U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

DELIVERING HIGH-QUALITY BIOMASS

Development of efficient biomass supply systems supports the national "all-of-the-above" energy strategy—the pursuit of all domestic energy options to increase U.S. competitiveness in the global race for clean energy technology.

Photos: AGCO, Auburn University (top); INL (bottom)

Feedstock Supply and Logistics:

Biomass as a Commodity

Providing biomass for conversion into high-quality biofuels, biopower, and bioproducts represents an economic opportunity for communities across the nation. The Bioenergy Technologies Office and its partners are developing the technologies and systems needed to sustainably and economically deliver a diverse range of biomass in formats that enable efficient use in biorefineries.

An expanding national biofuels industry will require large quantities of domestic biomass. A joint, in-depth analysis by the U.S. Department of Energy (DOE) and the U.S. Department of Agriculture (USDA) determined that the United States has the capacity to sustainably produce over a billion tons of biomass annually—and still meet demands for food, feed, and fiber. The broad diversity of suitable biomass resources means that communities across the country can reap the economic benefits; however, that diversity also means the biomass will exhibit a broad range of physical and chemical properties.

DOE's Bioenergy Technologies Office (BETO) is working with a variety of partners across industry to develop the technologies and systems needed to transform diverse forms of biomass into consistent, high-quality commodity products that can be efficiently handled, stored, and transported to biorefineries for processing. This work requires a complementary focus on feedstock supply interfaces and logistics.

- **Interfaces:** The wide variety of biomass feedstocks can create compatibility issues at interfaces with commercial-scale handling equipment and conversion processes. To address these issues, researchers are exploring biomass specifications and characteristics, the effects of various handling techniques, and the resulting impacts on conversion performance.
- **Logistics:** Systems for harvesting, collecting, preprocessing, storing, and transporting diverse forms of biomass can operate more efficiently if the biomass they handle is fairly consistent in terms of moisture, density, particle size, and other characteristics. Multidisciplinary teams are designing and developing advanced equipment and systems to improve biomass quality, reduce costs, and increase productivity.

Coordinating Interfaces

The compositional variability of biomass has a significant impact on biorefinery economics. BETO and its partners are exploring ways to increase biomass energy content while managing moisture, ash content, seasonal effects, and other characteristics that could hinder effective conversion processing.

Production Interface: Feedstock Assessment

Scientists and engineers from industry, government, and academia contributed to the 2011 *U.S. Billion-Ton Update: Biomass Supply for a Bioenergy and Bioproducts Industry*. This detailed report, which provides a more comprehensive assessment than the 2005 analysis, estimates that the United States could potentially produce 85 billion gallons of biofuels—enough to replace approximately 30% of the nation's 2004 gasoline consumption. The report is a critical resource for landowners, businesses, and other potential participants in biomass markets and the bioeconomy.

Diverse agricultural, forest, and waste resources from across the nation can contribute to the bioeconomy and provide rural America with new economic opportunities. The Office's Regional Feedstock Partnership, which includes land-grant universities, industry, and USDA, has identified and evaluated the top biomass crops in each region by conducting field trials and yield assessments.

Conversion Interface: Feedstock Quality and Characterization

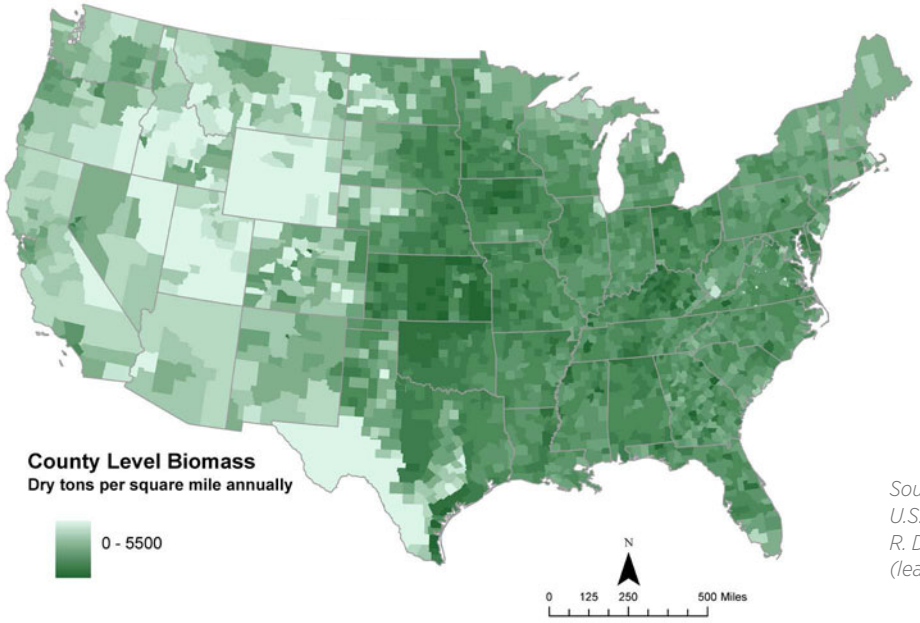
Modeling and analysis work at the national laboratories is helping to determine feedstock specifications and enable a reliable, high-volume supply of high-quality biofuels. Researchers are using science and engineering studies to develop mathematical models and advanced biomass preprocessing systems in support of a ramp up to commercial-scale feedstock supply.

To improve biomass feedstock interfaces and overall performance, Idaho National Laboratory (INL) maintains a comprehensive knowledge management system containing detailed feedstock development data as well as physical samples of feedstocks and process intermediates. This Biomass R&D Resource Library includes more than 65,000 samples, enabling researchers to explore the range of variability in biomass materials and to analyze both the impacts of preprocessing on feedstock characteristics and the impacts of those characteristics on conversion performance.

INL is also developing cost-effective, alternative screening techniques that can characterize and analyze feedstocks in a matter of minutes instead of days. One method combines multivariate analysis with near-infrared spectroscopy to determine the chemical composition of feedstock materials. Another can rapidly identify the inorganic content.

Total Potential Resources, Baseline Scenario 2030

($60/dry ton at landing/farm gate)



Source: U.S. DOE, 2011. U.S. Billion-Ton Update, R. D. Perlack and B. J. Stokes (leads), ORNL/TM-2011/224.

Improving Logistics

Meeting future volume targets for advanced biofuels will require innovative, high-tonnage supply systems and equipment. To develop the necessary logistics, the Office has been instrumental in developing high-volume harvesting equipment, an integrated depot supply system concept, and a process demonstration unit for evaluating preprocessing impacts on biomass characteristics.

DOE provided cost-shared funding for five competitively selected teams to develop and analyze advanced designs for harvesting multiple biomass species and plant parts (including bark, stem wood, needles, and leaves). Each project team included at least one equipment manufacturer and biorefinery to assess the quality of feedstocks delivered by the new system. These projects focused on increasing the bulk density of cellulosic feedstocks and transforming them into either a flowable format or stable packages for easier and more efficient handling, transport, storage, and conversion.

Equipment developed by the project teams was subjected to rigorous, industrial-scale field testing to establish cost and productivity benefits. These efficiency enhancements have helped reduce delivered costs, improve net energy ratios, and reduce harmful emissions.

Switchgrass being harvested in Oskaloosa, IA, where researchers are working with Idaho National Laboratory to assess long-term biomass storage options.
Photo: INL

Five Advanced Logistics Projects

Lead	Description	Feedstocks	
Auburn University	Improved tracked feller buncher with grapple skidder for small-diameter trees; enables in-woods storage and transpirational drying	Southern pine (loblolly) energy plantations	
SUNY	Single-pass cut and chip forage harvester with improved cutting head and handling systems expands harvesting window	Short-rotation woody crops: willow and hybrid poplar	
Genera Inc.	Forage harvester chops field-dried switchgrass for transport to storage, prior to automated compaction and loading into trailers for delivery to biorefineries	Switchgrass	
AGCO	Single-pass harvest system with square bale densification increases corn cob content, reduces ash, and reduces time and fuel consumption	Corn stover, switchgrass, sorghum, miscanthus	
FDC Enterprises	Single-pass harvester and high-density square baler with higher-capacity bale roadsider can harvest up to 70,000 tons of baled material over three years	Switchgrass, corn stover, miscanthus	

Photos: (top to bottom) Auburn University, SUNY, Genera Inc., AGCO, FDC Enterprises

Future Vision: A Uniform-Format Feedstock Supply

The Office is pursuing development of a system that links regionally distributed biomass preprocessing depots to a network of supply terminals and, ultimately, biorefineries (see diagram). The goal is to integrate time-sensitive feedstock harvesting, collection, storage, and delivery operations into efficient, year-round supply systems that deliver consistently high-quality, infrastructure-compatible feedstocks.

Process Demonstration Unit

The Office's Process Demonstration Unit (PDU), operated by Idaho National Laboratory, is a preprocessing research system for demonstrating the production of advanced biomass feedstocks. PDU capabilities include grinding and milling, drying and other thermal treatments, fractionation of plant components, formulation of feedstock blends from multiple biomass types, and feedstock densification. The PDU was recently designated as a National User Facility: the Biomass Feedstock National User Facility (BFNUF).

Advanced Uniform-Format Feedstock Supply System

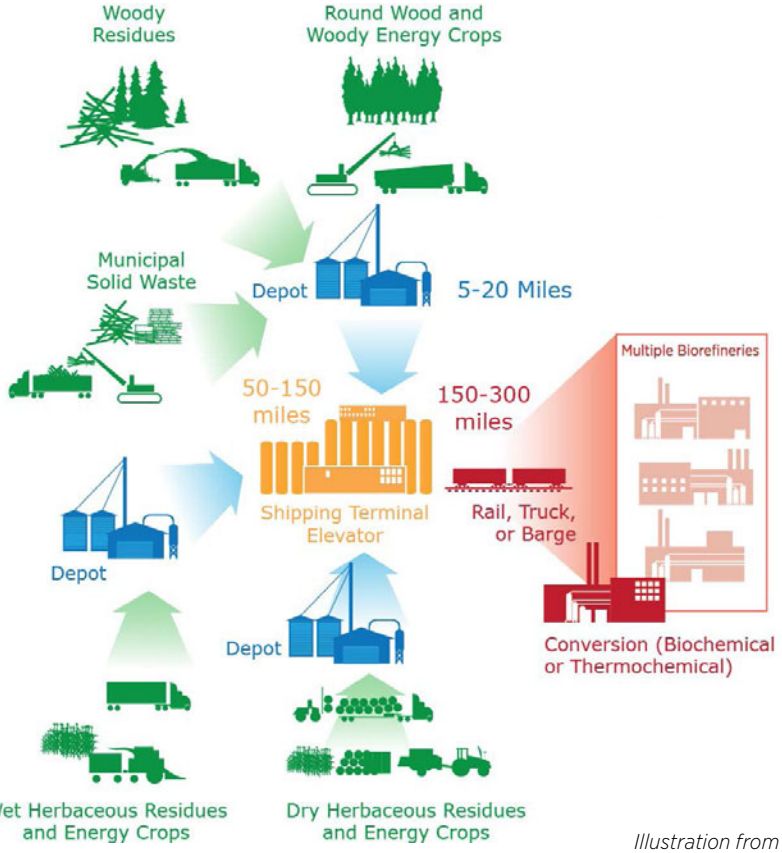


Illustration from BCS Inc.

BETO staff members tour the deployable PDU located at Idaho National Laboratory.
Photo: INL.

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