Conversion of Available Feedstocks

- "Billion Ton" study indicates that enough biomass is potentially available to displace > 30% of current U.S. petroleum consumption
- But it requires variety of biomass types
  - Agricultural lands
    - Corn stover, wheat straw, soybean residue, manure, switchgrass, poplar/willow energy crops, etc.
  - Forest lands
    - Forest thinnings, fuelwoods, logging residues, wood processing and paper mill residues, urban wood wastes, etc.
President’s Biofuels Initiative Timeline

- 2006: President Announces Biofuels Initiative (January 31, 2006)
- 2012: Make Cellulosic Ethanol Cost Competitive
- 2020: Replace 30% of Current Gasoline Consumption with Biofuels

Feedstock development to enhance starch-based industry with cellulosic feedstocks to stand alone facilities.

Feedstock development focus on pulp & paper mill residues, forest residues, & perennial energy crops.

Help industry build first-of-a-kind plants

Cost-share industrial-scale validation of technology & economics

Establish Regional Feedstock Partnerships

Re-Invigorate Thermochemical Platform

Timeframe for R&D Successes & Commercialization

- 2006: President Announces Biofuels Initiative (January 31, 2006)
- 2007: Baseline validation for 2 - 3 fermentation organism candidates for commercial development
- 2008: Establish 5 regional feedstock development centers
- 2009: Projects awarded under 932 Solicitation will have started commercial operations
- 2010: 20% of Current Gasoline Consumption with Biofuels
- 2011: Commercial development of at least 1 fermentation organism & validate >86% sugars conversion to ethanol
- 2012: R&D on bench and pilot scale projects results in $1.07 cellulosic ethanol

2006: Announced 932 Solicitation for commercial demonstration projects

2007: Anticipated Announcement of solicitation for 10% commercial demonstration projects

2008: President Announces Biofuels Initiative (January 31, 2006)

2009 - 2012: Potential development of commercial facilities resulting from loan guarantee program.

2007: Ethanologen project awards

Achieve Cellulosic ethanol production of 200GPD in 2013 and 1BGPY in 2015 per Section 942
**Pathways to Success**

**Fundamental R&D**
- Feedstock R&D
- Biochemical R&D
- Thermochemical R&D
- Products R&D
- Balance of Plant

**Development and Demonstration**
- Existing Wet & Dry Mill Improvements
- Agricultural Residue Processing
- Pulp and Paper Mill Improvements
- Forest Residue Processing
- Perennial Energy Crops Processing

**Deployment**
- Integrated Biorefineries

**Increasing Industry Participation**

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**U.S. Biomass Resource Potentials**

- **Corn** (largest volume grain and source of Ethanol in U.S.)
  - Potential to displace 25% + of our gasoline demand

- **Over 1 billion tons/year of lignocellulosic biomass** (trees, grasses, etc.) could be available in the U.S.
  - Long term potential to displace 50-70% of our gasoline demand (assuming continued research and advanced technology development)

**Short-term:** improve cost and efficiency of ethanol from corn (corn fiber conversion, biomass to fuel plant, develop potential of protein co-product)

**Mid-term:** add feedstock diversity to the existing infrastructure (corn stover, agricultural residues)

**Long-term:** focus on regionally available and sustainable lignocellulose (trees, grasses, & residues) in stand alone facilities
U.S. Biofuels Production (Million Gallons/Year)

Ethanol

- Ethanol Production to date
- Contribution from corn (NCGA estimates)
- Total Ethanol estimate from both grain and cellulose (based on presidents initiative)

Sources:
- RFA Ethanol Industry Outlook 2006
- National Biodiesel Board Estimated Biodiesel Production
- EERE Alternative Fuels Data Center:
  - NCGA
- Presidential Biofuels Initiative

Biofuels Sources

Today (2006)
- Grain Crops (Corn)
  - ~5 billion gallons

2030
- Grain Crops (Corn, Milo, Barley, Wheat, etc.)
  - ~15 - 20 billion gallons
- Corn Fiber
- Switchgrass
- Corn Stover
- Agricultural Residues
- Forestry Residues
  - ~45+ billion gallons
  - ~60 billion gallons
Commercialization Risks

Corn to Ethanol – technology is commercial – issues revolve around market risk
- The RFS will be met well before 2012 timeframe and the MTBE replacement market is close to saturation.
- Petroleum industry may attempt to control ethanol deployment through market price once RFS is met, lowering ethanol prices and curtailing deployment.
- What do we do with the protein?

Cellulose to Ethanol
- Technology Risk
  - Many technologies need continued technical development, before ready for deployment
  - Concern that venture capital may flow to unproven technologies
  - Funding needed in all stages of technology to lower risks
- Financial Risks
  - Loan Guarantees may help, but will they result in sustainability
  - Competition from corn-to-ethanol limits funding opportunities
- Policy Incentives
  - Need to support energy crop development
  - Need to be separate from corn to ethanol if market is to grow in near to mid-term
  - 1B gallon mandate by 2015 (RFS) for cellulosic ethanol needs to be accelerated and expanded
- Project Failure Risk
  - “Gold Rush Mentality” - VC funds, IPO's, Equity funds, and Federal Loan Guarantees tend to push projects to commercialization without proper due diligence leading to unsuccessful pioneer plant launches.
  - Technology failures) will result in a rapid pull-back of available commercialization capital
- General
  - Risk of technology deployment or industry and institutional investment if crude oil prices drop for an extended period
  - Risk of consumer perceived failure due to the lack of a well coordinated, national plan for FFV, Fueling station and transportation infrastructure deployment
  - Competition for engineering, construction and material resources may increase plant costs and limit the rate of deployment – Big Dig Phenomenon

Its all about developing and maintaining critical mass

Deployment Barriers and Solutions

Private Sector Investment (Balance Sheet, Venture, and/or Institutional) Spurred by Risk Mitigation through Validation

Technology Validation at 10% of commercial scale

Loan Guarantee Program/Risk Mitigation Pool
The combination of increased vehicle efficiency and biofuels production will result in reduced dependence on foreign oil imports.

A Balanced Approach

- Policy
- Economics
- Outreach
- Coordination
- Collaboration
- Ethanol Supply
- Fueling Infrastructure
- FFV Vehicles