VERENIUM
THE NATURE OF ENERGY™

Recent Developments in Cellulosic Ethanol Technologies and Their Policy Implications

Johns Hopkins School of Advanced International Studies
Washington, D.C.

FEBRUARY 24, 2009

Carlos A. Riva
President & Chief Executive Officer

Tackling US dependence on imported oil: A top-tier national challenge

- Economic Impact
  - High absolute cost (oil imports reached $650B in 2008)
  - Balance of trade: oil reached 80% of monthly trade deficit in 2Q08)
- Environmental Impact
  - Impacts from oil production are intensifying in frontier areas
  - 21st C carbon constraints will force sharp GHG emission reductions
- Oil Is a Depleting, Non-Renewable Resource
  - US peak of production was reached in 1970
  - A global peak in conventional oil is foreseeable and inevitable
- Global Security Implications
  - Competition for oil resources has driven many 20th-21st C conflicts
- Biofuels: the most viable near-term alternative liquid fuel

VERENIUM

Presentation overview

- Intro to biofuels and cellulosic ethanol
- Pros and cons of biofuel: the “mythic” view
- Addressing biofuel skepticism: the roadmap to sustainable methods and agronomics
- Roadmap implementation: a Verenium progress report
- Scalability: the challenges of building a new industry
- Third generation biofuels: beyond ethanol
- Q&A

VERENIUM

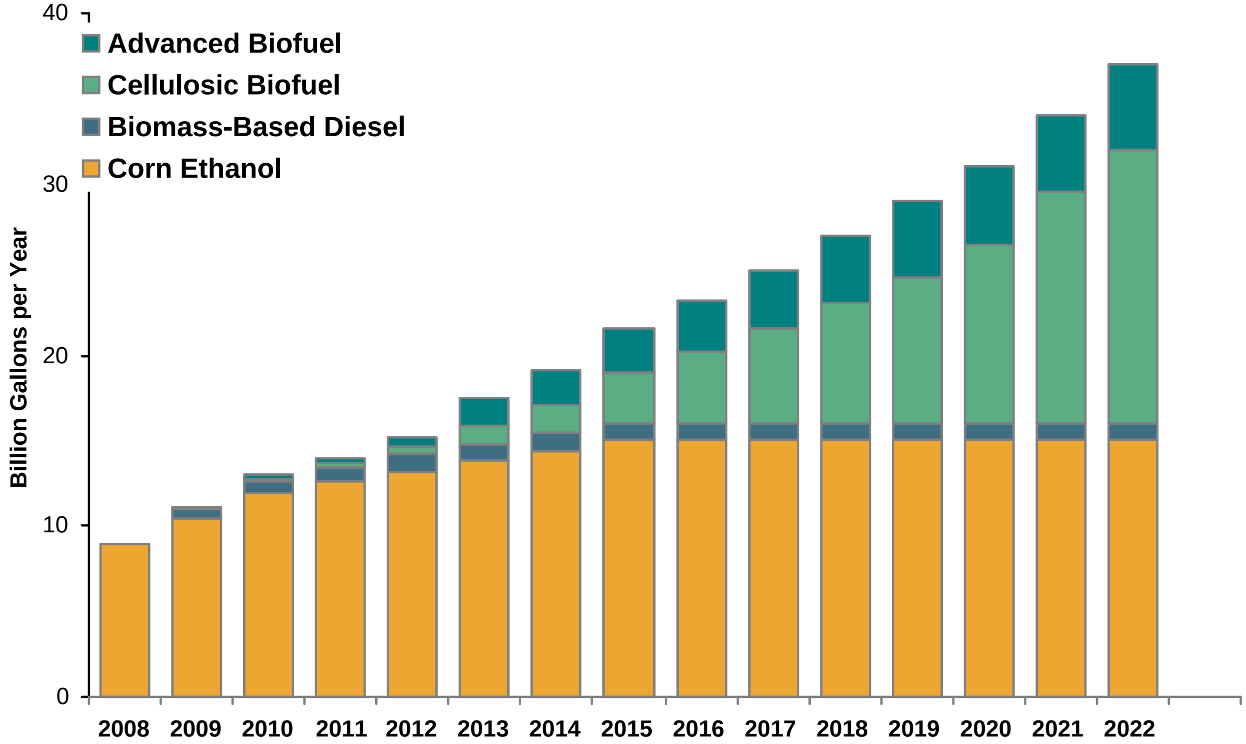
Overview of biofuels

- Typology of alcohol fuels:
  - 1st generation (conventional grain ethanol in the US)
  - 2nd generation (includes cellulosic ethanol, or CEtOH)
  - 3rd generation (higher alcohol molecules, e.g., biobutanol)
- Cellulosic feedstocks are abundant, lower cost and less volatile than grain – but more difficult to breakdown
- Traditional thermochemical methods for CEtOH are well-established, but this technology is relatively mature
- Industrial biotech offers new biochemical pathways (e.g., tailored microorganisms, enzymatic processes)
- Policy pull: state bans on MTBE triggered fast growth, followed by Congressional RFS mandates (EPAct ’05, EISA ’07)

VERENIUM

Energy law provide significant market potential

Market is widely expected to be “short” cellulosic ethanol for the foreseeable future



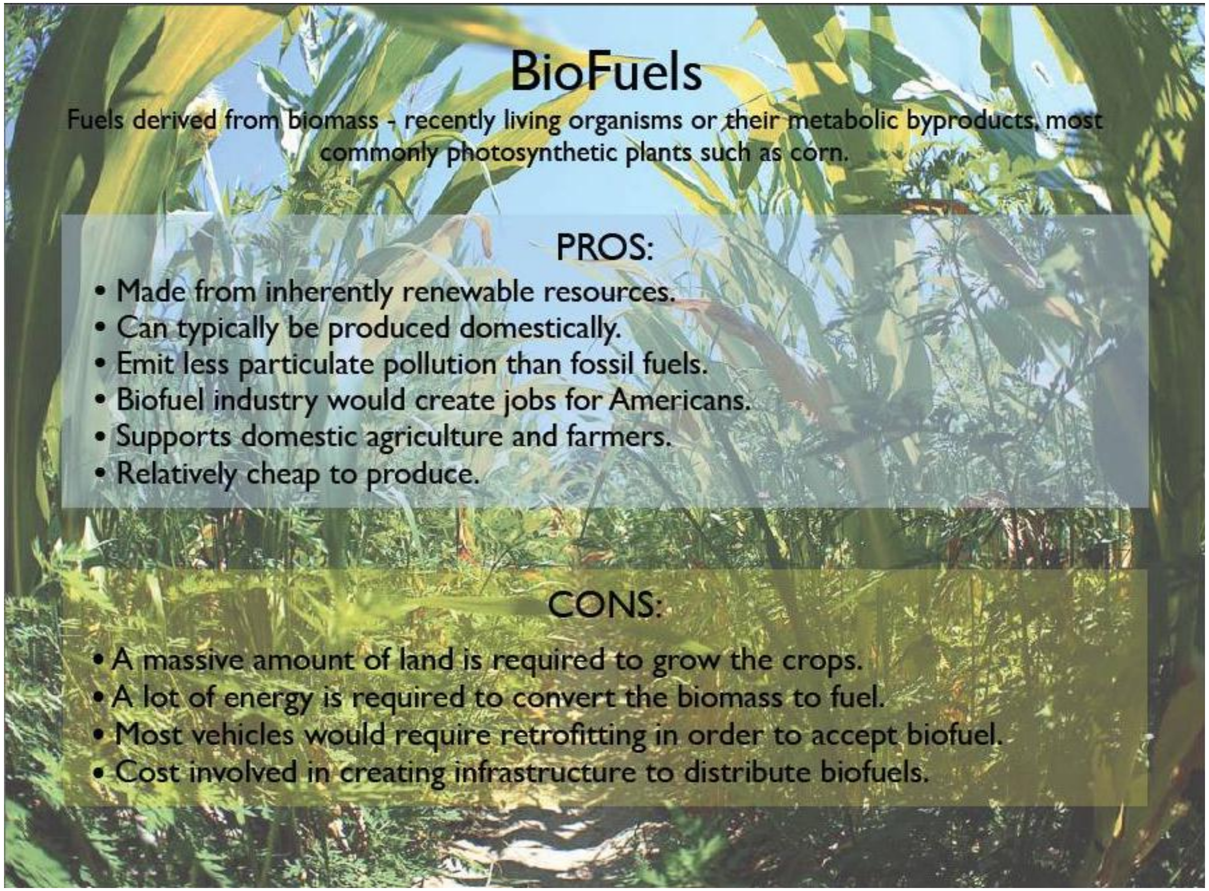
2007 EISA Renewable Fuels Mandate

	Cellulosic Biofuels Billion Gallons / Year
2010	0.10
2011	0.25
2012	0.50
2013	1.00
2014	1.75
2015	3.00
2016	4.25
2017	5.50
2018	7.00
2019	8.50
2020	10.50
2021	13.50
2022	16.00

VERENIUM

Biofuel pros and cons: the "mythic" view

- Biofuels seen as renewable, domestic, clean-burning, and a source of domestic job creation
- But critics claim they require a "massive amount of land" – and "a lot of energy to convert biomass to fuel"



SOURCE: "The 11th Hour: 2008 Election Discussion Guide"
(Based on Leonardo DiCaprio's 2007 Documentary Film)

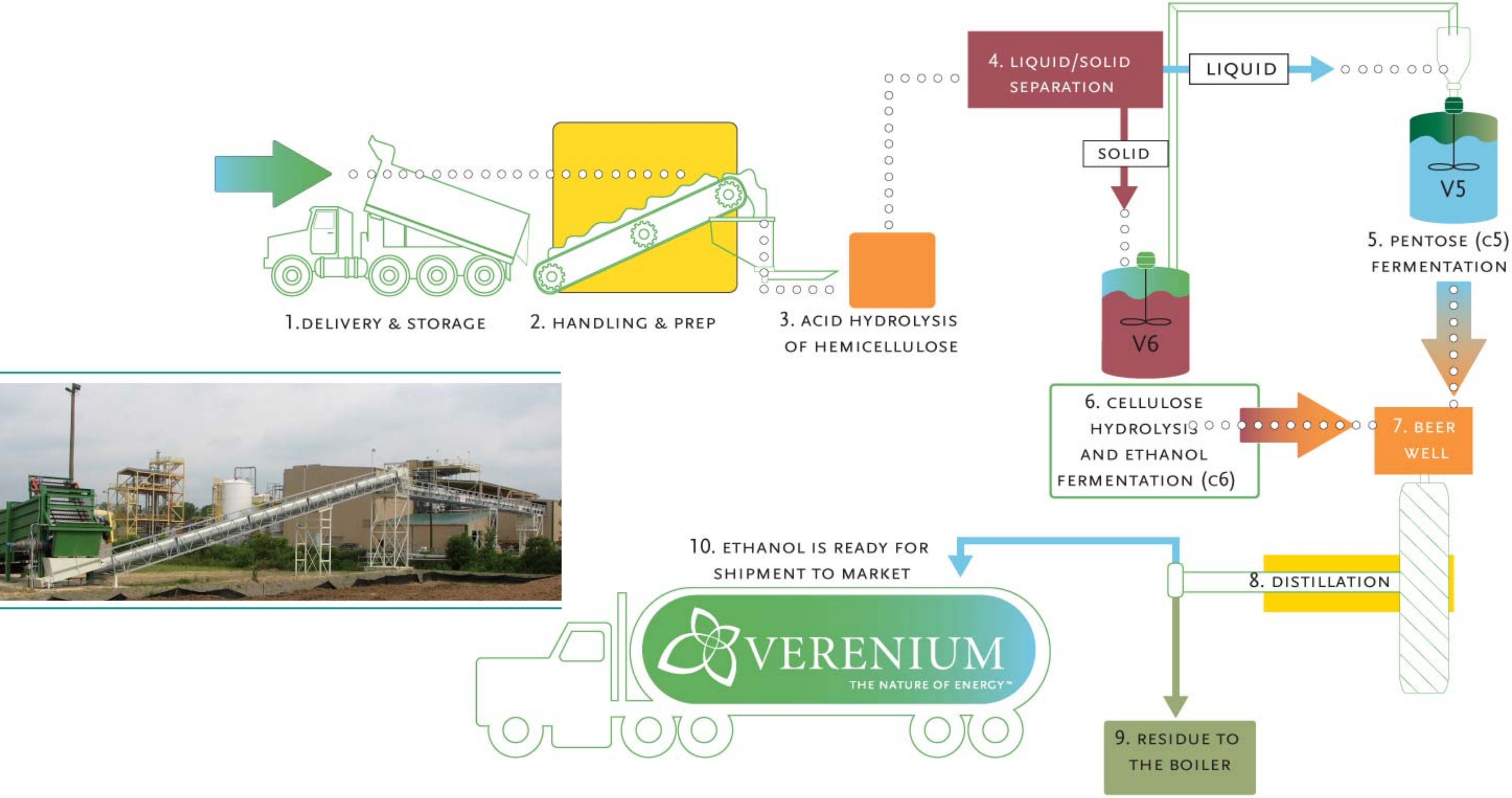
VERENIUM

Roadmap to sustainable biofuels

- Resolving the land use / “food vs. fuel” concern requires limiting the footprint by raising yield per acre
- 1G yields are a function of corn yields per acre (150-170 bushels x 2.8 gal. per bushel = 400-500 gal/acre, potentially rising to 600-700 gal, w/nitrogen fertilizer)
- 2G biofuels enable 4-5 fold yield increases to 1800-2000 gal/acre, by using all sugars (C5+C6)
- 2G biofuels expected to have better energy, carbon profile
- Bottom line: by optimizing land use patterns and producing biofuel from high-biomass feedstocks, the US could produce more food and more fuel – with lower carbon emissions!

VERENIUM

The Verenium process: getting to ethanol



Leading the market in advancing CEtOH technology to commercial scale

2007 – Pilot Plant

- ~ 50,000 gallons/year
- Primarily bagasse, energy cane

2008 – Demo Plant

- 1.4 MGY
- 1st of its kind in U.S.
- Fully integrated, large-scale cellulosic ethanol facility
- Built to test wide range of feedstocks, enzymes
- Completed start-up and commissioning, recently began optimization

2011 – 1st Commercial Plant

- ~36 MGY
- $250 - $300M (est.)
- Build in partnership with BP
- Plan to break ground 2010
- Located in Highlands County, FL
- Additional facilities to follow as soon as practical

VERENIUM

BP partnership:
Significant accelerant for commercial-scale development

Assembling core capabilities across the value chain to accelerate commercial-scale cellulosic ethanol production

VERENIUM

bp

Biomass cultivation and logistics

Gene discovery, enzyme development & novel microbes

Proprietary
Enzymes & microbes that enable production of ethanol from a wide array of feedstocks

Engineering, finance, licensing & partnerships

Assets & property processes

Commercial off-take, logistics & marketing

BP partnership:

Deal overview — two phases of collaboration

Phase One:

- Focus: technology development for deployment into commercial production facilities in the U.S., and eventually ROW
- Structure: 50/50 owned special purpose entity (SPE) created as technology repository, licensing vehicle
- $90M funding to VRNM over the next 18 months; *non-dilutive capital*
- Joint Steering Committee established to manage phase one activity

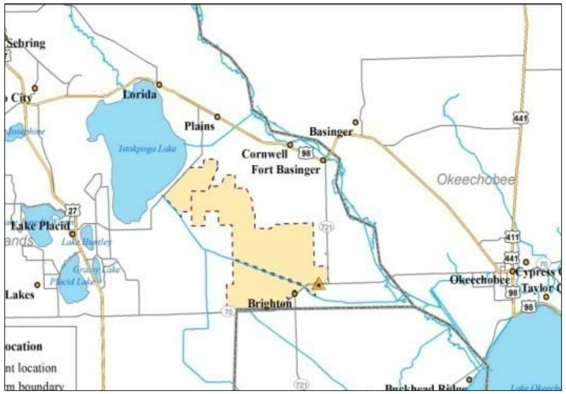
Phase Two:

- Focus: development of first commercial plant, following portfolio of facilities
- Structure: 50/50 owned JV company
- Key terms: BP contributes $22.5M, Verenium contributes development assets, including Highlands, FL, project and another early stage commercial site

VERENIUM

Highlands Ethanol: Project Overview

- Verenium and BP’s first commercial-scale, cellulosic ethanol production facility
- Establishes Florida as a leader in 2G Fuels
- Located in Brighton (Highlands County)
- 36 MGY capacity
- Growing services w/Lykes Bros. on 20,000 farmable acres
- $250-$300M capital investment, generating 140 permanent jobs (production/agriculture) and over 400 temporary construction jobs
- Uses landmark C5 conversion technology originated by Dr. Lonnie Ingram & team at UF



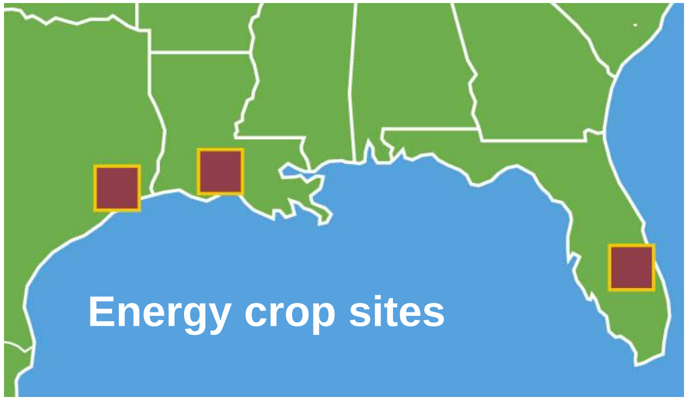
VERENIUM

Commercial development:
Near-term focus on southeast US

- Ultimately national / global play; Gulf region is first leg
- Initial focus: position 6 projects for close between 2009 and 2011

- Commercial sites in development
  - Grass/energy cane/bagasse
  - Local agricultural partners
  - Good logistical interfaces
  - Some co-located

- Three energy crop plantations
  - ~100 acres / plantation
  - Energy cane and sorghum
  - Energy cane expandable in two years to 17k acres
  - Validation platform for growers



VERENIUM

Building a scalable 2G biofuels industry

- One project can prove out the feasibility of CEtOH – but a new industry requires infrastructure and policy support
- 1G ethanol set a template for 2G biofuels expansion
- Key challenges in the scale-up of 2G biofuels:
  - Identify, establish appropriate regional feedstocks; attract growers / landowners into crop production (forsaking traditional crops and government support programs)
  - Design, build, deploy new agricultural (harvest/haul) equipment
  - Specialized plant designs from engineering & construction firms
  - Fuels handling, transportation & dispensing infrastructure
  - Address the “chicken & egg” problem of Flex-Fuel Cars & E85 infrastructure

VERENIUM

Third generation biofuels:
Are Further Advances in Store Beyond "Advanced Biofuels?"

- 2G ethanol is chemically identical to 1G ethanol
- 3G biofuels use same feedstocks to yield higher-alcohol molecules (e.g., biobutanol)
- At issue: will the US have one, or multiple, standards for liquid fuels? (Analogy: Windows vs. MAC OS)
- Key issues:
  - Compatibility with existing storage/delivery infrastructure
  - Energy content (ethanol has higher octane, but lower BTUs)
  - Chemical characteristics (e.g., corrosiveness, miscibility)
  - Environmental characteristics of different molecules
  - Compatibility with existing cars, small engines, boats

VERENIUM

The future of fuels: concluding thoughts

- Our energy-intensive, industrial civilization is approaching a turning point (1750s wood-coal; 1850s whale oil-petroleum)
- Fossil energy development costs continue to rise – biofuel technology advances driving costs down
- Financial markets meltdown has pulled back global oil demand and prices, postponing the crossover point
- Given GHG / peak oil concerns and long lead times, do not have the option not to pursue renewable biofuels. Question is, *how to do biofuels right!*
- Urgent that the US achieve success in demonstration and proto-commercial deployments – and remove uncertainty by resolving standards for future fuel molecules.

VERENIUM

VERENIUM

THE NATURE OF ENERGY™