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U.S. Department of Energy Bioenergy Technologies Office

Association of Fish & Wildlife Agencies
Agricultural Conservation Committee Meeting
March 29, 2013

Kristen Johnson
Sustainability Lead
Bioenergy Technologies Office
U.S. Department of Energy

Overview

- National priorities and the Renewable Fuel Standard
- Overview of the Bioenergy Technologies Office (BETO)
  - Mission
  - Key RDD&D Activities
- DOE's Billion-Ton Update: National Resource Assessment
- DOE's Commitment to Sustainability
- Take-aways and Discussion

Supporting National Priorities

The utilization of biomass as an energy source supports the following national priorities:

Dramatically reduce dependence on foreign oil

Promote the use of diverse, domestic, and sustainable energy resources

Establish an advanced bioindustry and create jobs

Reduce carbon emissions from energy production and consumption



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Office Mission and Key Goals

Mission

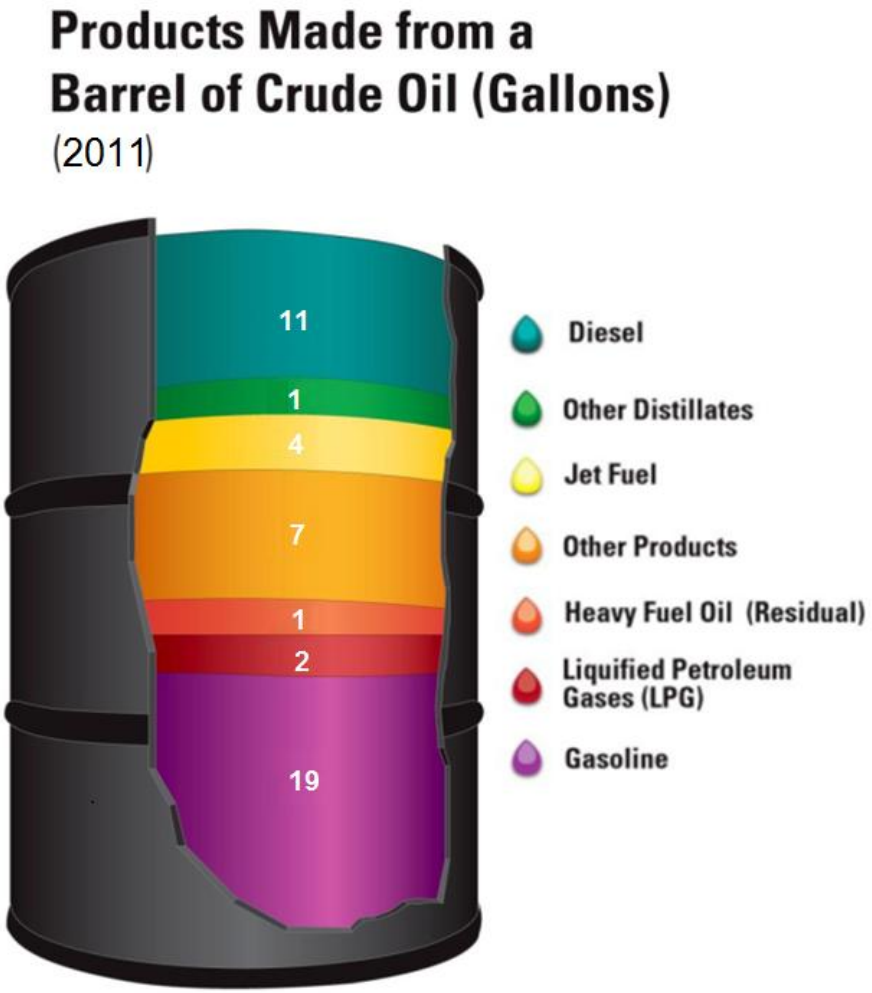
Develop and transform our renewable biomass resources into commercially viable, high-performance biofuels, bioproducts, and biopower through targeted research, development, demonstration, and deployment supported through public and private partnerships.

Goals

The goal of the Office is to develop commercially viable biomass utilization technologies to:

- Enable sustainable, nationwide production of advanced biofuels that are compatible with today's transportation infrastructure and can displace a share of petroleum-derived fuels to reduce U.S. dependence on oil
- Encourage the creation of a new domestic bioenergy industry supporting the Energy Independence and Security Act of 2007 goal of 36 billion gallons per year of renewable transportation fuels by 2022.

Replacing the Whole Barrel

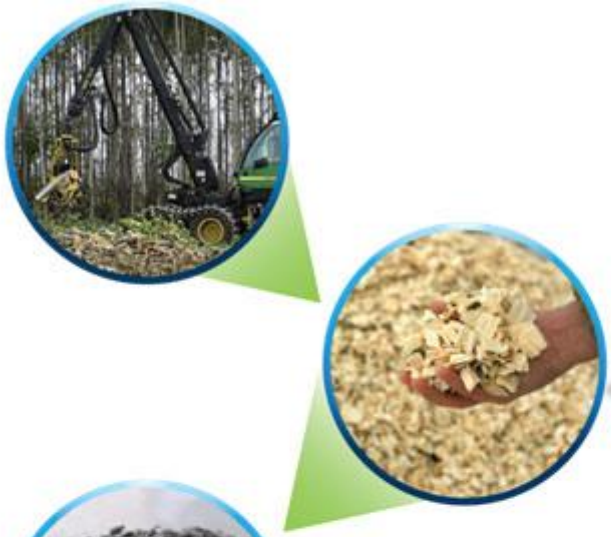


- Reducing dependence on oil requires replacing diesel, jet, heavy distillates, and a range of other chemicals and products
- Greater focus needed on RDD&D for a range of technologies to produce hydrocarbon fuels and displace the entire barrel of petroleum

Source: Energy Information Administration, “Oil: Crude Oil and Petroleum Products Explained” and AEO2009, Updated July 2012, Reference Case.
*American Petroleum Institute.

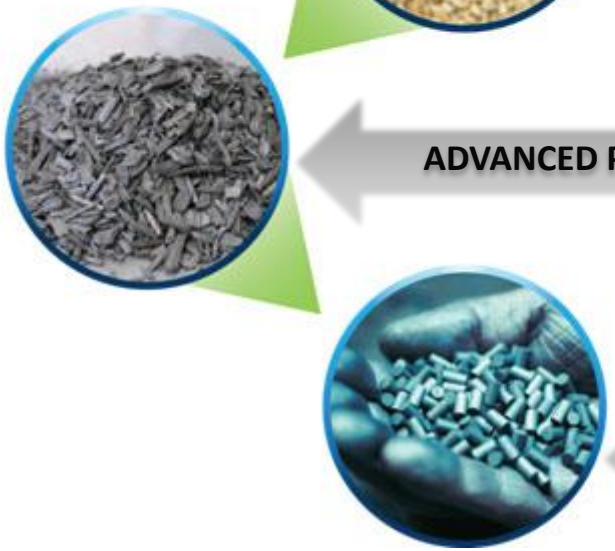
Sustainable Feedstock Supply

Feedstock supply efforts focus on RD&D to develop and optimize cost-effective, integrated systems for harvesting, collecting, storing, preprocessing, handling, and transporting.



FEEDSTOCKS

Sustainable feedstocks include
- Agricultural residues
- Forest resources
- Dedicated energy crops
- Algae



ADVANCED PREPROCESSING

UNIFORM FORMAT TARGETS

A new uniform format advanced supply system design will improve the capacity and efficiency of each feedstock logistics unit operation

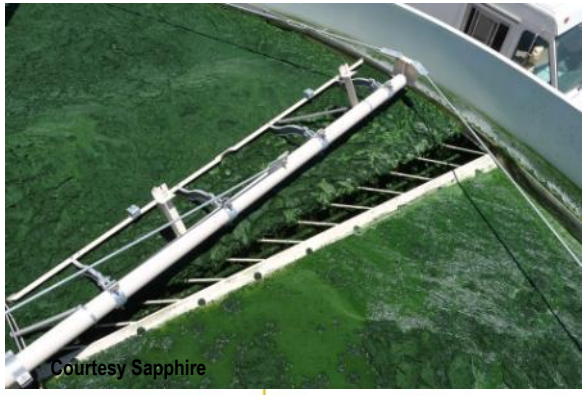
Algae Feedstocks

Activities include R&D on algal feedstocks and issues related to the sustainable production of algae-derived biofuels.

Benefits	Challenges
High productivity expands domestic biomass potential	Affordable and scalable algal biomass production
Adds value to unproductive or marginal lands	Feedstock production and crop protection
Ability to use waste and salt water	Energy-efficient harvesting and drying
Potential recycling of carbon dioxide	Extraction, conversion, and product purification
Production of a range of biofuel feedstocks suitable for diesel and aviation fuels	Siting and sustainability of resources


Courtesy University of Arizona


Courtesy Sapphire


Courtesy Sapphire

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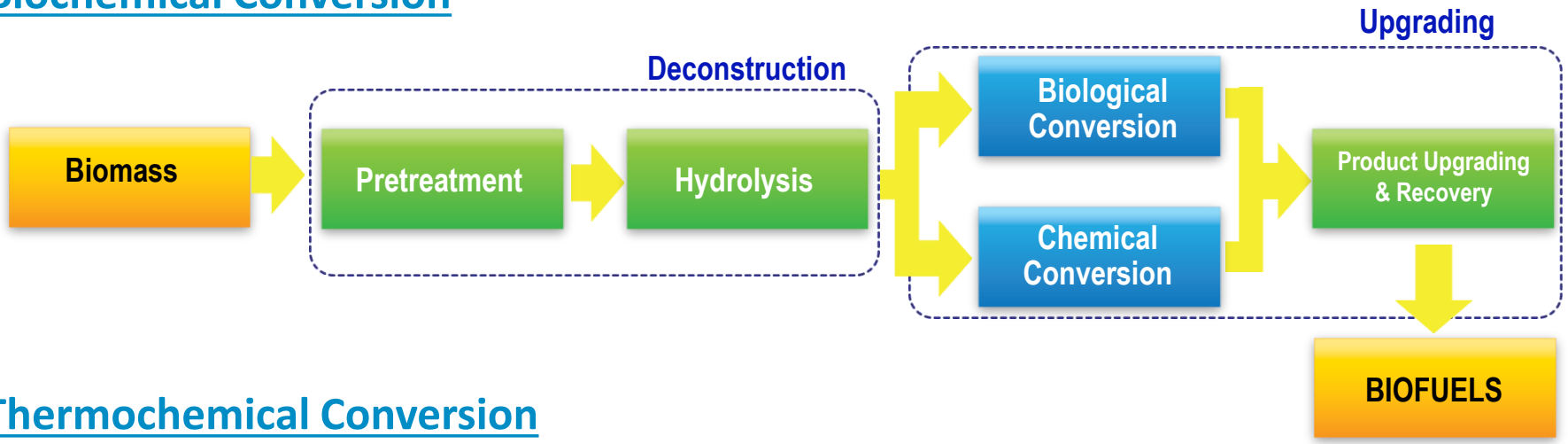
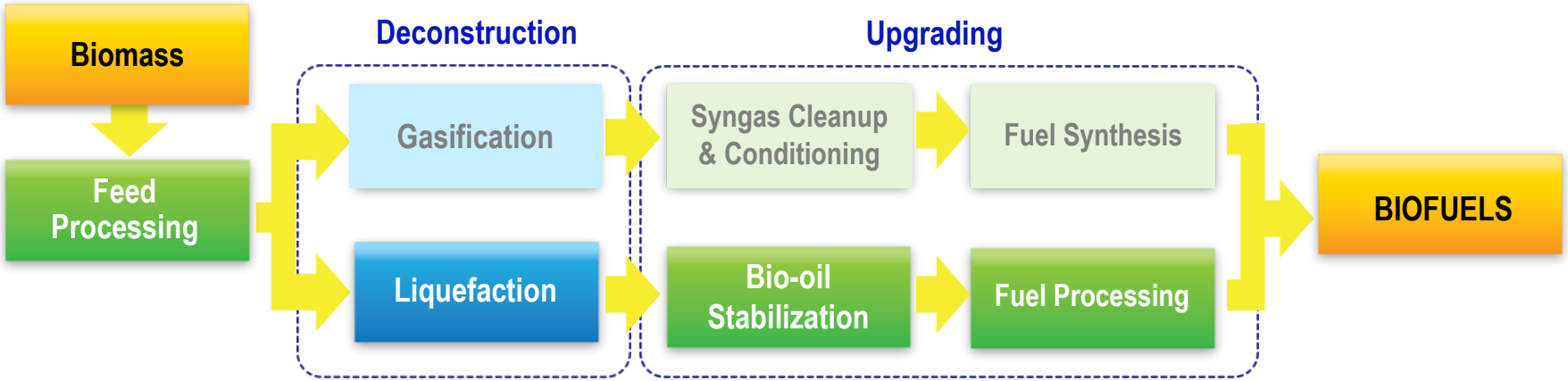
Biomass Conversion RD&D

Biochemical Conversion

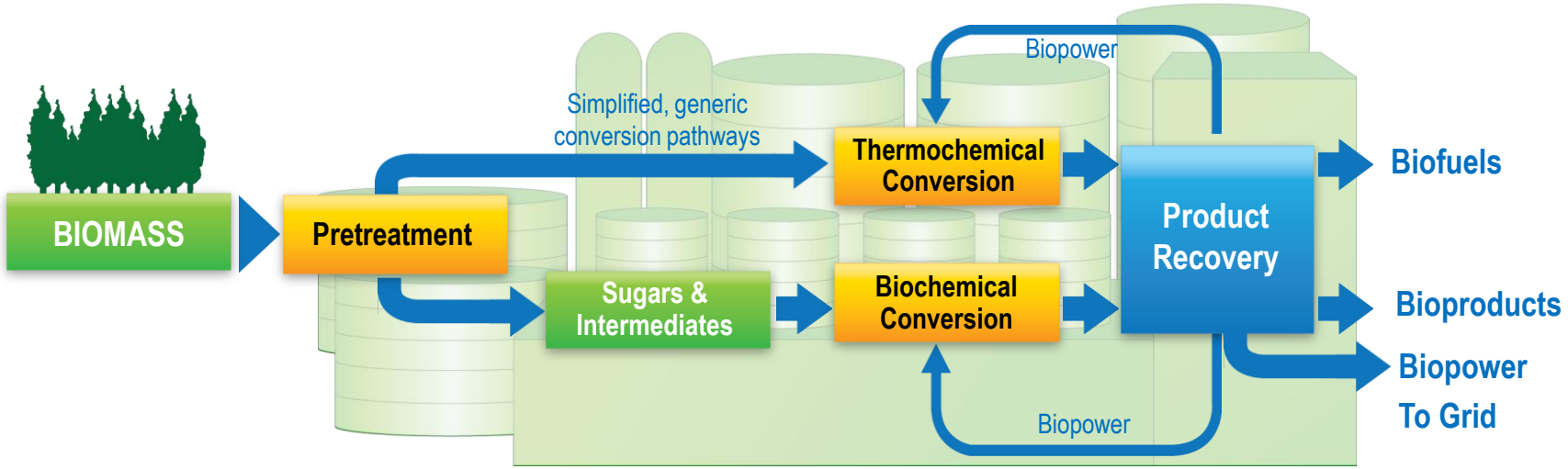


Thermochemical Conversion



Demonstration and Deployment

Integrated biorefinery (IBR) projects prove the viability of various feedstock and conversion pathways and reduce technical and financial risks by following a progression from pilot-, to demonstration-, to commercial-scale facilities.



Biomass Key Challenges	Pretreatment Key Challenges	Conversion Key Challenges	Product Key Challenges
• Reliable supply • Consistent quality • Affordable delivery	• Biomass feeding • Biomass sizing and moisture • Solids handling	• Product yields • Construction materials • Catalysts • Fermentation organisms	• Separations • Catalytic upgrading • Recycle loops

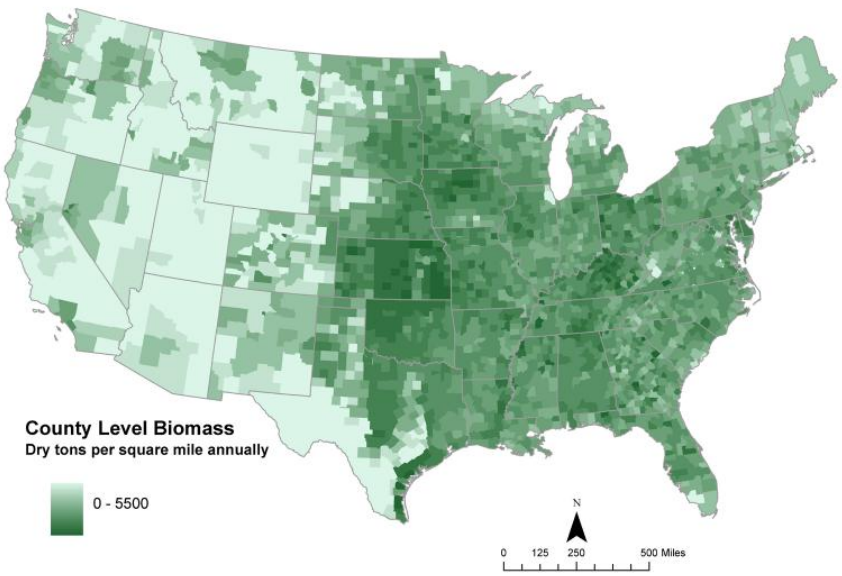
Integrated Biorefinery Project Locations

Grey markers signify projects that are no longer active with the Bioenergy Technologies Office

U.S. Billion-Ton Update

- **Provides current and potential available biomass for 2012-2030**
- **Estimates are at the county level and for a range of costs to roadside**
- **Has scenarios based on crop yields and tillage practices**
- **Models land use for energy crops and ensures meeting food, forage, and export commodity crop demands**
- **Includes sustainability criteria**
- **Report and data on the web**

www.bioenergykdf.net



Biomass Feedstock Resource Base

- Forest resources
  - **Logging residues**
  - **Forest thinnings (fuel treatments)**
  - **Conventional wood (new)**
  - **Fuelwood**
  - **Mill residues**
  - **Pulping liquors**
  - **Urban wood residues**

- Agricultural resources
  - **Crop residues**
  - Grains to biofuels
  - **Perennial grasses**
  - **Short-rotation woody crops**
  - Animal manures
  - **Annual energy crop (new)**
  - Food/feed processing residues
  - MSW and landfill gases

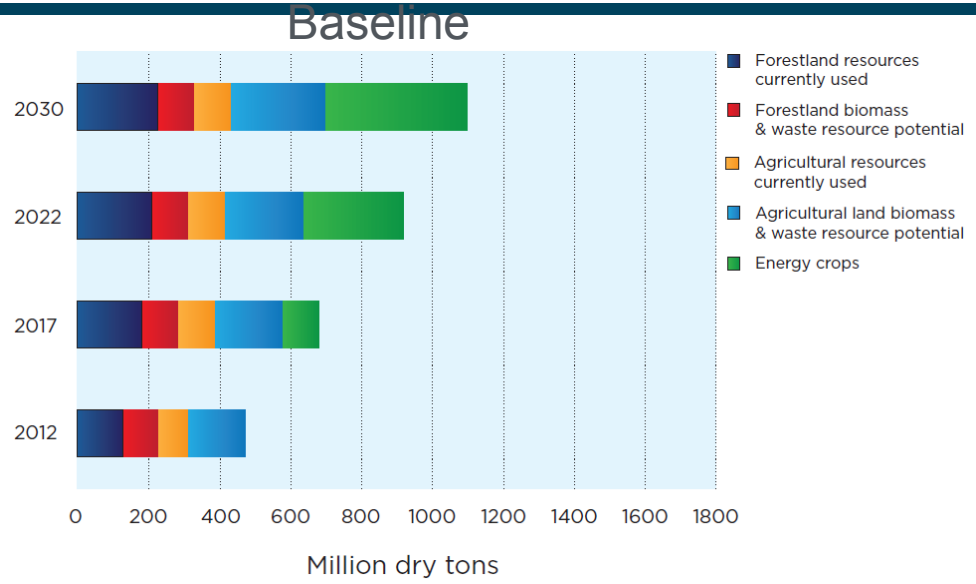
U.S. Billion-Ton Update: Findings

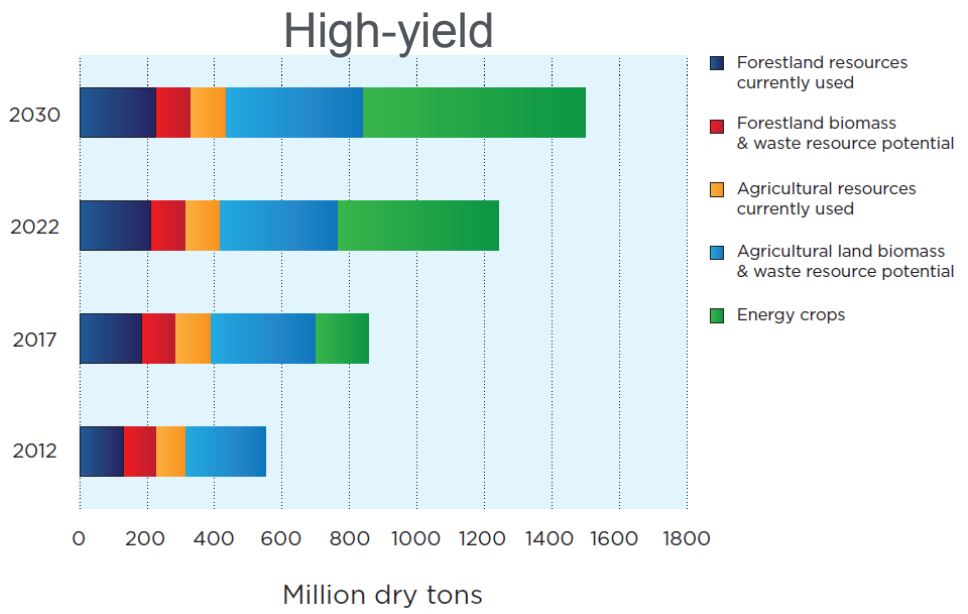
Baseline scenario

- Current combined resources from forests and agricultural lands total about 473 million dry tons at $60 per dry ton or less; about 200 million dry tons from forestry
- By 2030, estimated resources increase to nearly 1.1 billion dry tons; about 300 million dry tons from forestry

High-yield scenario

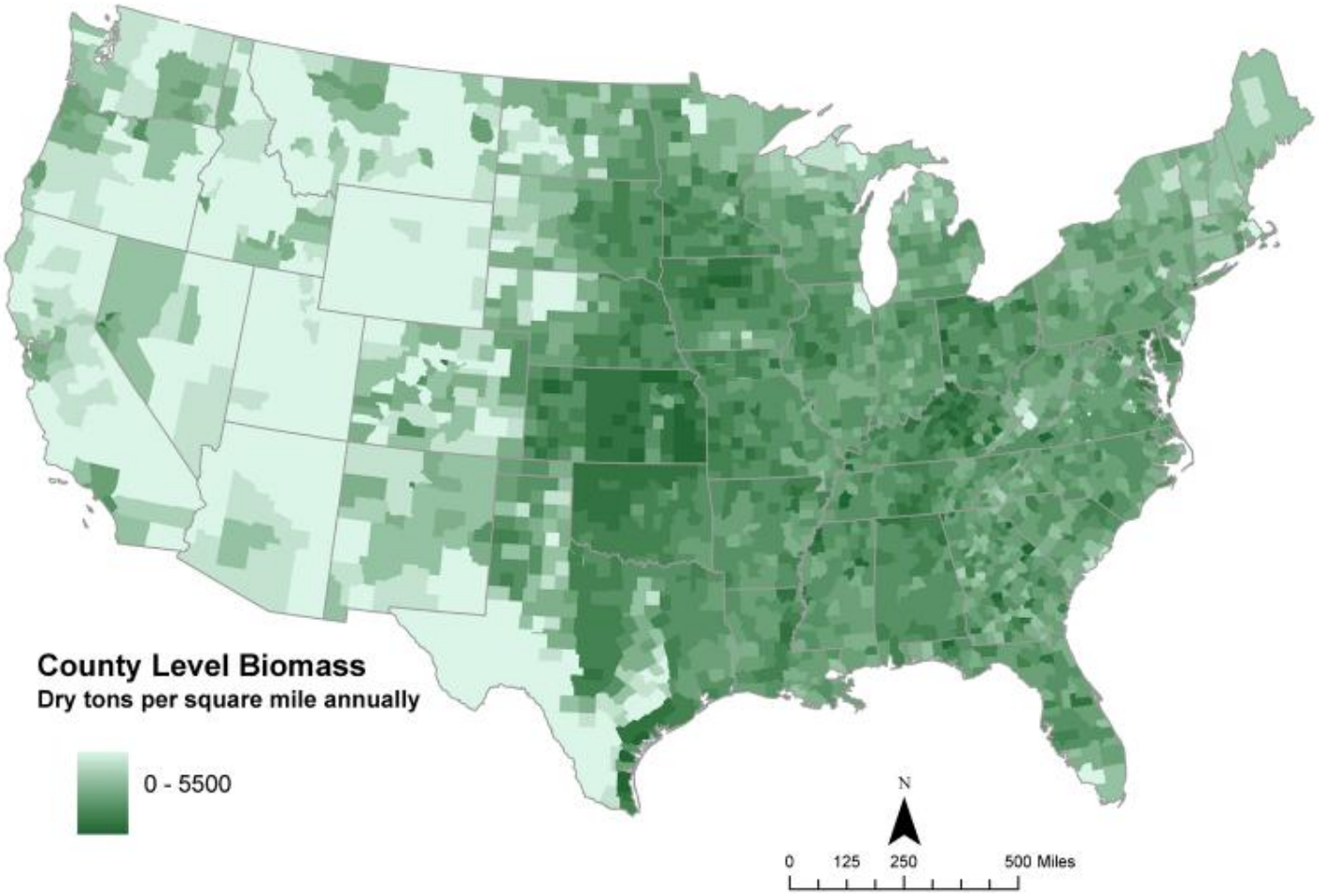
- Total resource ranges from nearly 1.4 to over 1.6 billion dry tons annually of which 80% is potentially additional biomass;
- No high-yield scenario was evaluated for forest resources, except for the woody crops





Potential County-level Resources at $60 Per Dry Ton or Less in 2030

Under Baseline Assumptions



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Sustainability Approach

- **Crop Residues**
  - Residue removal tool used to estimate retention coefficients for wind and water erosion and soil C
  - No removals on tilled land
  - Nutrient replacement

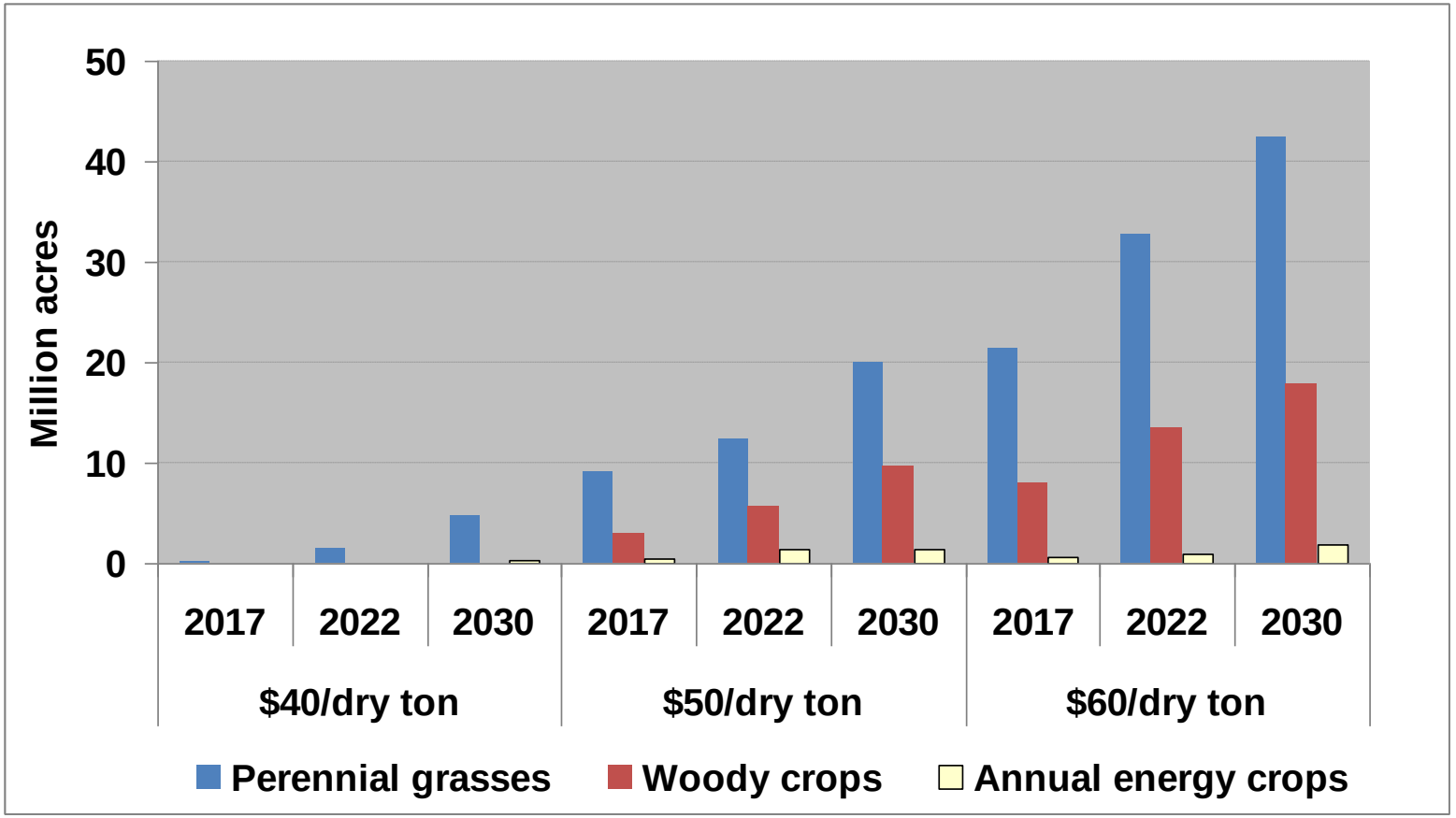
- **Forest Residues**
  - Removed reserved and roadless designated areas
  - Removed steep and wet areas, and sites requiring cable systems
  - No road building
  - Biomass retention levels by slope class
    - Logging residues - 30% left on-site
    - Fuel treatment thinnings - Slope <40% = 30% of residue left on-site; Slope >40% to <80% = 40% of residue left on site; Slope >80% = no residue is removed (no limbs or tops yarded)
  - No harvest greater than growth by state
  - Merchantable mill capacity limits by state
  - Assumed BMP compliance in costs

Sustainability Approach (Continued)

- **Energy Crops**
  - Allowed on cropland, cropland pasture, permanent pasture (no forestlands)
  - Did not include CRP lands
  - Not allowed on irrigated cropland & pasture
  - No supplemental irrigation
  - Intensification of pasture land required to meet lost forage
  - Conversion of pasture constrained to counties east of the 100th meridian except for Northwest
  - Energy crops returns must be greater than pasture rent plus additional establishment and maintenance costs
  - BMPs for establishment, cultivation, maintenance, and harvesting of energy crops
  - No tillage for perennial grasses establishment
  - Used limits of land change to ensure landscape diversity
    - 10% of cropland can convert annually up to 25% maximum
    - 20% of cropland pasture annually up to a maximum of 50%
    - 5% of permanent pasture annually up to a maximum 50%
  - Annual energy crops (i.e., energy sorghum) limited to non-erosive cropland and part of multi-crop rotation
  - Retained low-levels of biomass for long-term site productivity with nutrient replacement

Energy Crop Simulated Land Use Change (Baseline Scenario)

- **Land use change at highest simulated prices by 2030**
  - 22 million acres cropland
  - 40 million acres pasture





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Assessing water quality and quantity impacts

Watershed Modeling

- SWAT model (nutrient, sediments, flow)

+

Water Footprint Analysis

- Cellulosic and advanced feedstocks
- Biochemical and thermochemical conversion

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WF Database and Tool Development

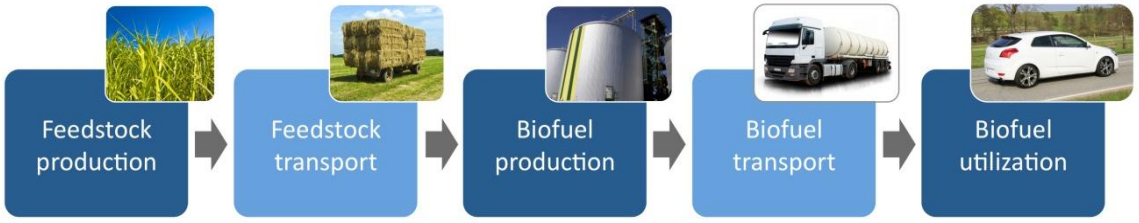
Water use
Water availability
Water footprint
Water quality

Features

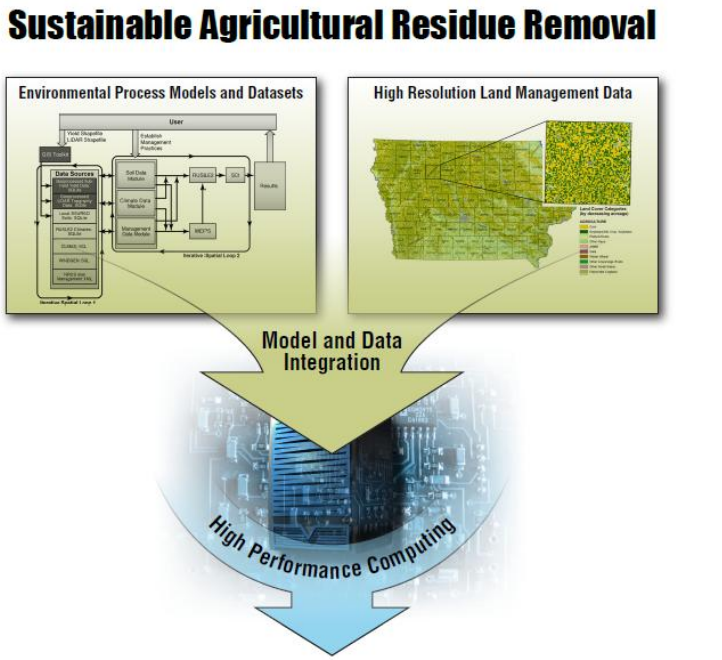
- Spatial and temporal resolution at watershed and county scale
- Baseline and future scenarios
  - Feedstock type
  - Management and practices

Watershed simulation

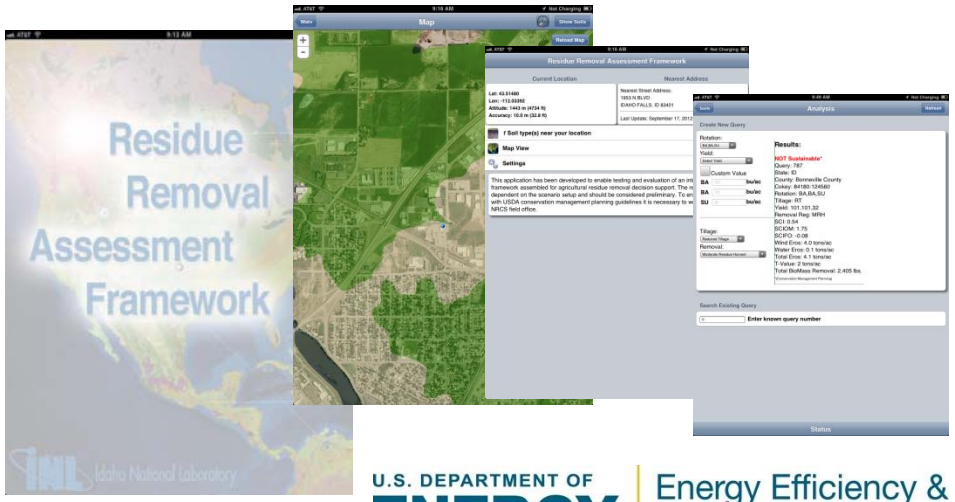
Biofuel life cycle



Harvesting residue at sustainable rates



- The Landscape Environmental Assessment Framework (LEAF) is a decision-support tool that integrates environmental process models and datasets
- Allows farmers and researchers to use site-specific information to estimate sustainable residue removal rates at the sub-field scale
- SustainR2 Mobile App available
  - URL: http://bioenergyldt.inl.gov/mobile



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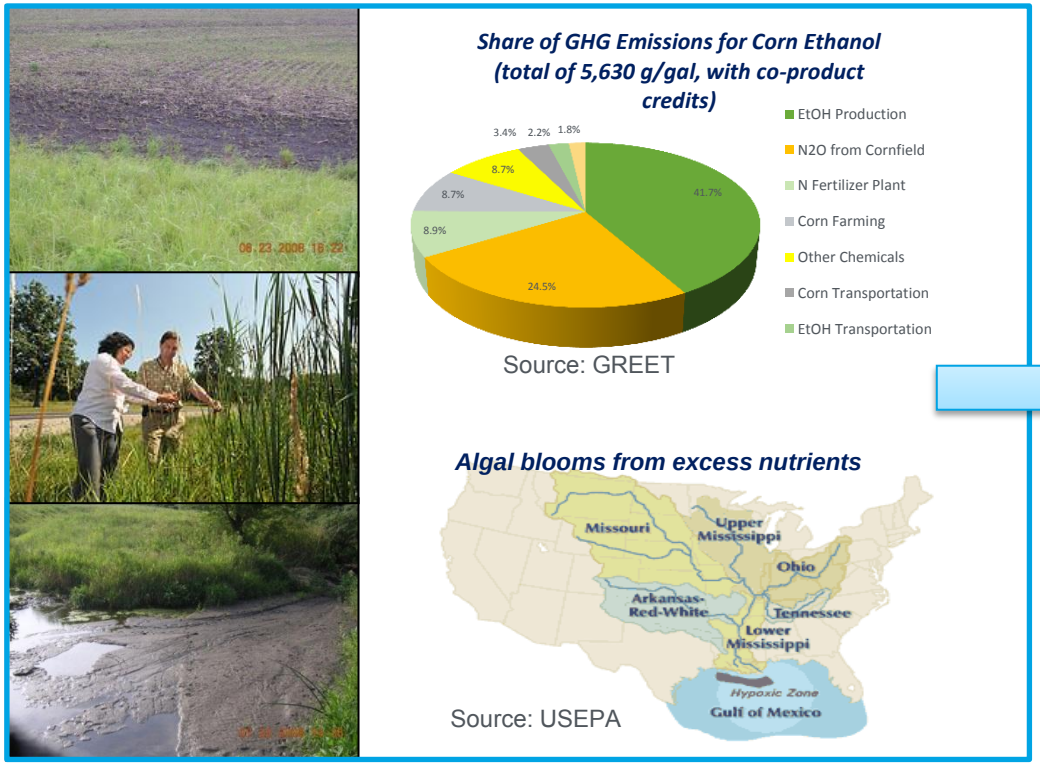
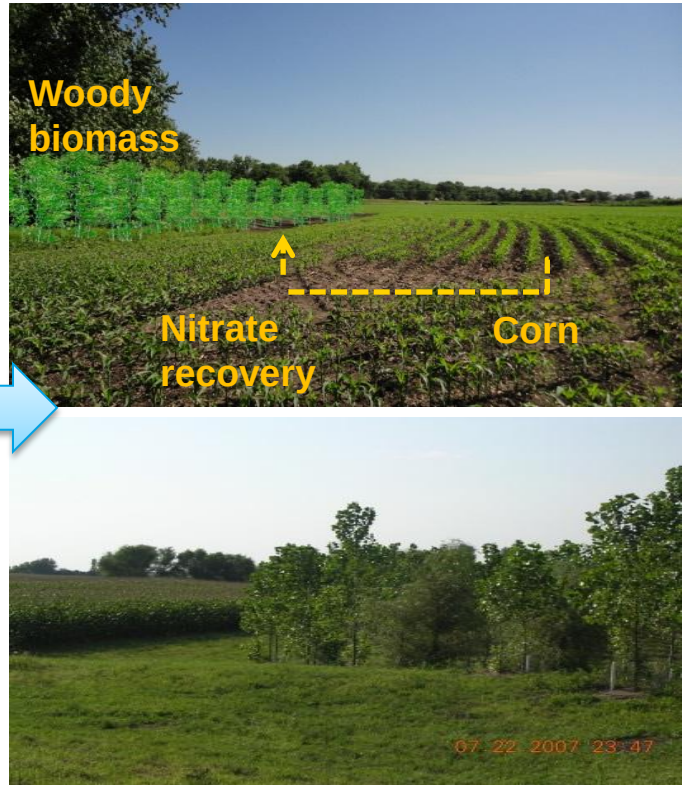
Recovering nutrients with bioenergy crops

- Growing bioenergy crops on underproductive land to recover nutrients from adjacent corn production
- Increasing overall productivity while mitigating non-point source pollution and GHG emissions from agriculture





Negri et al., Argonne National Laboratory

Other Research Efforts

Department of Energy, Office of Science

- Great Lakes Bioenergy Research Center, led by the University of Wisconsin-Madison with Michigan State University as a major partner.
  (http://www.glbrc.org/sustainability)

- Some example recent publications:
  - Robertson BA & Doran PJ (2012) "Biofuels and biodiversity: the implications of energy sprawl."
  - Schrotenboer AC (2011) "Prairie grasses for biofuels and ecological restoration: Modifications to native species and their place in human-modified landscapes."

Other Research Efforts

USDA, National Institute of Food and Agriculture

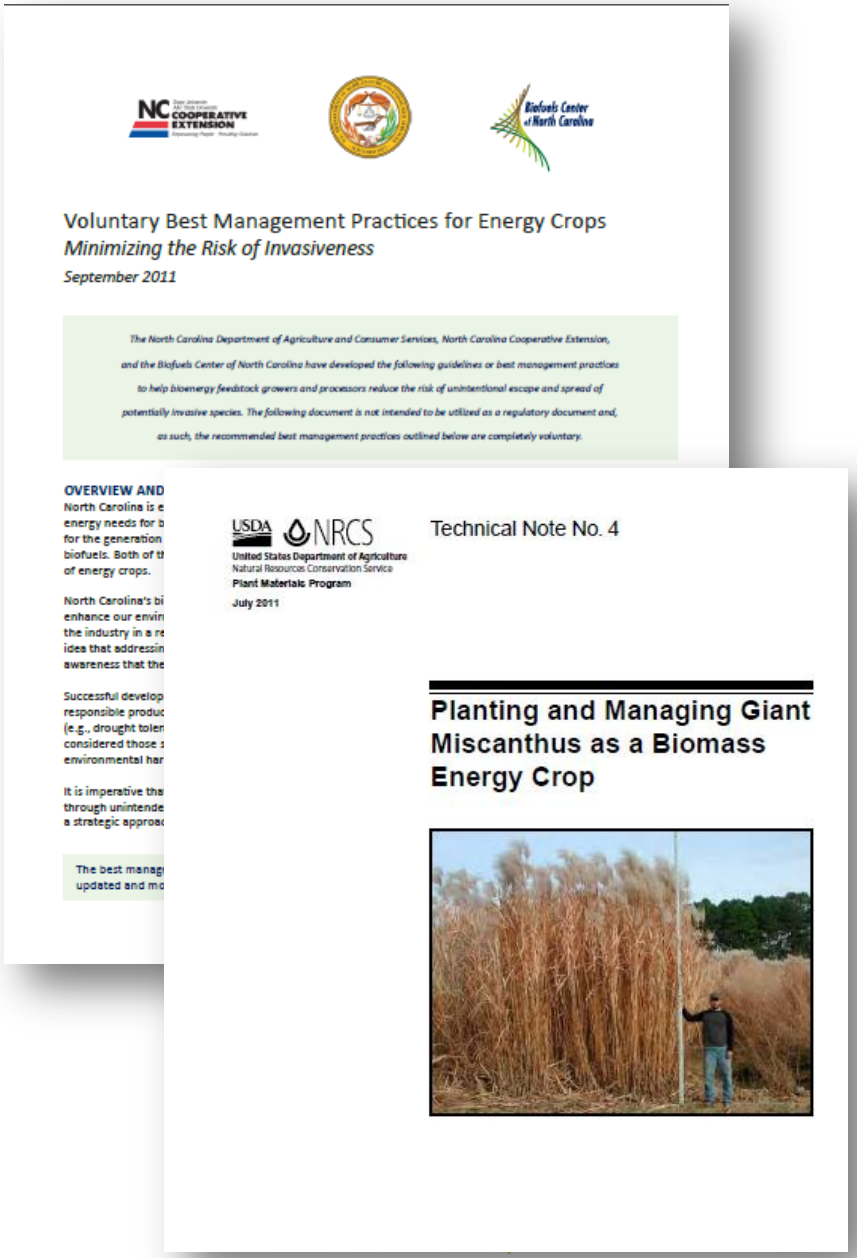
- Agriculture and Food Research Initiative – Sustainable Bioenergy Competitive Grants (http://www.nifa.usda.gov/fo/sustainablebioenergyafri.cfm)

- Some examples of recently awarded research projects:
  - Optimizing grassland bird conservation in an era of biofuel production
  - Multi-scale assessment of wildlife sustainability in switchgrass biofuel feedstock production in the eastern us
  - Developing sustainable perennial bioenergy crop management for birds and pollinators: effects of harvest, refuges and landscape context

Energy Crop BMPs

"Voluntary Best Management Practices for Energy Crops: *Minimizing the Risk of Invasiveness,"* September 2011 (Biofuels Center of North Carolina)

Giant Miscanthus BMPs (NRCS)



Take-aways and Discussion Topics

- The Billion-Ton Study enables a range of analyses; can help counties and states have more informed discussions about local feedstock potential and develop targeted best practices for habitat and wildlife

- DOE's annual conference Biomass 2013 in July
- On May 20–23, 2013, BETO will be hosting a public Peer Review of the projects in its portfolio at the Hilton Mark Center in Alexandria, Virginia
- More information on future events at www.biomass.energy.gov

Take-aways and Discussion Topics

- Energy associations provide information on key players and state-level initiatives
  - NASEO (National Association of State Energy Officials)
  - ASERTTI (Association of State Energy Research & Technology Transfer Institutions) [See Bioenergy Committee]

- A number of states have bioenergy development initiatives to promote technology R&D and commercialization. (e.g., Biofuels Center of North Carolina). Are there opportunities to increase communication and develop mutual objectives?

- Considering the range of current/future R&D and deployment activities underway (feedstock production, feedstock logistics technologies, and biorefineries), are there opportunities for collaborating on data collection, research, and promoting best management practices?



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