Cellulosic Sugar as a Fuel or Bio-product Intermediate

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Catchlight Energy™
A Chevron | Weyerhaeuser Joint Venture

Catchlight Energy Integrates the Value Chain

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):

- **Provides feedstock supply & product off-take services to cellulosic biofuel producers**
- **Develops & acquires technology for the conversion of biomass to transportation fuels**
  - **CLE is interested in collaborating with companies on feedstock aggregation and conversion technology.**

Outline

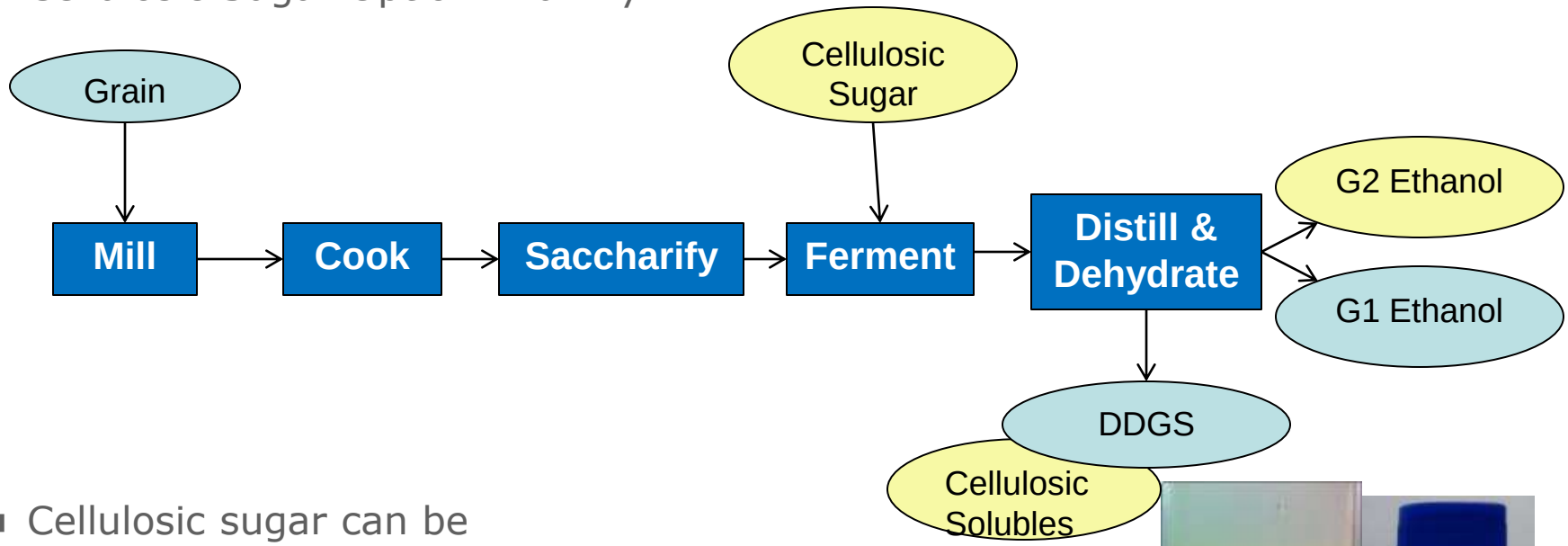
- Integration of Cellulosic Sugars into a Generation 1 ethanol plant
- CLE Developments

Value of Co-Producing Ethanol from Cellulosic Sugar

- Renewable Fuel Standard 2 (RFS2) Requires Cellulosic Biofuels
  - Cellulosic incentives add significantly to the effective price of ethanol
  - Incentives have potential to hedge against low ethanol price
  - Mandate grows to match available cellulosic biofuel production
- Feedstock price stability
  - Corn prices have doubled in the last 7 years
  - Woody (cellulosic) feedstock prices have been more stable
  - Corn stover is also an emerging opportunity for cellulosic biofuel
- Relieve pre-fermentation bottlenecks

Cellulosic Sugar Addition

- Cellulosic Sugar Option in a Dry Mill

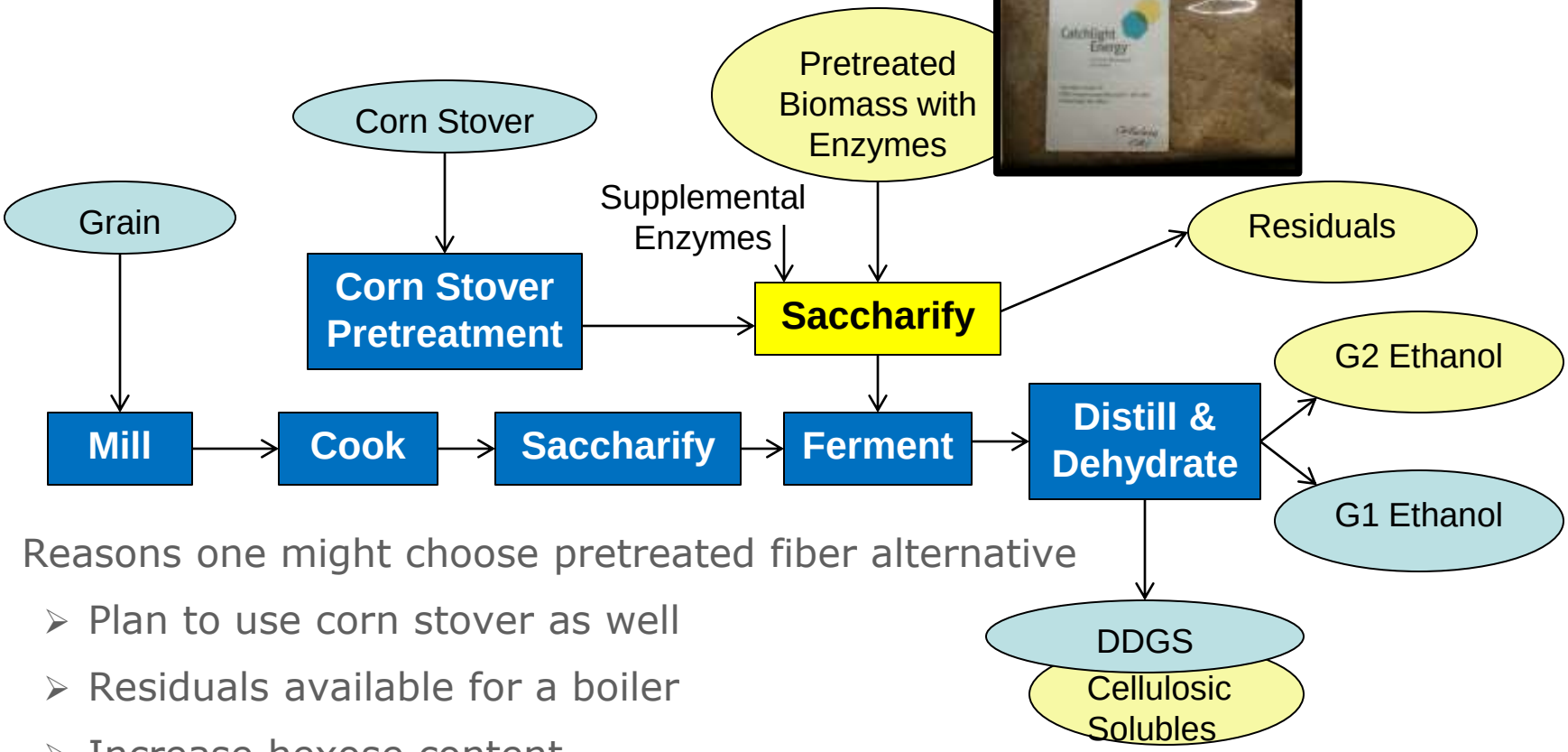


- Cellulosic sugar can be
  - Direct from CLE's process (10-14% concentration)
  - Concentrated to 25%, or higher target as desired
  - Purified as needed

- Economics depend on shipping logistics and relative energy costs

Process Alternative: Pretreated Fiber Addition

- Pretreated Fiber Option in a Dry Mill



- Reasons one might choose pretreated fiber alternative
  - Plan to use corn stover as well
  - Residuals available for a boiler
  - Increase hexose content

Cellulosic Solubles

- Impact should be evaluated
- Cleanliness of sugar stream is controllable at the sugar facility
- Effect of CLE Sugar processing liquor on cattle feed expected to be benign
  - Spent sulfite liquor added to cattle feed rations showed no adverse effects on growth or carcass grade up to 7% lignosulfonate content[1]

[1] Journal of Animal Science, 46(4), 878-884, 1977

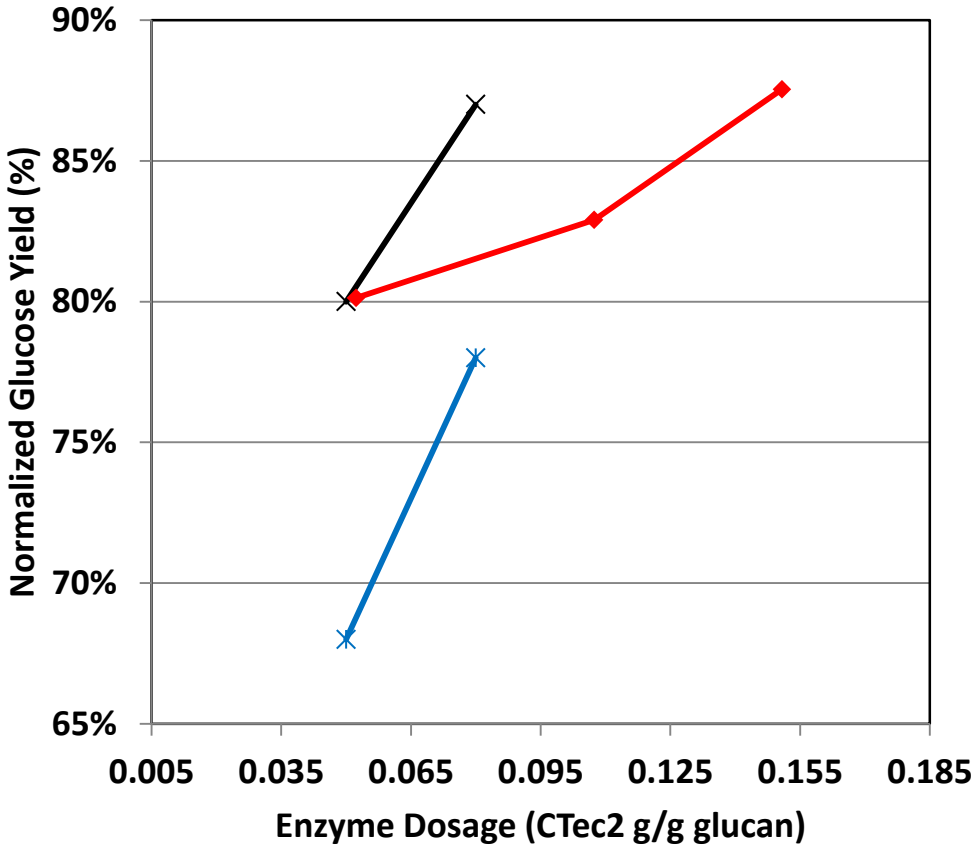
Feedstock Choices

- Implications of cellulosic feedstock choices: corn stover, CLE softwood options

	Corn Stover	CLE Pretreated Biomass	CLE Sugar (Syrup)	CLE Sugar (Solid)
Storage	Keep dry	Keep wrapped	Need tank	Keep wrapped
Availability	November-April	Year-round		
Enzyme Use	Add in plant	Can be included	Not needed	
Sugar Conc.	12%		Up to ~75%	80-95%
% C6 sugars (balance is C5)	60%	>93% due to softwood composition		

CLE Sugar options are convenient and easy to use

CLE Pretreated Fiber Hydrolyzes Like Acid-Pretreated Corn Stover

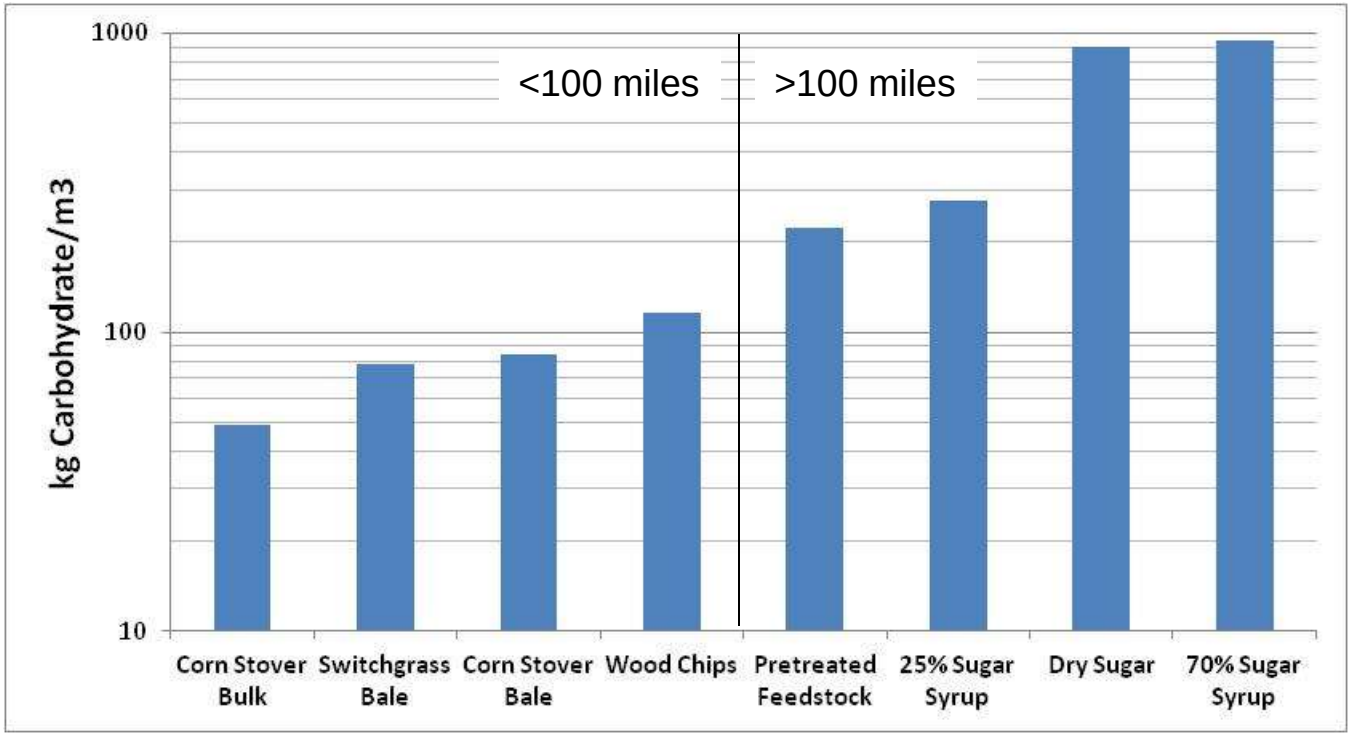


- Acid-Pretreated Corn Stover, 7 days
- CLE Pretreated Softwood Forest Residuals, 4 days
- Acid-Pretreated Corn Stover, 3 days

Pretreated Corn Stover data from www.novozymes.com. Used with permission.

Cellulosic Raw Material Candidates

- Densification enables greater haul distance, expands feedstock candidate list
  - Wood chips < 100 miles
  - Densified feedstocks >>100 miles
  - Enables feedstock diversification



Feedstocks Geographic Distribution

- Little geographic overlap between crop and forest residues
- But they are relatively close!

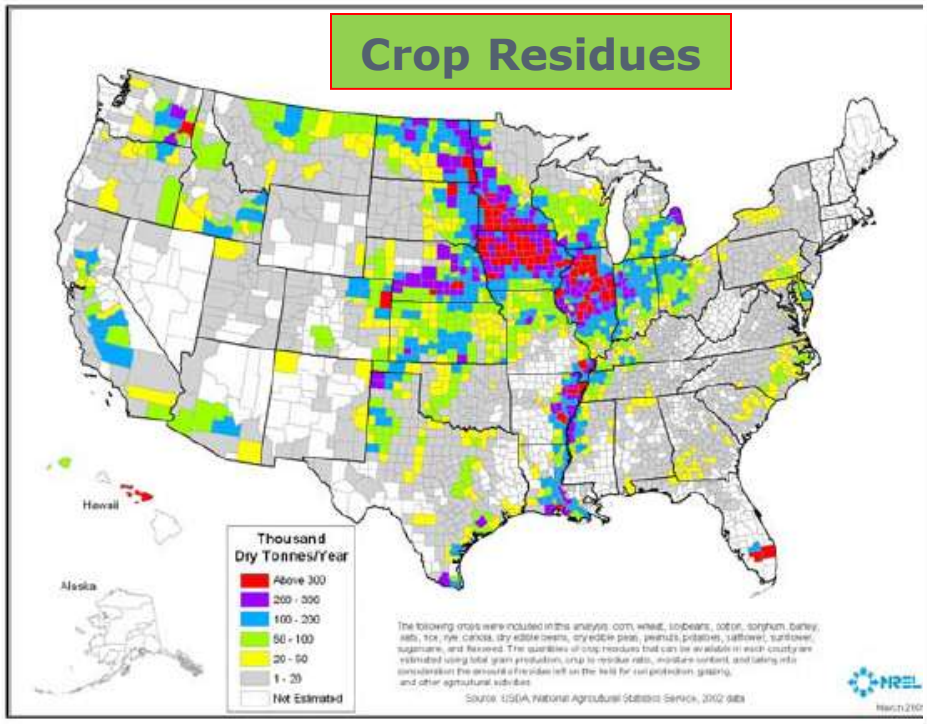


Figure 11 Estimated Crop Residues by County

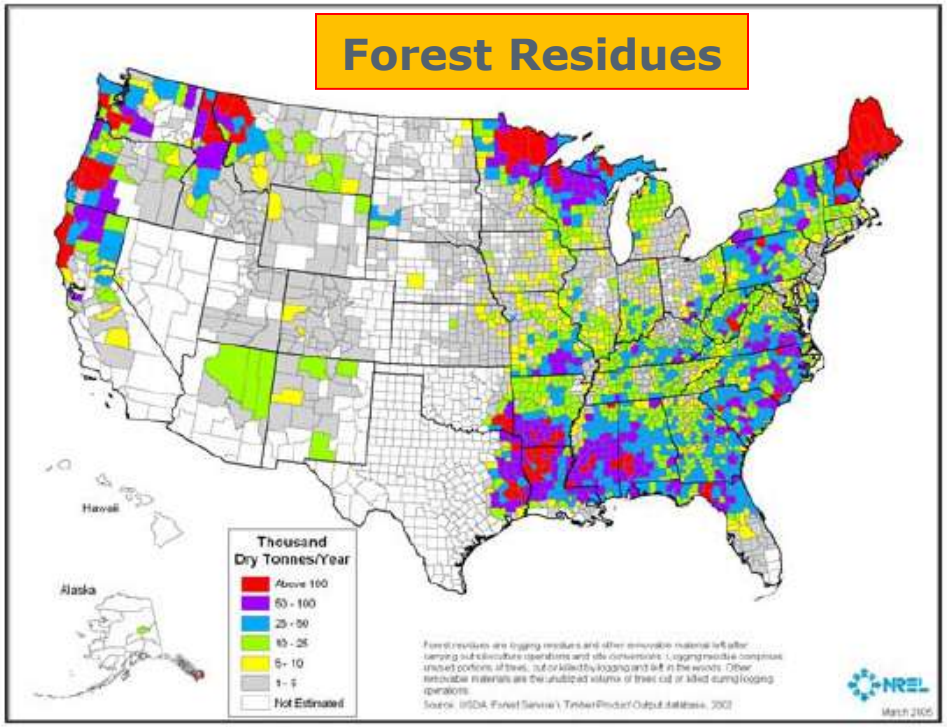
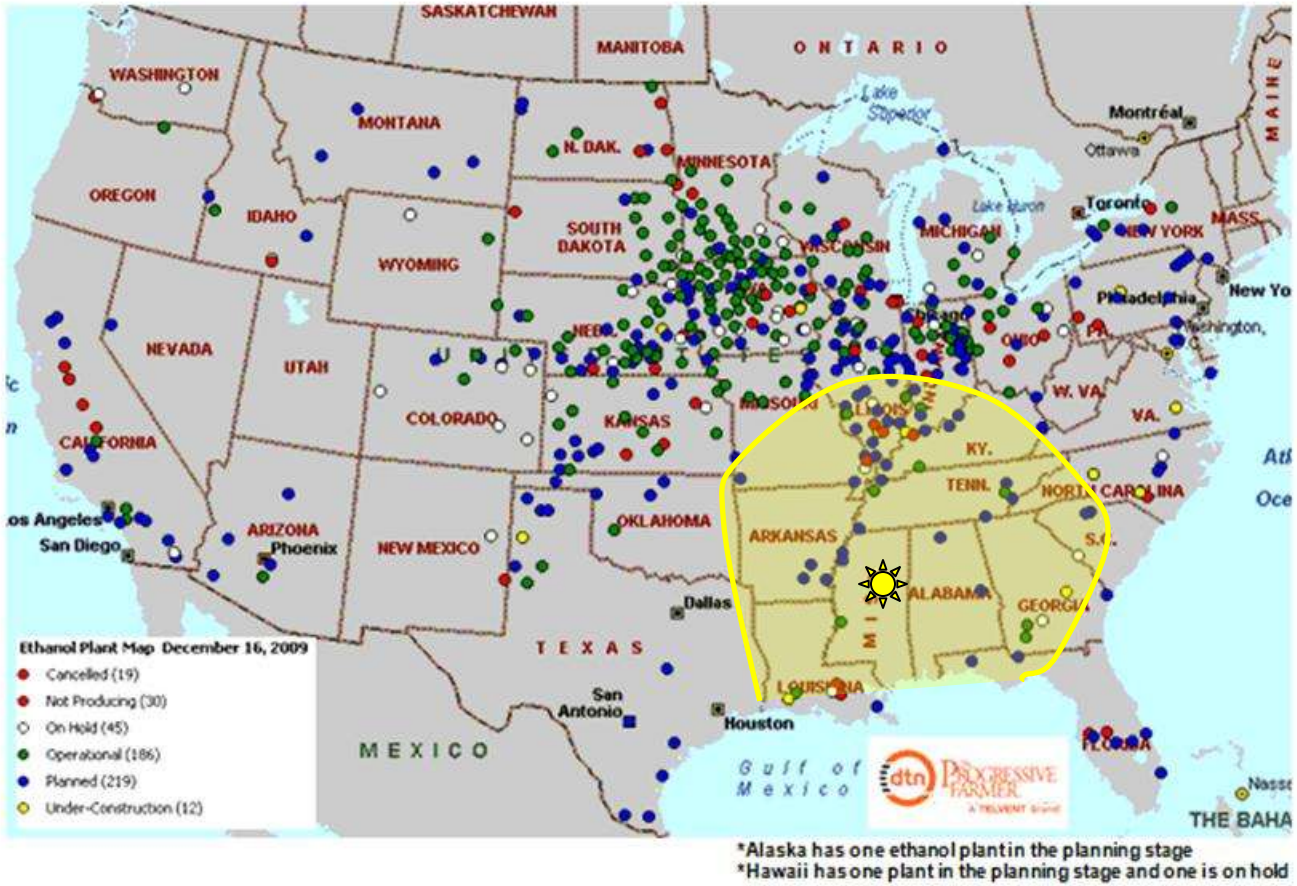


Figure 13 Estimated Forest Residues by County

Milbrandt et. al, 2005

Densified Woody Feedstock is in Range of Most Ethanol Plants

- 500-Mile Road Radius Around Columbus, Mississippi



CLE Sugar Process

- Demonstrated effective on softwood and other feedstocks
- Uses scalable processes well-known in the pulp and paper industry
- Currently operate at kg scale
- Sugars are fermentable by yeast even without cleaning, but any necessary level of cleanliness can be achieved

Unpurified and purified softwood sugars: Both are fermentable!

Douglas-fir Syrup

Pine Sugar

Summary

- Corn-based ethanol plants can produce cellulosic ethanol with minimal investment by adding RFS2-qualifying cellulosic sugar to fermentation
  - Hedges against high feedstock cost and low fuel prices
  - Accesses strong renewability incentives
  - Cellulosic sugar from woody biomass can be available year-round
- Catchlight Energy is discussing feedstock supply/cellulosic fuel off-take agreements with selected partners
  - Can extend feedstock supply to cellulosic sugar supply
  - Open to partnering with sugar users

Catchlight Energy™
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Catchlight Energy is uniquely positioned for commercial success

Chevron

"The power of Human Energy to find newer, cleaner ways to power the world"

Weyerhaeuser

"Releasing the potential in trees to solve important problems for people and the planet"