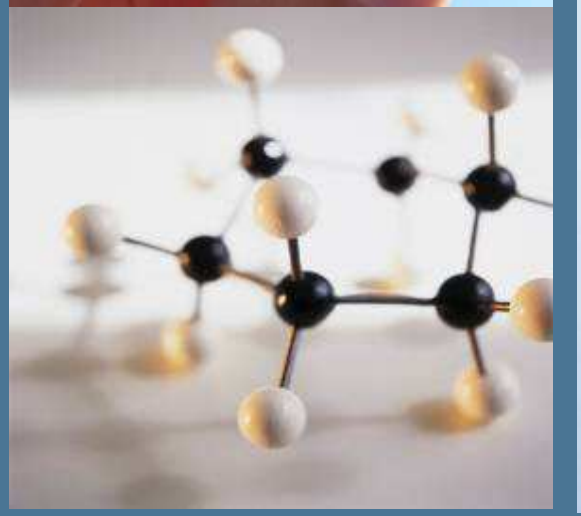

U.S. Department of Energy Biomass Program

Sustainability and Biofuels Production: A DOE Perspective

National Academies' Federal Sustainability R&D Forum
October 17, 2007

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EERE Biomass Program Mission

Develop and transform our renewable and abundant **biomass resources** into cost competitive, high performance biofuels, bioproducts, and biopower.

This will be achieved through **targeted research, development, and demonstration,** leading to deployment in **integrated biorefineries**, and supported through **public and private partnerships**.

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Research, Development and Demonstration

Collaborative R&D

- **Feedstocks:** integration of feedstocks with conversion processes
- **Conversion Technologies:** biochemical and thermochemical
- **Integrated Biorefineries:** systems integration, demonstrations, infrastructure development

Integrated Biorefineries

- **Systems Integration:** feedstocks, conversion, biopower, infrastructure
- **Demonstration:** pilot scale, commercial scale

DOE efforts are paving the way for a strong, domestic bioenergy industry—with commercial success possible by 2012.

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Biofuels Technologies: Today and Tomorrow

	Feedstock Pathways	Conversion Processes	Distribution of Biofuels
Today & Near Term	Corn Ethanol	Biochemical Conversion • Fermentation	Existing Distribution Infrastructure
2012 and Beyond	Cellulosic Ethanol *Agricultural residues, energy crops, natural oils, wood/forestry resources*	Biochemical Conversion • Fermentation • Advanced enzymes Thermochemical Conversion • Gasification • Pyrolysis	Expanded, Advanced Distribution Infrastructure

To Market

Cellulosic ethanol will help meet future biofuels demand

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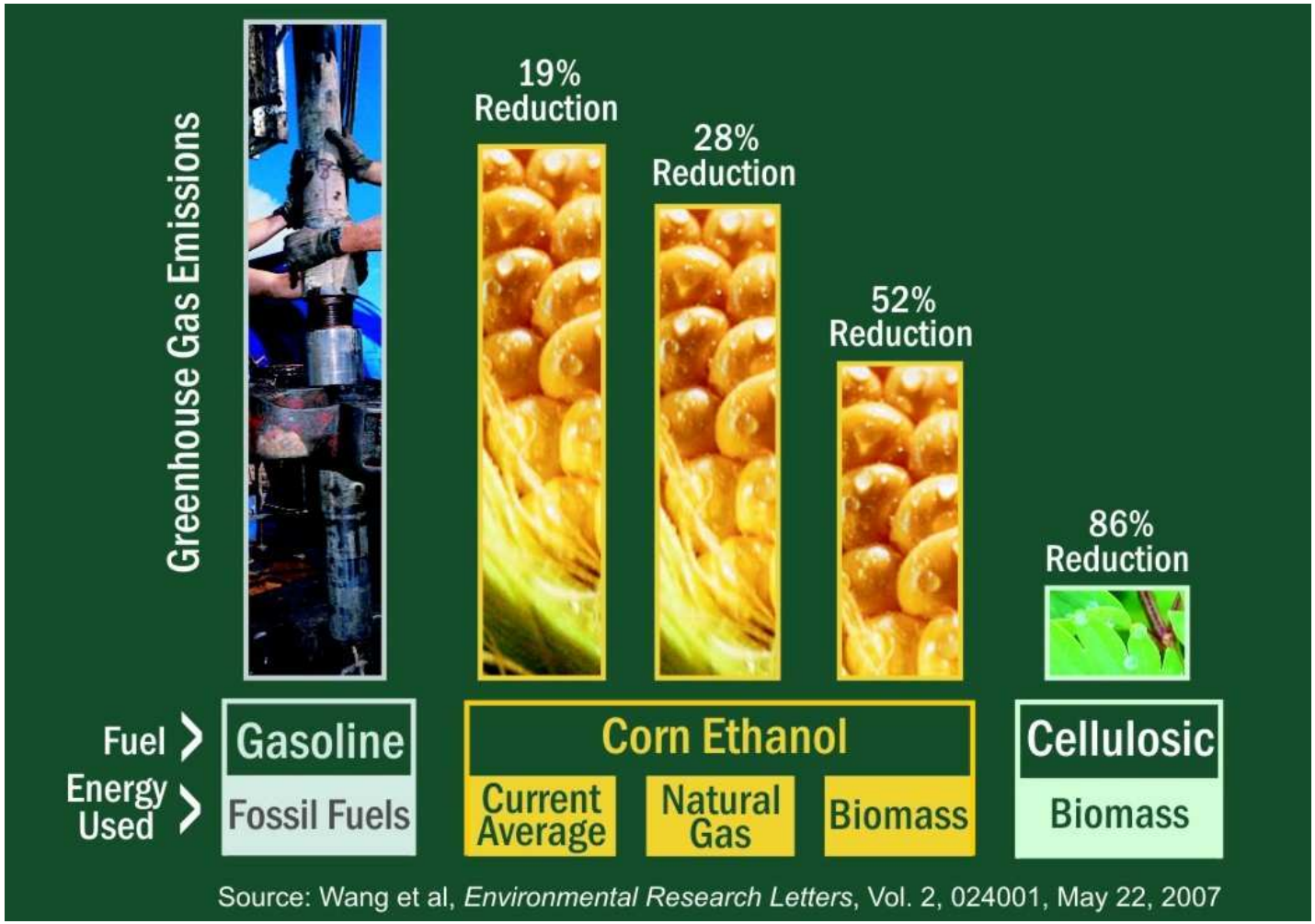
Focus on Cellulosic Ethanol



Cellulosic ethanol can deliver significant greenhouse gas benefits, while not competing with food crops.

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Competitive Solicitations to Engage Diverse R,D,&D Partners

Commercial Scale Biorefineries ($385 million)

- Selected six companies for cost-shared integrated biorefineries
- Projected to produce 130 million gallons of cellulosic ethanol in 5 years

10% Biorefinery Validation ($200 million)

- One-tenth of the projected scale of a first of its kind commercial facility
- Cost-shared integrated biorefinery demonstrations using cellulosic feedstocks and producing a combination of fuels, chemicals, and substitutes for petroleum-based feedstocks and products

Enzyme Solicitations ($56.8 billion)

- Overall Goal: Create commercially available, highly effective & inexpensive enzyme systems for biomass hydrolysis
- Ethanologen: Selected five research teams for work on microorganisms
- Additional second phase of cellulase development with cost-sharing industry partners

Thermochemical Conversion ($8 million)

- Integration of gasification and catalyst development

Joint DOE-USDA Solicitation ($18 million total)

- Biomass R&D Initiative

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EERE Sustainability Efforts

EERE Sustainability Efforts

- Types of Work
  - R&D: field trials, conversion technology development
  - Analysis: model development and forecasting
  - Data collection: synthesizing existing knowledge
  - International cooperation
- Consider impacts on land, air, and water
  - Sustainable feedstock production
    - Ensure magnitude sufficient to support large-scale production facilities
  - Sustainable harvesting
    - Current harvesting, storage and transportation systems need to expand
  - Sustainable biofuels production

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"GREET": A Tool for Projecting Greenhouse Gases, Regulated Emissions and Energy Use in Transportation

Example

- Full life-cycle model
- Full fuel-cycle/vehicle-cycle basis
- Various vehicle and fuel combinations
- For a given vehicle and fuel system, GREET separately calculates—
  - Consumption of total energy
    - Energy in non-renewable and renewable sources
  - Emissions of CO2-equivalent greenhouse gases
    - Primarily carbon dioxide (CO2), methane (CH4)
  - Emissions of six criteria pollutants
    - Volatile organic compounds (VOCs), carbon monoxide (CO), nitrogen oxide (NOx), particulate matter with size smaller than 10 micron (PM10), particulate matter with size smaller than 2.5 micron (PM2.5),and sulfur oxides (SOx)

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National Bioenergy Atlas

Example

- A spatially-referenced decision support system currently under development
- The Atlas will map—
  - Current and potential feedstocks with environmental and infrastructure constraints
- This tool will support a variety of needs
  - Assessing relevant resources and infrastructure regionally and nationally
  - Locating new feedstock production as well as processing facilities (e.g., biorefinery siting)
  - Evaluating the potential contribution of biofuels to the “20 in 10” goal, and beyond
  - Protecting air quality, water resources, and other land use requirements

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Regional Feedstock Partnership

Example

- Part of Sun Grant Initiative (Section 9011 of Farm Bill)
- Partnership between USDA, DOE, DOT, and land grant universities
- Corn stover removal tool
  - Identifies amount of corn stover that needs to be left in the field to ensure sustainability (yield-focused)
  - Prototype has been developed by ARS
  - Plan to begin validation next year through field trials
  - Partnership with USDA/ARS and industry partners
- Energy crop field trials
  - Address environmental impacts of growing energy crops on a dedicated basis
  - Soil carbon
  - Water quality and quantity
  - Air quality including GHG

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International Partnerships

Examples

- US DOE/Brazilian Ministry of Science and Technology Partnership
  - Paper under development
    - "Expansion of Biofuels Production in Brazil and the United States: Greenhouse Gases, Criteria Air Pollutants and Other Sustainability Factors"
  - Life cycle analysis of bioenergy scale-up
  - Establish uniform standards and codes for sustainable biofuels economy
  - Bring benefits of biofuels to other countries while ensuring sustainability – economic, land use, environmental impacts
- Participation in Global Bioenergy Partnership (GBEP)
  - Harmonization of GHG life cycle analysis methodology (Participants: State Department, USDA, DOE, NIST, EPA, EU, Japan, Canada, UN Foundation, Brazil)
- Joint study with NREL, ORNL, and Brookhaven on potential for imports to contribute to "20 in 10" goals (coordinated by DOE policy office and EERE OBP)
  - MARKAL model is used to investigate a variety of scenarios including carbon taxes, oil prices, tariffs, etc.
  - Report is expected by end of 2007; will be publically available
- Plans for bilateral cooperation with Sweden, Denmark, Germany, U.K. and China (forthcoming) to promote R&D for a sustainable energy system

Conclusions

- Sustainability must be addressed through the entire bioenergy supply chain

- We must consider environmental, social, and economic impacts
- As the bioenergy industry grows, the importance of sustainability increases
- DOE/EERE R&D will help identify and address environmental impacts of biofuel production.
- None of us can address sustainability on our own
  - Partnering with public, private, and non-profit sectors

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THANK YOU