



## DOE Activities on Biofuels Sustainability Issues

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# Introduction: Department of Energy Biomass Program



- **The Biomass Program (OBP) at the DOE works closely with industry, university, and other partners to conduct research, development, and demonstration in the area of cellulosic ethanol production**
  - **Over \$1 billion announced within the last year for multi-year biofuels research and development projects**
  - **Technology deployment (small and commercial scale biorefinery construction) and core R&D (ethanologen) support**
- **Sustainability is a part of our core mission**
  - **Sustainability is essential to process and distribute biomass on the scale needed to support larger volumes of biofuels production over the long term**
  - **Sustainability activities support R&D aimed at assessing the impacts of biofuels on the environment**

# Biofuels Beyond Ethanol



Today

**Ethanol** – as a blending agent from either grain or cellulosic material from agriculture and/or forestry sectors

**Biodiesel** – Transesterified vegetable oils blended with diesel



**Renewable diesel**– fats, algal oils, waste oils, or virgin oils converted to low sulfur diesel in a petroleum refinery

**Higher alcohols** – butanol, mixed alcohols

**Fischer-Tropsch Liquids** – and other products from synthesis gas including methanol, dimethyl ether, etc

**Pyrolysis Liquids** – alternative feedstock to petroleum refinery or gasification facility

**Methanol derived fuels** – Methanol to gasoline, dimethyl ether and other products

**Other fuels** – Liquid transportation fuels from sugars/oils

Future



## Background: Sustainability within OBP

- Sustainability Program Purpose: To understand and reduce the potential environmental impacts of biofuels production activities
- Sustainability tasks are supported by the Feedstocks platform and Strategic Analysis activities
  - Feedstocks (~\$1.3M in FY09; ~\$600K in FY10)
    - Field-based research to evaluate nutrient and carbon cycling
    - Sustainability standard development
  - Analysis (~\$2.8M in FY09; ~\$4.3M in FY10)
    - LCA of GHG emissions
    - Land use change analysis
    - Water quantity research

# DOE-OBP Research: Land use change



- Using econometric models to help study international land use change issues due to growth of biofuels
- Working with Purdue University's GTAP and Argonne's GREET model to quantify future land use impacts under different scenarios
- Preliminary results were presented to stakeholders at a workshop on January 2009 (<http://www.agecon.purdue.edu/staff/tyner/>)
- Further work is on-going to incorporate land use data and yield assumptions



# DOE-OBP Research: Sustainable Feedstock production



- Regional Biomass Energy Feedstock Partnerships conducting field studies to determine best location for dedicated energy crops
  - Considering climatic conditions, soil types, water quality, and land use
- Series of trials focused on validation of “stover removal tool” to ensure soil health while utilizing agricultural waste for bioenergy
- The Sun Grant Initiative, as a part of the ongoing energy crop field trials carried out through the Regional Partnerships, is collecting and analyzing data on
  - Soil Carbon
  - Hydrology and Water Quality
  - Nutrient cycling—carbon, nitrogen, phosphorous, and potassium
  - Direct Green House Gas (GHG) Emissions

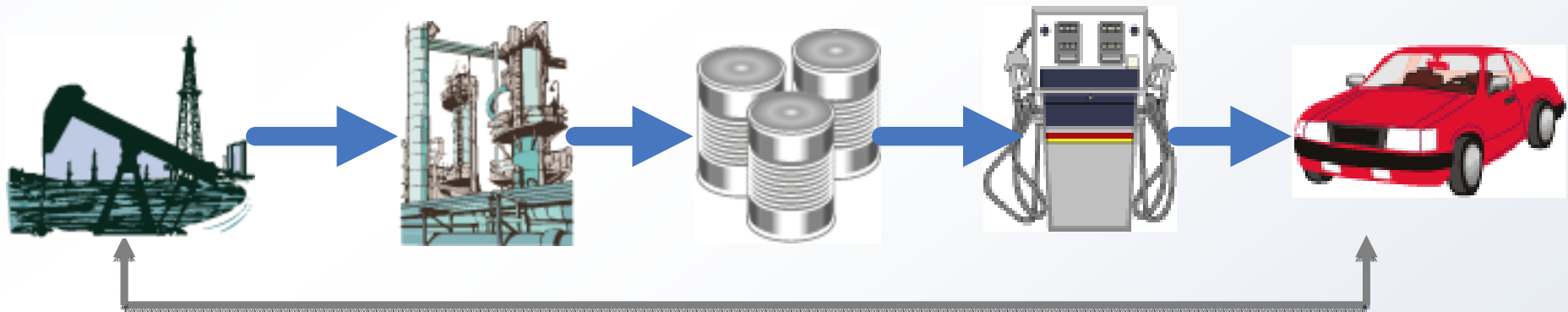


# Climate Change: The GREET Model



## Greenhouse gases, Regulated Emissions, and Energy use in Transportation (GREET) Model

- Developed by Argonne National Laboratory to assess Well-to-Wheels Energy and Greenhouse Gas Emissions of Vehicle/Fuel Systems
  - More than 100 fuel production pathways from various feedstocks
  - More than 75 vehicle/fuel systems
- GREET and its documents are available at Argonne's website at <http://www.transportation.anl.gov/software/GREET/>



**Well to Wheels**

**Fuel Cycle GREET 1.8**

# Cross-cutting efforts: The Great Lakes Bioenergy Research Center



- **GLBRC one of three Office of Science-funded centers**
  - Only one focused on sustainability issues
- **DOE-OBP leveraging existing GLBRC sustainability efforts through the American Economic Recovery and Reinvestment Act**
  - Novel production systems for perennial, native grassland systems, and integrated systems.
  - Biogeochemical, biodiversity, and socioeconomic responses to expansion and intensification of agriculture and silvicultural practices
  - Spatially explicit land use change forecast on crop area changes

# Mitigation Strategies for Indirect Land Use Change



- Both corn based ethanol and cellulosic biofuels production technologies can be improved to reduce the potential impacts of land use change
- The following draft guiding principles can lead to the development of more detailed mitigation strategies
  - Verify and model land use change effects and impacts for all crops, fuels, and commodities.
  - Understand and manage the direct impacts first using rigorously developed life cycle analysis tools.
  - Increase domestic commodity and feedstock yields to minimize global shifts in crop production.
  - Reduce the mismanagement of global agricultural and forest lands with appropriate research, deployment, and incentive programs.
  - Grow energy crops on marginal lands that do not support high value cash crops.
  - Conduct research to realize the future potential for new feedstocks such as algae grown in marine environments which would have negligible land use impacts.



# Elements of a Land Use Change Model

- Global
- General equilibrium (agriculture, energy, forestry)
- Geo-spatially referenced
- Ability to back-cast and forecast
- Incorporate economic and social aspects of land use change
- Ability to generate policy-based scenarios and sensitivity studies
- Ability to establish cause-and-effect among the different drivers of land use change
- Ability to quantify the contributions of land use change drivers
- Ability to rapidly interchange different feedstocks, conversion technology pathways, and land use data
- Transparent, peer-reviewed, and in the public domain



# Information Resources

- DOE Biomass and Biofuels Program - [www.eere.energy.gov/biomass/](http://www.eere.energy.gov/biomass/)
- DOE Office of Science, Bioenergy Research Centers - <http://genomicsgtl.energy.gov/centers/>
- Alternative Fuels Data Center - <http://www.eere.energy.gov/afdc/fuels/ethanol.html>
- Bioenergy Feedstock Information Network - <http://bioenergy.ornl.gov/>
- Biomass R&D Initiative – [www.biomass.govtools.us](http://www.biomass.govtools.us)

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