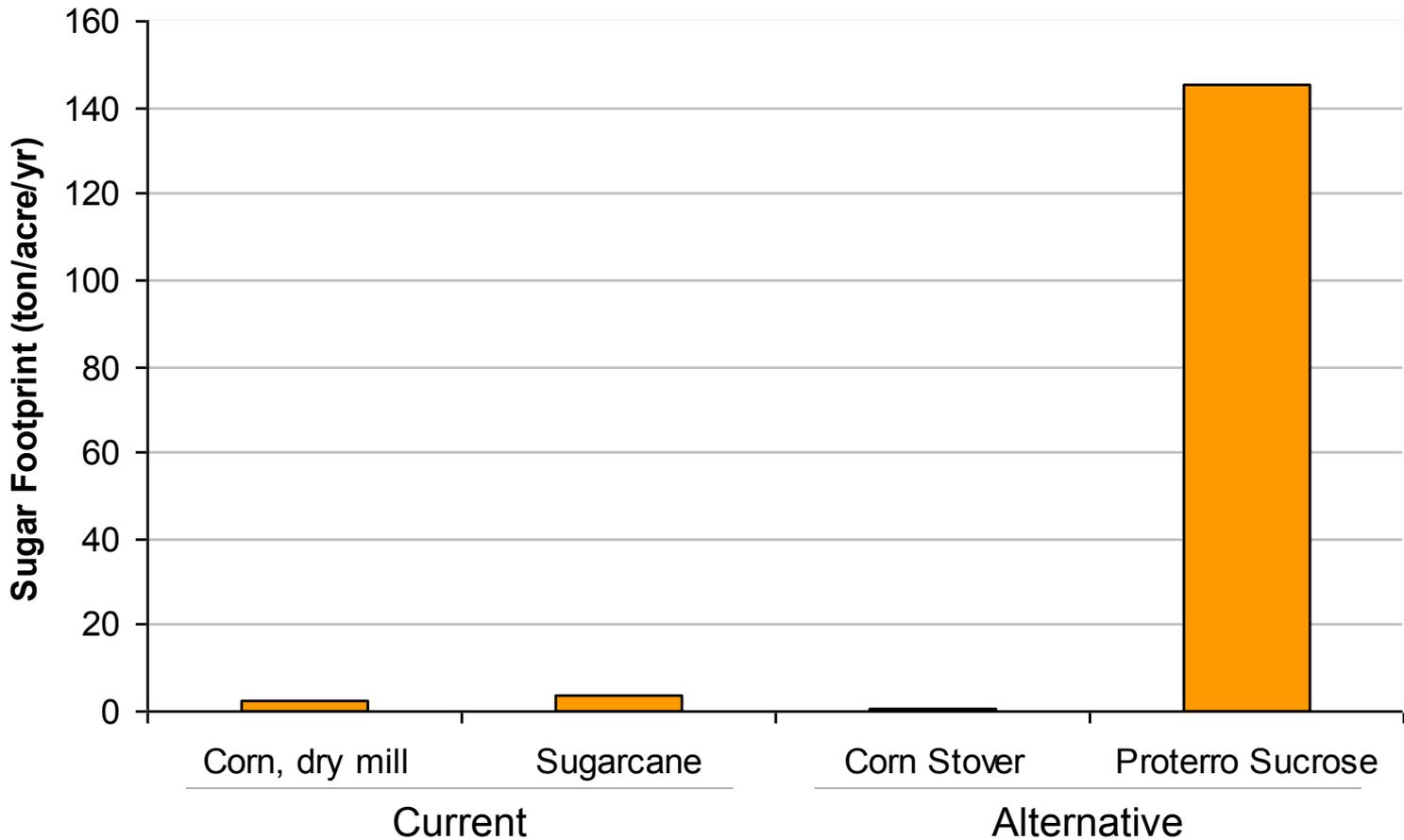
***3D format and modular design substantially reduce capex***

# Preliminary Plant Design Complete



- Modular plant design mitigates scaling risk
- Capex all basic equipment: capex projected at 35-60% cheaper than most cellulosic

# Sugar Productivity per Acre



***Demonstrated 30x Greater Productivity than Sugarcane***

# Proterro Unit Economics

## Capex

- Capex projected at 35-60% cheaper than most cellulosic
- Capex all basic pipes, tanks and pumps (no exotic or elaborate equip)
- Battelle and engineering consultant have validated capex build

## Opex

- No biomass feedstock = industry leading opex
- At scale opex projected <\$0.05/lb\*

## Investor Returns

- No biomass feedstock, simple equipment, low capex = high IRRs
- Unlevered project IRRs projected >40%

***Proterro's disruptive unit economics can restore an uneconomic industry to profitability***

\*Proterro opex shows fully-baked opex including depreciation; excluding depreciation opex ~\$0.02/lb

# Proterro Unit Economics Comparison



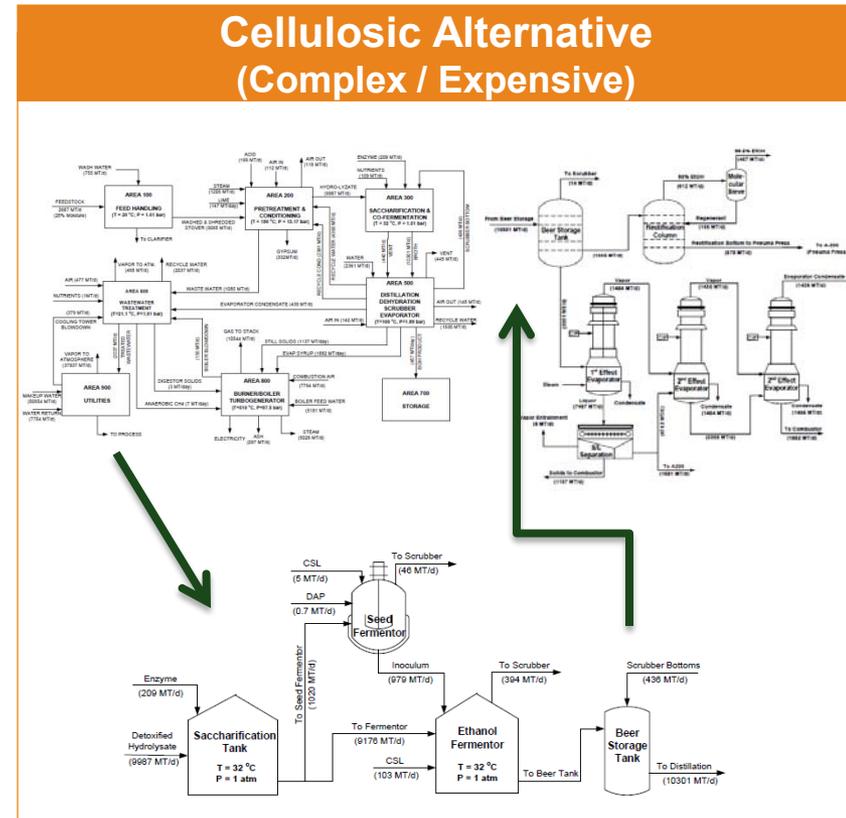
Proterro Unit Economics Comparison - Ethanol				
	Proterro		Ethanol	
	Ethanol		1st Gen	Cellulosic
Plant size	600.0	mm lbs	50.0	50.0 mm gal
Plant capex	\$169.8	\$ mm	\$87.5	\$400.0+ \$ mm
Capex per gallon of ethanol equiv	\$5.15	\$ / gal	\$1.75	\$8.00+ \$ / gal
Feedstock opex per unit	\$0.02	\$ / lb	\$2.38	\$0.87 \$ / gal
Total opex per gal ethanol equiv	\$0.98	\$ / gal	\$2.39	\$2.30 \$ / gal
EBITDA	\$92.0	\$ mm	(\$8.7)	\$16.5 \$ mm
Total EBITDA per gal ethanol equiv	\$1.24	\$ / gal	(\$0.17)	\$0.33 \$ / gal
Unlevered plant IRR	44.8%		Currently Negative	Single Digit
Partner IRR	33.5%			

Detailed assumptions on next slide

Note: 1<sup>st</sup> Gen ethanol plant depicts US corn ethanol plant; Proterro economics projected at commercial scale; assumes \$0.15 per lb internal transfer price for Proterro sugar and \$2.10 per gallon ethanol per current ethanol spot price

# Capex Comparison

- Plant design consists of disruptive solid phase photobioreactors connected with pipes and fittings
- Water, CO<sub>2</sub>, and sucrose at room temperatures allows use of low cost materials
  - PVC Piping
  - Low cost storage tanks
- Competitors use complex thermochemical or biological process requiring exotic equipment and enzymes
  - Steam
  - Acid
  - Supercritical water



***Pipes & plumbing vs. exotic thermochemical equipment***

# Strong Value Proposition for Partners



Unique Benefits

Sample Opportunities

## First Generation Ethanol

- Largest challenge is feedstock price volatility
  - Largest driver of financial performance & stock price
  - Companies required to be specialist in commodity hedging
- State & Federal incentives under attack
  - Concern about food vs. fuel
  - Significant CO<sub>2</sub> footprint

## Renewable Fuels & Chemicals

- Stable, reliable source of sucrose is major challenge
  - Forcing some to look at locating internationally just for access to stable feedstock
  - Commodity hedging not a core competency (worse than first gen ethanol)
- Need high purity feedstock streams
  - Bioengineered organisms are highly susceptible to any contaminants

## Biogas / Other Unique Markets

- Need recurring stable feedstock
- Sucrose is easily digestible / high yield feedstock
- Produce waste CO<sub>2</sub> feedstock
  - Regulatory pressure to mitigate CO<sub>2</sub> footprint



# Case Study: First Gen Ethanol



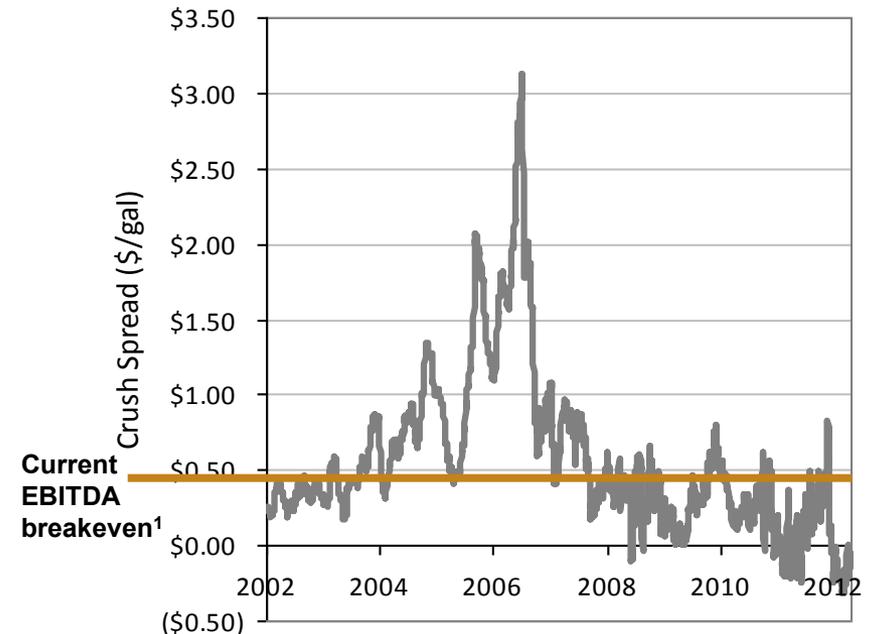
## Sucrose Feedstock JV



### First Gen Ethanol Co.

- Realize substantial cash flows from JV
- Have guaranteed off take for product
- Access to low-cost CO<sub>2</sub> stream
- Partner capital to finance project equity
- Lock-in low cost feedstock
- Increase margins/IRR of ethanol business
- Realize substantial cash flows from JV (~30% IRR) – ~2X+ better ROI than alternative uses of capital
- Eliminate carbon footprint & resulting regulation risk

## Historical Ethanol Crush Spread

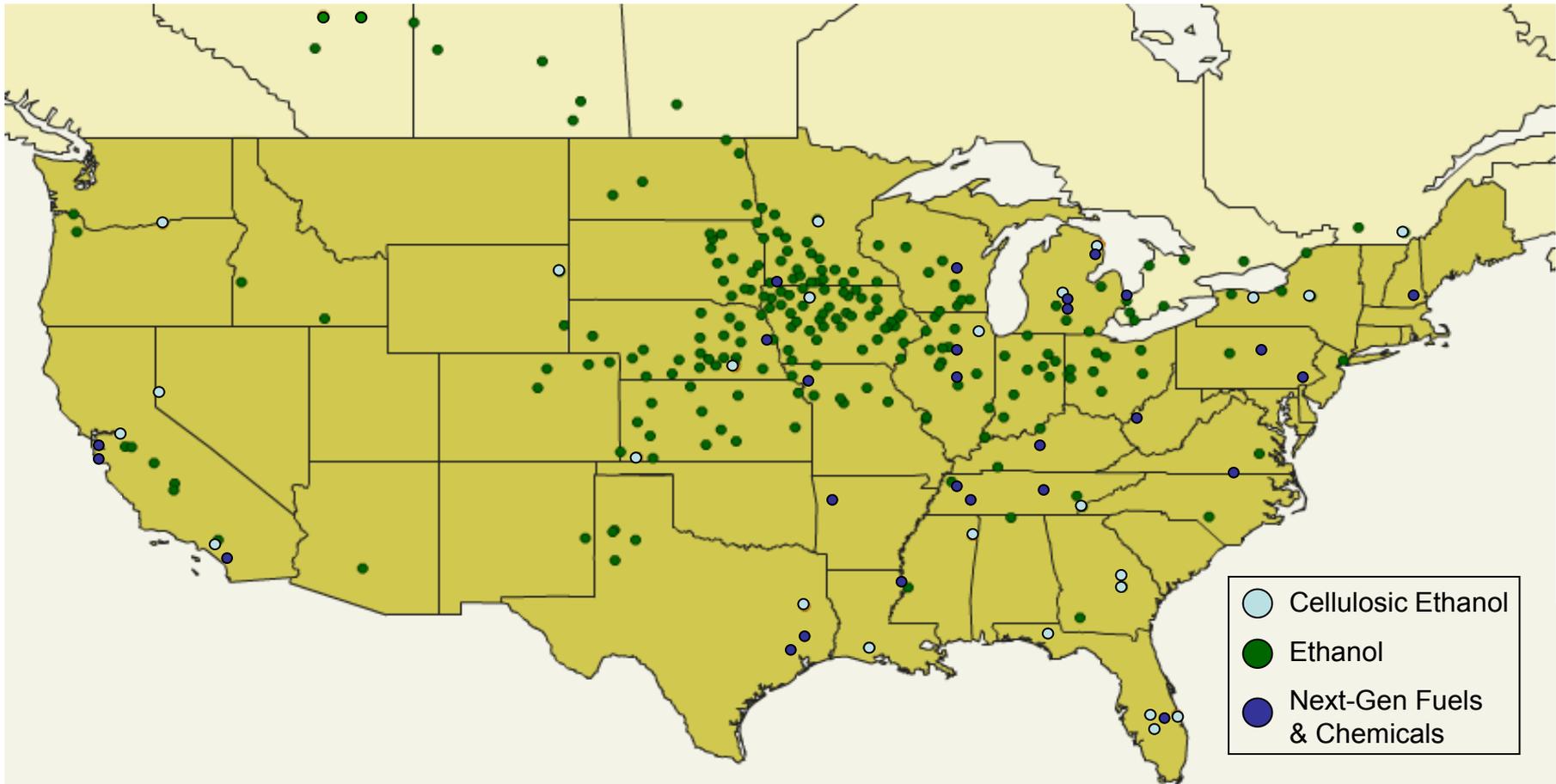


**Proterro solves the greatest challenges facing first generation ethanol: feedstock price & volatility**

Source: Capital IQ, CBOT spot prices for corn and ethanol; crush spread reflects different between ethanol spot price and corn spot price / 2.8

(1) Assumes \$0.15 /gal utilities; \$0.10 other variable cost; \$0.12 fixed costs \$0.10 debt coverage

# North American Example: Significant Partner Opportunities



***211 ethanol facilities in North America, 29 next gen fuels & chemicals  
and numerous other opportunities such as biogas***

# Accomplishments to Date

## Technology

- Genetic engineering successful
  - Proprietary, targeted chromosomal modifications
  - Novel expression system: unique promoter, no stress
  - 35x greater productivity than sugar-making crops
- High sucrose productivity demonstrated
  - Sucrose sampled to potential partners & validated
  - Consistent over 3 months continuous operation

## Engineering

- Bioreactor & scale-up demonstrated; preliminary designs
  - Replicated in the lab and at two greenhouse sites
  - No contamination; no impact on productivity when deliberately contaminated
- Preliminary plant layout / capital equipment list completed

## Economics / Market

- Robust & validated model shows industry leading sugar cost, lower capex
- Significant market opportunity
- Discussions with multiple potential partners

# Summary

## *Delivering Exceptional Economic Returns and Enabling Multi-Billion Dollar Markets*

**Proprietary, Disruptive Technology Platform Offers Sugar <\$0.05/lb**

**Simple, Scalable Plant Design Creates Low Risk Path to Market**

**Large and Existing End Markets Realizing Significant Growth**

**Compelling Partnership Story Creates Capital Light Path to Market**

**Unlocks Economical Production of Biofuels and Chemicals**

**Experienced Team with Strong Investors and Advisors**



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