Roadmap to the future: Cellulosic Ethanol
BP Biofuels a growing alternative

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Monday 10\textsuperscript{th} June 2013
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Today’s agenda

- Cellulosic ethanol – what’s the deal?
- Key Success Factors
- BP’s involvement
Cellulosic process flow (bio-chemical)

Similar to sugarcane ethanol

Energy Grass Harvest

3 key components to biomass
Hemi-Cellulose ~ 25%
Cellulose ~ 40%
Lignin ~ 35%

Boiler

Steam for process

Similar to sugarcane ethanol

Simplified Cellulosic Ethanol Schematic

Feed Pre-Treatment

Hydrolysis

Biocatalysts

Supply

Acid Hydrolysis of Hemicellulose

Liquid Xylose sugar stream

Solid /liquid Cellulose + Lignin stream

Fermentation

Xylose + Cellulose/ Glucose Fermentation

Separation / Recovery

Distillation

Lignin

Boiler
California
10% GHG reduction of all road transport fuels (LCFS) by 2020

US Federal Renewable Fuel Standard (RFS2)
3 categories: Conventional, Advanced (>50% GHG savings) and Cellulosic
16bn gal by 2022

EU Renewable Energy Directive
Cellulosic biofuels counting 2X or 4X

Fuels Quality Directive
2020 6% lifecycle GHG Reduction of road transport fuels vs a 2010 baseline

Regulatory Support
Drivers of success - technology

- Biocatalyst key driver of profitability
- Two main biocatalysts – enzymes and yeast
- Inter-dependency with Process
Drivers of success – process integration

• Multi-factorial optimization
  • Capital
  • Operating costs
  • Reliability

• No standard answer

• The scale-up challenge

⇒ Know-how!
Drivers of success - feedstocks

- Large share of production cost
- Multiple choices
  - Fungible?
  - Grown v collected?
- Sustainability matters…
Drivers of success - financing

- What does the banker want?
- De-risking the technology
- Offtakes
- Operating credibility
Drivers of success – operating know-how

- “First-of-its-kind” technology
- Biology not Chemistry!
BP technical capability

- World-leading biotechnology R&D facility in San Diego
- Partnership with Energy Bioscience Institute (EBI)
Jennings Demonstration Facility

The proof of the pudding...
Feedstocks: Highlands, Beaumont

Dedicated bio-energy feedstocks
End-to-end capability

Integrated know-how (field to pump)
In summary...

- Attractive opportunity
- Five things to get right
- Distinctive, advantaged technology
- Getting ready to licence
Biofuels at BP

BP Biofuels a growing alternative