

Prospects for the Commercialization of Cellulosic Ethanol from Forest Biomass

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Range Fuels, Inc.**



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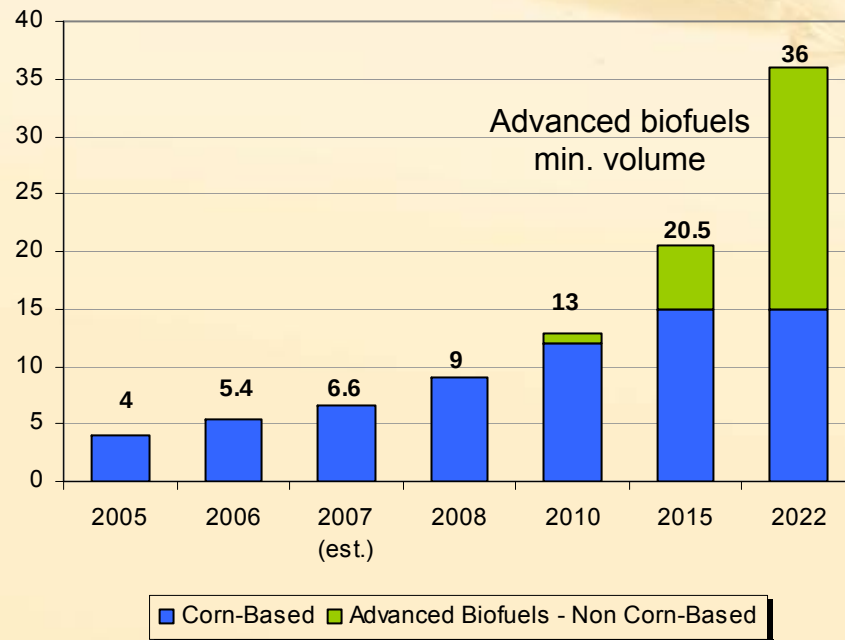
Range Fuels Overview

- Formed in July 2006 by Khosla Ventures to commercialize cellulosic ethanol
 - Multi-sourced technology
- Supported by substantive federal, state and local incentives
 - DOE: \$76MM in a competitive evaluation
 - Other state and local incentives
- Development Center and K2A Pilot Plant complete
- Broke ground in Soperton, GA, for first U.S. commercial-scale cellulosic ethanol plant utilizing woody biomass
- Additional sites and partnerships secured



Increasing Ethanol Demand and Support

- 60% growth in demand from 4 Bn GPY in 2005 to 6.6 Bn GPY in 2007
- Strong, bipartisan support for cellulosic biofuels
 - Recent passage of “Energy Independence and Security Act of 2007”
 - 36 Bn GPY by 2022 includes 21 Bn GPY of Advanced Biofuels
 - Increased cellulosic credits likely in new Farm Bill in 2008 (\$0.64/gal)



Source: Renewable Fuels Association

- Higher demand for E85 fuel as FFVs are more widely adopted
 - By 2012 U.S. automakers have committed to % of production to FFVs

DOE Est. Corn
Max. Volume



U.S. Cellulosic Ethanol Potential

- 140 Bn GPY – 2005 U.S. DOE/USDA Study
 - Agricultural 100 Bn gpy
 - Crop residues, perennial crops, animal manure, process residues and grains used for biofuels
 - Forestlands 40 Bn gpy
 - Wood and paper & pulp processing residues, logging and site clearing residues, fuel treatment thinnings
- Total U.S. Gasoline Consumption
 - 140 Bn gpy
 - President's goal - 35 Bn gpy alternative fuels by 2017

Worldwide Cellulosic Ethanol Potential

- Total Worldwide Gasoline Consumption
 - 300 Bn gpy vs. 140 Bn gpy from U.S.
- Assessments Underway Globally

Range Fuels' Business

- Focus
 - Green energy
 - Cellulosic ethanol
- Business Model
 - Design
 - Build
 - Own
 - Operate
- Global Presence

Key Highlights

- Thermo-chemical based technology with a developmental headstart
 - Economically competitive without subsidies from inception
- Low marginal cost of production
- Feedstock flexibility
 - Feedstock advantages of woody biomass
- Highly scalable business model; replicable plant modules
- Environmentally friendly production process
- Access to economic development funds and additional legislative measures that support development of cellulosic ethanol technologies
- Experienced management team and strategic investors and partners

Operational Facilities

- 4 generations of biomass conversion testing environments
- Catalyst testing facilities
 - CC10's
 - CC100
 - CC400
 - CC1000
- Pilot-scale
 - K2A Optimization Plant

K2A Optimization Plant



Management Team

- Proven Leadership from High Tech, Renewable Energy Industries and Tech-Intensive Coal, Coal Gasification, and Gas-to-Liquids Industries
 - Mitch Mandich, CEO – Apple Computer
 - Rick Winsor, President & COO – Horizon Wind Energy
 - Kevin Biehle, V.P. Production – VeraSun; BASF
 - Mike Cate, V.P. Procurement & Fabrication – Washington Group
 - Arie Geertsema, Sr. V.P. Technology – CAER; Sasol
 - Dan Hannon, CFO – Reliant Energy, Exxon
 - Bud Klepper, Chief Technical Specialist – Inventor
 - Larry Robinson, V.P. Projects - Bechtel
 - Bill Schafer, Sr. V.P. Business Development – NexGen

Limitations of Current Technology

■ Current production technologies use corn or sugarcane

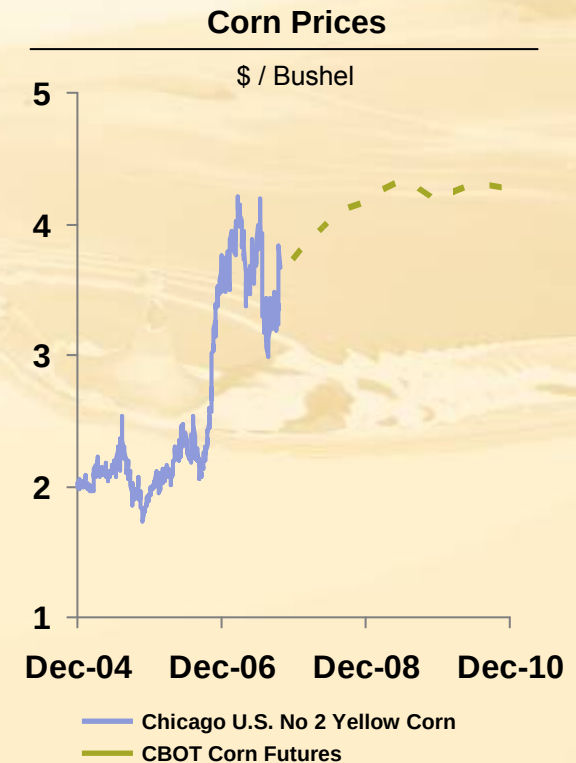
- Limited max. capacity (corn 15 BGY); high cost
- Import tax of \$0.54/gallon

■ Food versus fuel

- Low land efficiency for fuel production
- Sharp increase in feedstock prices
- Depleting water tables
- Wide price fluctuations due to weather
- Resistance from animal feed lobby

■ Low fossil energy ratios

- Corn at 1 to 1.4 input to output
- Sugarcane ethanol at 1 to 8
- Cellulosic ethanol at 1 to 10



Source: Bloomberg

Range Fuels' Technology

- Cheaper than gasoline, unsubsidized

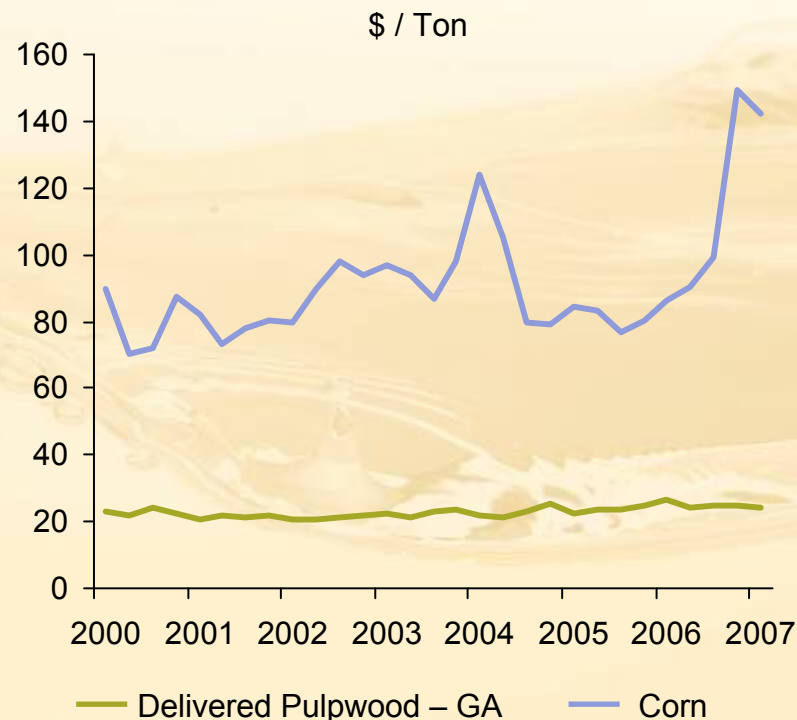
- Cheaper, less volatile feedstock

- Flexible “high volume” feedstock supply

— <u>Wood chips</u>	— Switchgrass
— Municipal waste	— Corn stover
— Industrial waste	— Olive pits
— Manure	— Coal

- Environmentally superior

Volatility: Corn vs. Pulpwood Prices

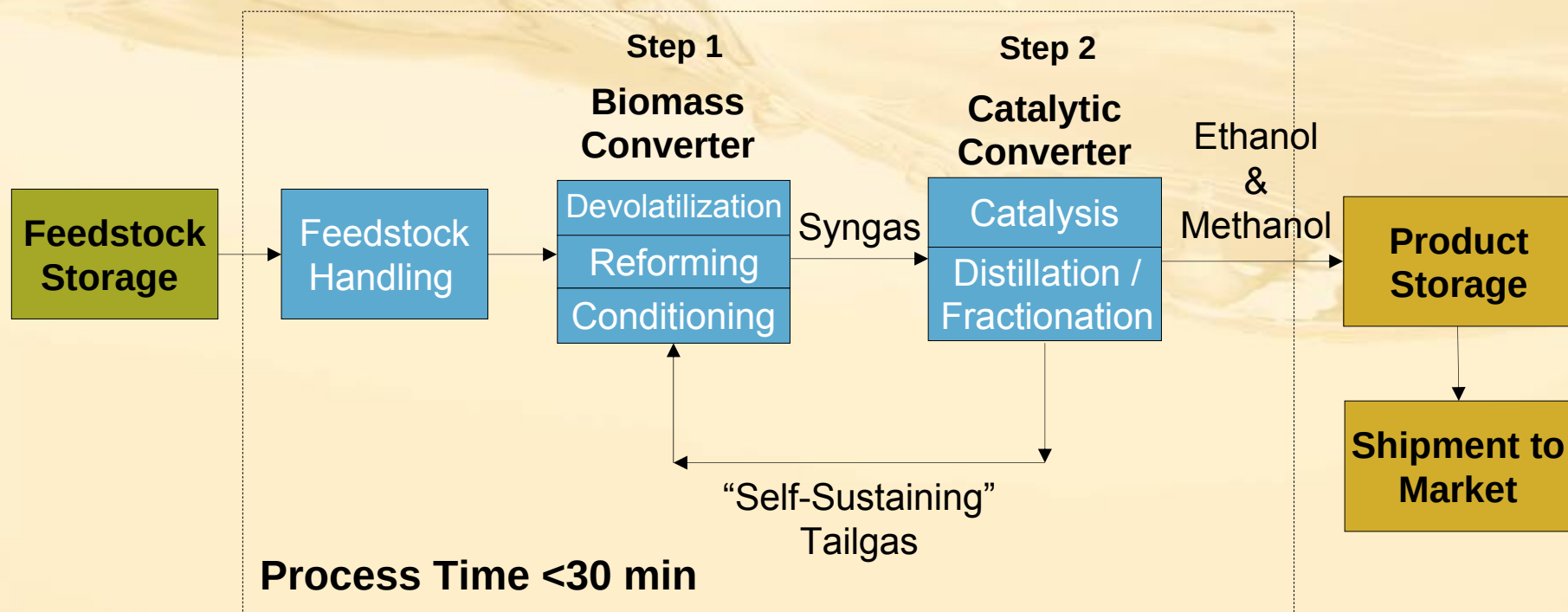


Sources: Bloomberg and Pöyry

Differentiated Technology

- Proven two-step thermo-chemical process
- Highest yield of ethanol per ton of feedstock

K2 System Configuration





Environmentally Friendly Production Process

■ Soperton: minor emissions source permit

- Only one waste stream: saleable char

■ Lower water use

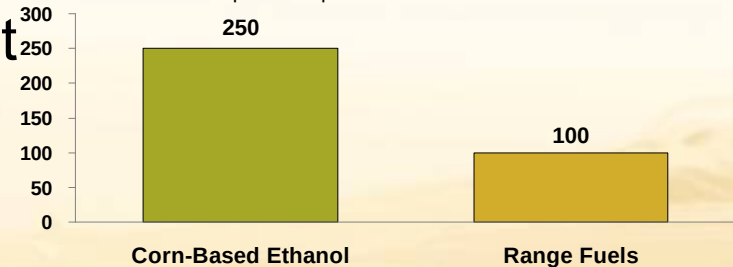
- 25% of typical corn-ethanol plant
- Reduces purification costs and impact

■ Material land use benefits

- Polyculture “compatible”
- Better yields, biodiversity, low inputs

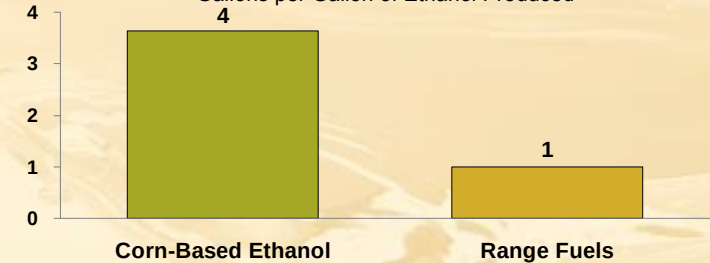
Emissions

Tons per Year per 100 MGY Ethanol Produced



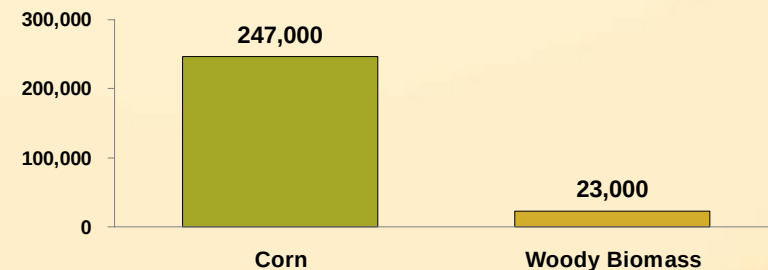
Water Usage

Gallons per Gallon of Ethanol Produced



Land Required to Supply Feedstock

Acres per Year per 100 MGY Ethanol Produced





World's First Commercial Cellulosic Plant

Soperton, GA: World's First Commercial Cellulosic Plant



- ① **Wetlands:**
Will be protected and left undisturbed
- ② **Range Fuels Drive:**
Specially created road that separates plant operations from the wetlands
- ③ **Feedstock Receiving and Storage:**
Receipt and storage of wood chips
- ④ **Conveyor System:**
Moves feedstock from receiving and storage area to modular converters
- ⑤ **Biomass Converters:**
Convert wood chips to syngas
- ⑥ **Catalytic Converters:**
Transform the syngas into alcohols, which are then separated and processed
- ⑦ **Product Storage:**
Collection and storage of liquids (ethanol and methanol)
- ⑧ **Loading and Delivery:**
Transportation by either truck or rail

Soperton Plant – Site Work



Soperton Plant – Artist's Rendering



Soperton Plant – Groundbreaking



Soperton Plant – Groundbreaking



Soperton Plant – Site Clearing



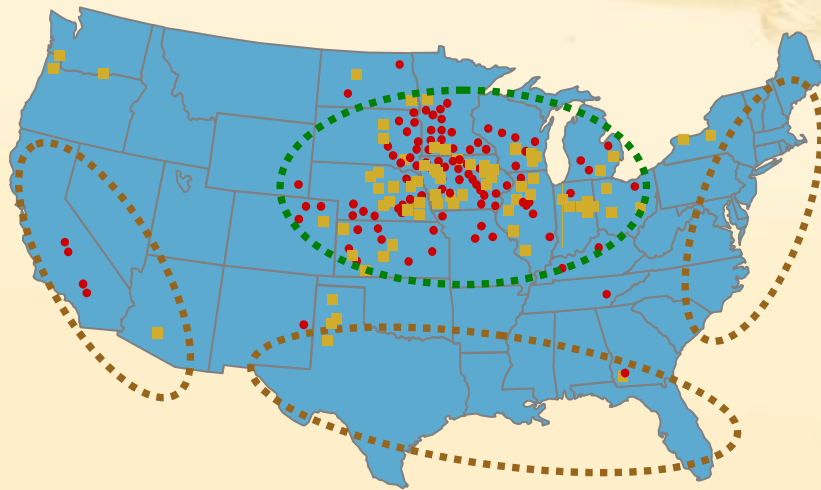
Soperton Plant – Woody Biomass Feedstock



Stable Pricing, Large Availability Using Woody Biomass

- Over 400 MM tons of “low cost” woody biomass available annually
- High land efficiency for cellulosic crops; low water and fertilizer inputs
- Cellulosic availability fits demand; fewer transportation issues
- Little competition for feedstock as paper mills decline

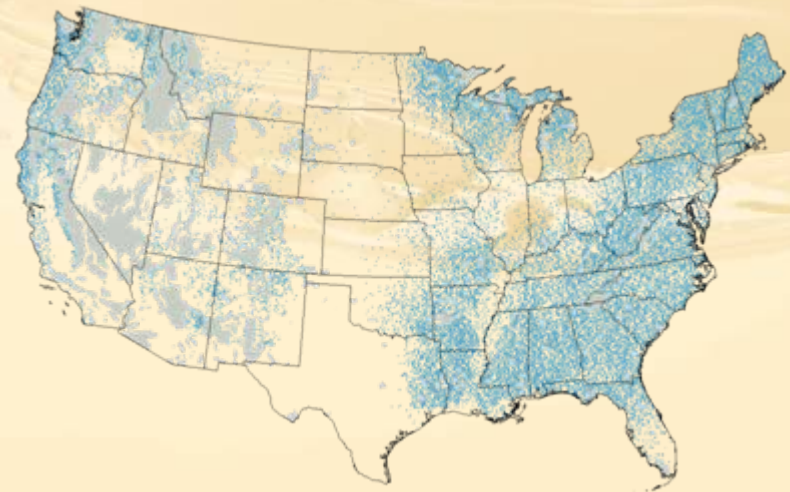
U.S. Ethanol Biorefinery Locations



- - Biorefineries in Production
- - Biorefineries under Construction
- - Corn-Ethanol Production
- - Major Gasoline Consumption

Source: Renewable Fuels Association

Non-Federal Forest Land Density, 1997



- - 25,000 acres of Forest Land per dot
- - 95% or more Federal area

Source: U.S. Department of Agriculture

Challenges for the Western United States

■ Why Georgia?

- “In the southeastern U.S., trees are agriculture. In the western U.S., they’re parks”
- Sustainability is key!
 - Plants cannot be economically relocated
 - ◆ Woody biomass must be sustainably and economically available with a proven silviculture, harvesting and transportation infrastructure
 - ◆ Competing biomes
 - Growing season
 - Rainfall
 - Soils
 - ◆ Competing tree farmers or state and federal agencies?

Injury to Insult

- H.R. 6: The Energy Independence and Security Act of 2007
 - Renewable Biomass is:
 - *Planted trees and tree residue from actively managed tree plantations on non-federal land cleared at any time prior to enactment of this sentence.*
 - ◆ *Does this include "commercial thinnings"?*
 - ◆ *How is "actively managed" defined?*
 - ◆ *If it has been cleared at any time in the past is it eligible? Is forestland cleared 100 years ago eligible, or is that not considered actively managed?*
 - *Slash and pre-commercial thinnings that are from non-federal forestlands.*
 - ◆ *How are slash and pre-commercial thinnings defined?*
 - ◆ *Non-federal forestland exclusion will discourage any siting in regions dominated by federally managed forestlands, i.e. the western U.S.*

How Can Range Fuels Produce Cellulosic Ethanol from Woody Biomass in Colorado?

- We need a package that competes with other options
 - Economically
 - Delivered cost of woody biomass
 - Cost of infrastructure and operations
 - ◆ Tax rates
 - ◆ Power and natgas rates
 - ◆ Labor rates
 - ◆ Rail and truck access for feedstock deliveries and product shipments
 - Value of cellulosic ethanol
 - Environmentally
 - Impact of plant operations
 - ◆ Rural communities
 - Impact of feedstock growing, harvesting and transportation operations