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

Photos (clockwise from upper left): AGCO, Auburn University, INL

Feedstock Supply and Logistics:

Biomass as a Commodity

Providing non-food biomass for conversion into biofuels represents an economic opportunity for communities across the United States. The Bioenergy Technologies Office and its partners are developing the technologies and systems needed to sustainably and economically deliver a broad range of biomass in formats that enable efficient use in biorefineries.

The growing U.S. bioindustry is poised to convert domestic biomass resources into the full range of fuels and products needed to reduce U.S. oil imports and boost economic growth. Achieving the potential benefits of biofuels for the nation will require large quantities of domestic biomass.

A joint, in-depth analysis by the Energy Department 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 all forecasted demands for food, feed, and fiber. The broad diversity of suitable biomass resources means that communities across the country can reap the economic benefits. That diversity also means that the biomass will exhibit a broad range of physical and chemical properties.

The Energy Department'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, quality-controlled 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 this issue, 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 greatly affects 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 about 85 billion gallons of biofuels—enough to replace approximately 30% of the nation's current petroleum consumption. The report improves our understanding of future biomass markets and is a critical resource for landowners, businesses, and other potential participants in the clean energy economy.

Diverse agriculture, forest, and waste resources from many regions across the nation can contribute to a new bio-based economy and provide rural America with new economic opportunities. The Office's Regional Feedstock Partnerships, which include land grant universities, industry, and USDA, have identified and evaluated the top biomass crops in each region by conducting critical field tests and yield assessments.

Conversion Interface: Feedstock Quality and Characterization

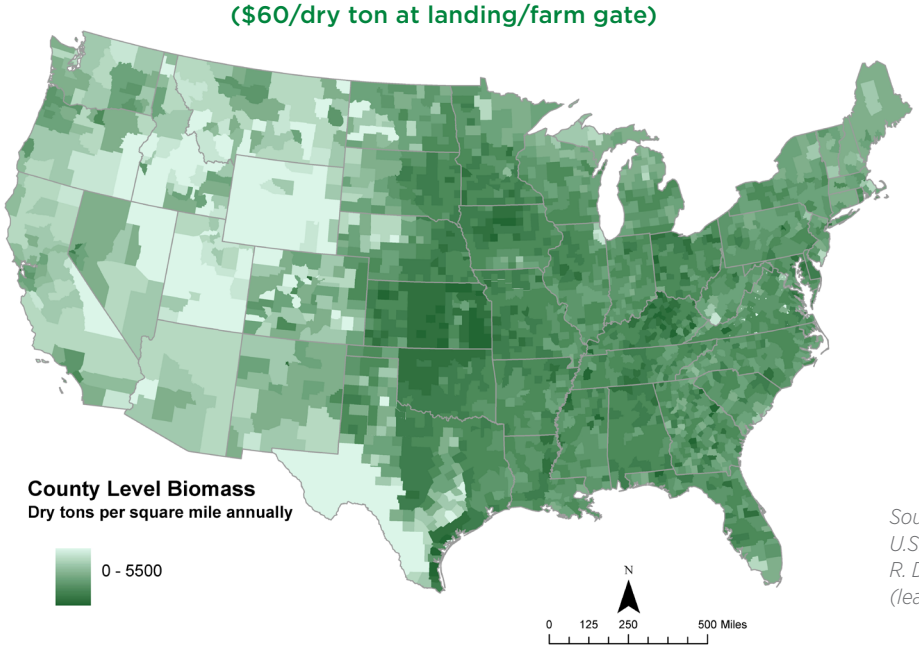
Modeling and analysis work at the national laboratories is helping to determine feedstock specifications and enable a reliable, high-volume supply of high-quality biofuels. Researchers are using science and engineering studies to develop mathematical models and advanced biomass preprocessing in support of a 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 Resource Library includes more than 14,000 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 the future volume targets for advanced biofuels will require innovative, high-volume supply systems and equipment. To develop the necessary logistics, the Office is helping to develop high-volume harvesting equipment, an integrated supply system concept, and a pilot-scale feedstock processing unit for evaluating impacts on biomass characteristics.

The Office competitively selected five Advanced Logistics Projects to develop and analyze advanced designs for using multiple biomass species and plant parts (including bark, stem wood, needles, and leaves). Each project team contributes a 50% cost share and includes at least one equipment manufacturer and at least one biorefinery to assess the quality of feedstocks delivered by the new system. These multi-partner projects are 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 will undergo rigorous, industrial-scale field testing to establish cost and productivity benefits. Efficiency enhancements will reduce delivered costs, improve the net energy ratio, 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

Awardee	Description	Feedstocks	
Auburn University	Improved tracked feller buncher with grapple skidder for small-diameter trees; 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 to expand 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 designed to increase corn cob content, reduce ash, and reduce time and fuel consumption	Corn stover, switchgrass, sorghum, miscanthus	
FDC Enterprises	Single-pass harvester and high-density square baler with higher capacity bale roadsider. Will 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

To integrate the overall preparation (production, harvest, storage, transport, and pretreatment) of an advanced, 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 Feedstock Process Demonstration Unit (PDU), operated by Idaho National Laboratory, is a preprocessing research system for demonstrating the production of advanced biomass feedstocks at pilot scale. Feedstock 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.

Advanced Uniform-Format Feedstock Supply System

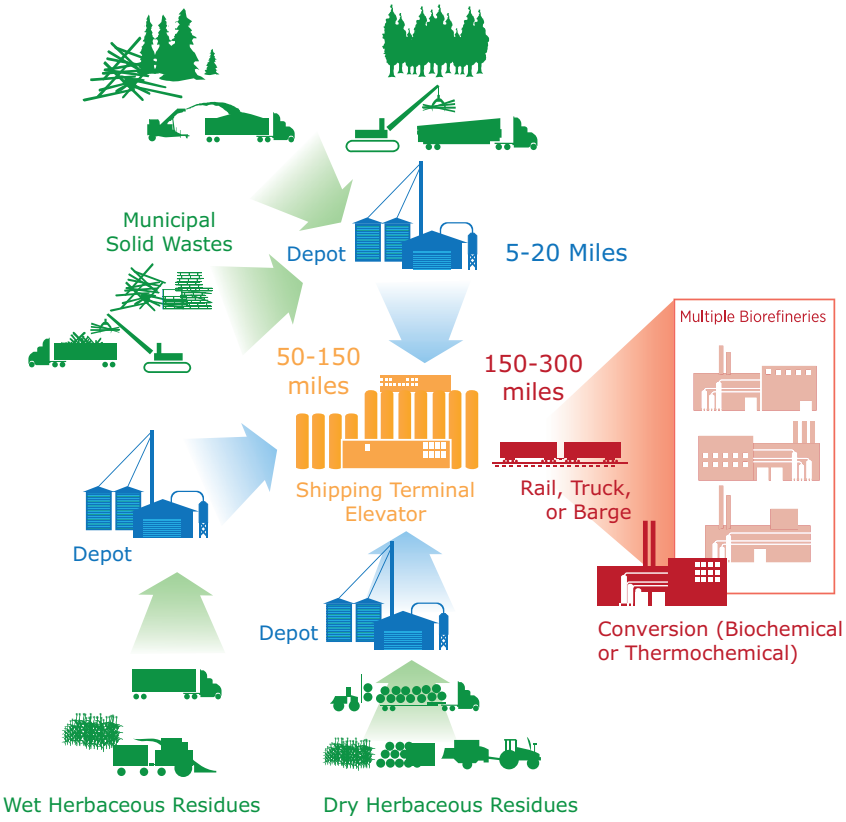


Illustration from BCS Inc.

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

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