



U.S. DEPARTMENT OF ENERGY

## BIOENERGY KNOWLEDGE DISCOVERY FRAMEWORK

Mapping the future of bioenergy with GIS  
and other cutting-edge data and tools

### Sustainable Future for Bioenergy

To meet the mandated national bioenergy goals, the United States' evolving bioenergy industry must be efficient, reliable, and sustainable. A key challenge to achieving these goals is synchronizing all of the steps in the biomass-to-biofuels supply chain—from biomass production and logistics to bioenergy production, distribution, delivery, and end use. Each current and proposed production system will be subject to economic, environmental, and infrastructure challenges unique to its region. While energy demand and end use may be concentrated in highly populated areas, bioenergy production may be dispersed throughout the United States. Determining the optimal sustainable solutions, therefore, requires considering a variety of regional factors, including climate, soils, vehicle fleets, and transportation routes.



Cars at electric vehicle charging station.  
Photo: iStock/000003075798.



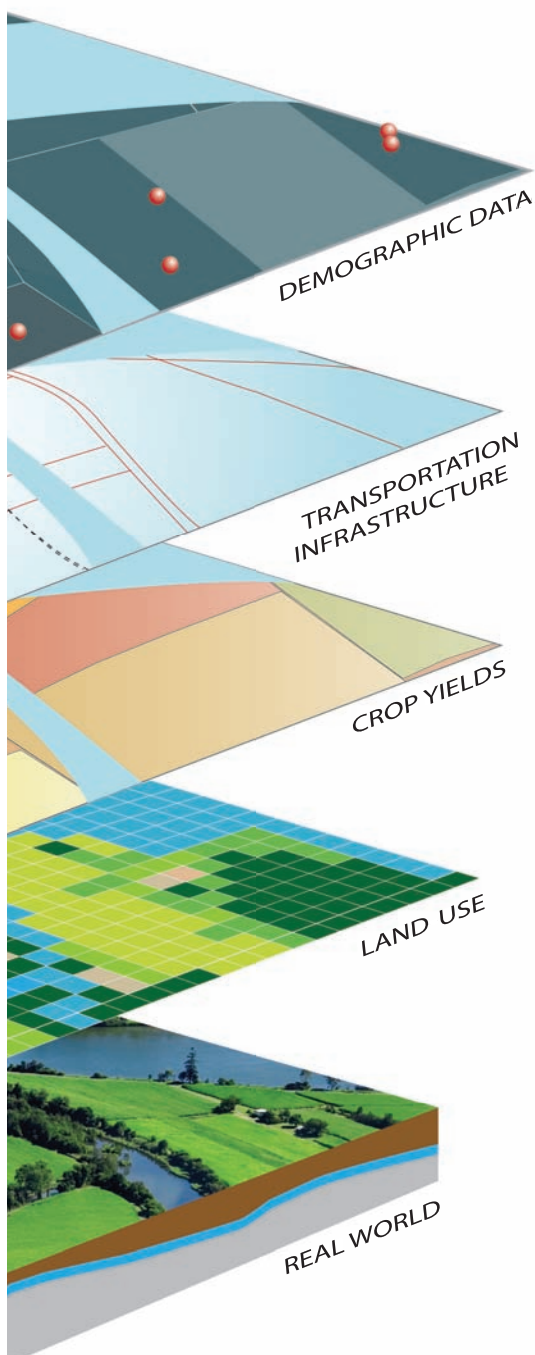
Farmer. Photo: iStock/5990146.

### Achieving the Vision

The development of a sustainable bioenergy industry requires thorough knowledge integration and decision support. The [Bioenergy Knowledge Discovery Framework](#) (KDF) facilitates informed decision making by providing a means to synthesize, analyze, and visualize vast amounts of information in a spatially integrated manner. This Geographic Information System (GIS)-based framework allows users to comprehensively analyze the economic and environmental impacts of various development options for biomass feedstocks, biorefineries, and infrastructure. Analysis and visualization of socioeconomic and industrial factors integrated with spatial data can be used for planning, development, and management decisions, ensuring reliable and sustainable bioenergy production.

### What is a Geographic Information System?

A GIS is a collection of data where every data point has an explicit spatial location. Essentially, a GIS can be thought of as a digital model of the physical world where every data point corresponds to a place. Modern GIS' are suites of hardware, software, and electronic databases built from a variety of data sources that can range from remotely sensed measurements to waypoints collected in the field with handheld devices. Geographic information science is an advanced field that utilizes GIS to enable researchers to analyze, visualize, and synthesize vast amounts of information to help understand real-world interactions and support decision-making processes. GIS is a critical component in planning and deploying renewable energy technologies, including biomass production capabilities.



### A Framework Built through Collaboration

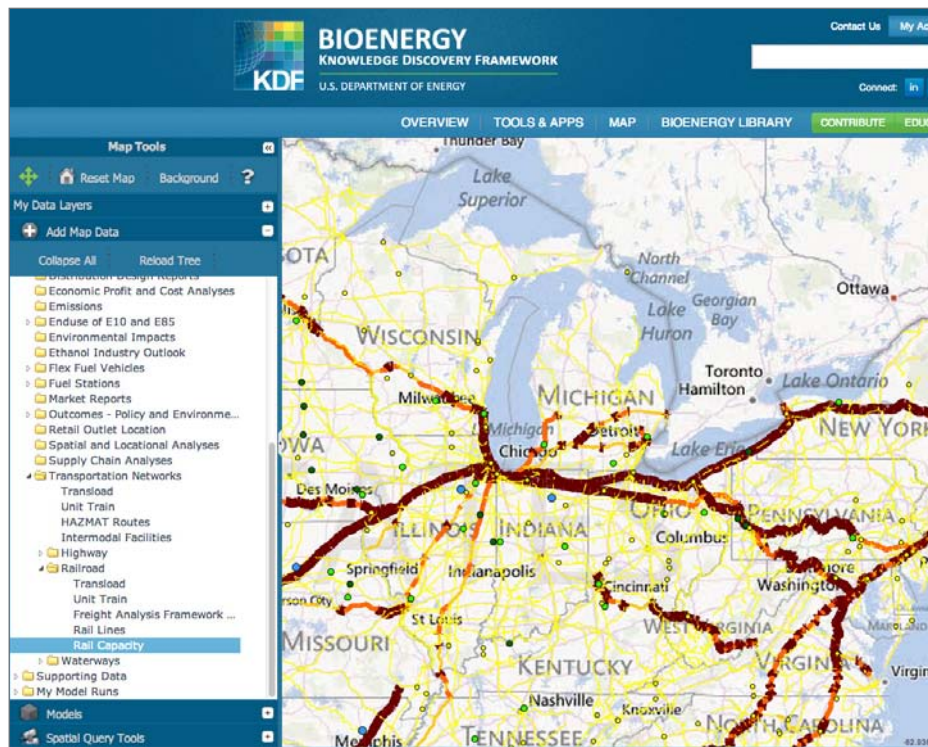
Developed by Oak Ridge, Argonne, and Idaho National Laboratories and university partners under the direction of the Bioenergy Technologies Office, the KDF is helping achieve the vision of a biomass-based energy generation and delivery network that provides reliable, cost-effective, and sustainable bioenergy.

### Data Framework

- Robust geospatial technology framework for data collection, integration, and management to ensure quality analysis and visualization
- Dynamic, distributed architecture that integrates data, models, and tools developed by the Department of Energy with those from other federal partners, industry, and academia
- Web-enabled and interactive access
- Role-based user access to relevant content and functionality, determined by security and data restrictions
- Standards-based technology framework that allows integration of data, models, and tools from distributed sources
- Components accessible through multiple platforms, from desktops to handheld devices

### User Interface Features

- Easy labeling functions that allow users to associate related literature, data, and models
- Quick-search function for rapid information access and easily accessible folder tree for more thorough data exploration
- Multi-site search for easy access to data and publications from external sites and sources, such as the U.S. Department of Agriculture or Open Energy Information (i.e., Open EI)
- Data-uploading capabilities that allow users to keep data private, share with specific users, or make available to everyone with a KDF account



The online KDF interface ([bioenergykdf.net](http://bioenergykdf.net)) offers users news and research highlights, search functions, data access, mapping tools, and more.

## Supporting Complex Decisions

As a national decision-support framework, the Bioenergy KDF unlocks the value of readily available information to support the development of a sustainable and robust bioenergy industry. It helps individuals and organizations identify promising areas for feedstock production and processing, assess relevant infrastructure resources at multiple scales, and evaluate the

potential for biofuels to meet legislated renewable fuels targets. The decision support provided by the KDF can also improve efforts to reach air quality, water resources, land conservation, and other environmental goals by fostering information exchange and collaboration between stakeholders.



### Consumers

Consumers can learn about the newest sustainability standards and explore the latest research on the impact of the bioenergy industry on the economy, environment, and local communities.

## KDF

bioenergykdf.net



### Policy Makers

- Federal
- State
- Local

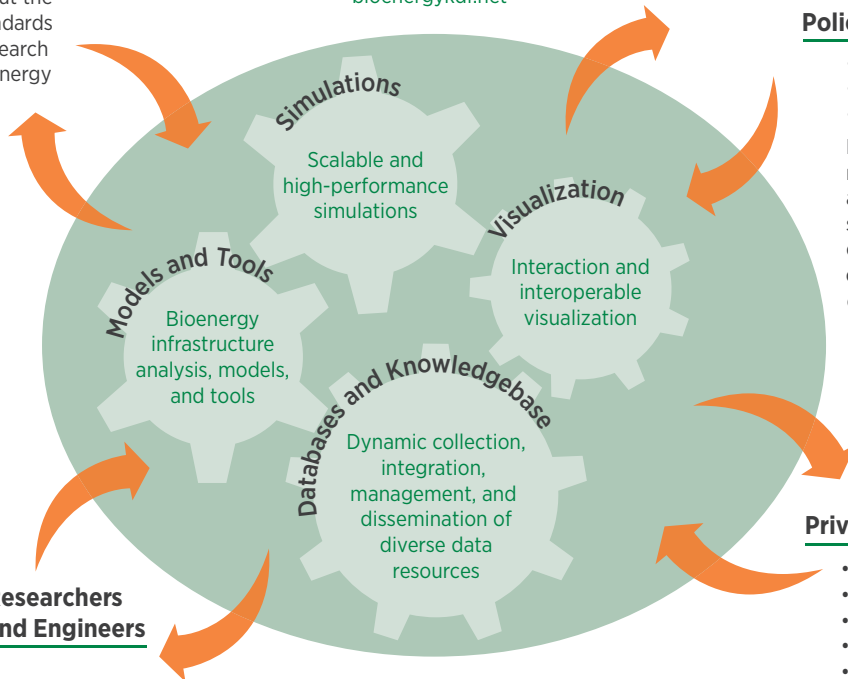
Policy makers can decide on areas for research and demonstration funds and assess vulnerabilities in the bioenergy supply system, such as the impact of crop failures, transportation shutdowns, or lower-than-anticipated volumes of biofuel production.



### Researchers and Engineers

- Academia
- National Laboratories
- Non-Governmental Organizations

Researchers and engineers can share data on sustainability metrics—such as water availability, soil type, land-use patterns, and climate trends—and connect multiple institutions that perform complex assessments of bioenergy industry development.



### Private Industry



- Feedstock Producers
- Biorefinery
- Transportation Sector
- Distribution and Retail
- Transportation Technology Developers

Private industry can identify feedstock production potential, energy-demand patterns, and available infrastructure in order to develop market strategies and invest in bioenergy business opportunities.



Sorghum. Photo: iStock/4494799.

## Knowledge Discovery

Knowledge discovery, an advanced area of study at the intersection of computer and data sciences, enhances decision making through the analysis of dynamic and disparate databases of information and patterns. The Bioenergy KDF is a collaborative decision-support environment designed to foster the discovery of optimal bioenergy pathways and infrastructure solutions by integrating data, models, and visualization tools available from across government, private industry, and academia.

## Integrating the Bioenergy Technologies Office's Research Portfolio

The KDF is the portal for bioenergy data from many GIS projects receiving support from the Bioenergy Technologies Office, including efforts to analyze algal growth potential, site-integrated biorefineries, and understand land-use change.

### Sun Grant Initiative Resource Assessment

An integrated effort to collect energy crop field trial data from the Regional Feedstock Partnership program and develop regional GIS-based tools to advance understandings of nutrient and water requirements and differences in crop productivity.

### Feedstock Supply Logistics Analysis

An Idaho National Laboratory effort to couple a GIS-based crop resource model with a feedstock supply system model to produce accurate and spatially explicit harvest assessment modeling.

### Microalgae Biofuel Potential

A systematic, GIS-based national assessment of microalgae production potential throughout the United States led by Pacific Northwest National Laboratory. The assessment will speed the development of economically feasible algal production schemes.

### Regional Land-Use Change Modeling

An initiative at the Great Lakes Bioenergy Research Center to link biogeochemical models of carbon dynamics, soil erosion, and nutrient loading to spatially explicit information on U.S.

cropland. This project will help understand and model the role of biofuels and land management as they relate to carbon sources and sinks.

### International Project Partnerships

Conservation International is identifying areas of biodiversity concern to avoid siting biofuel crops. Oak Ridge National Laboratory is documenting and modeling global systems of biofuels-driven land-use change.

### Biomass Resource Potential

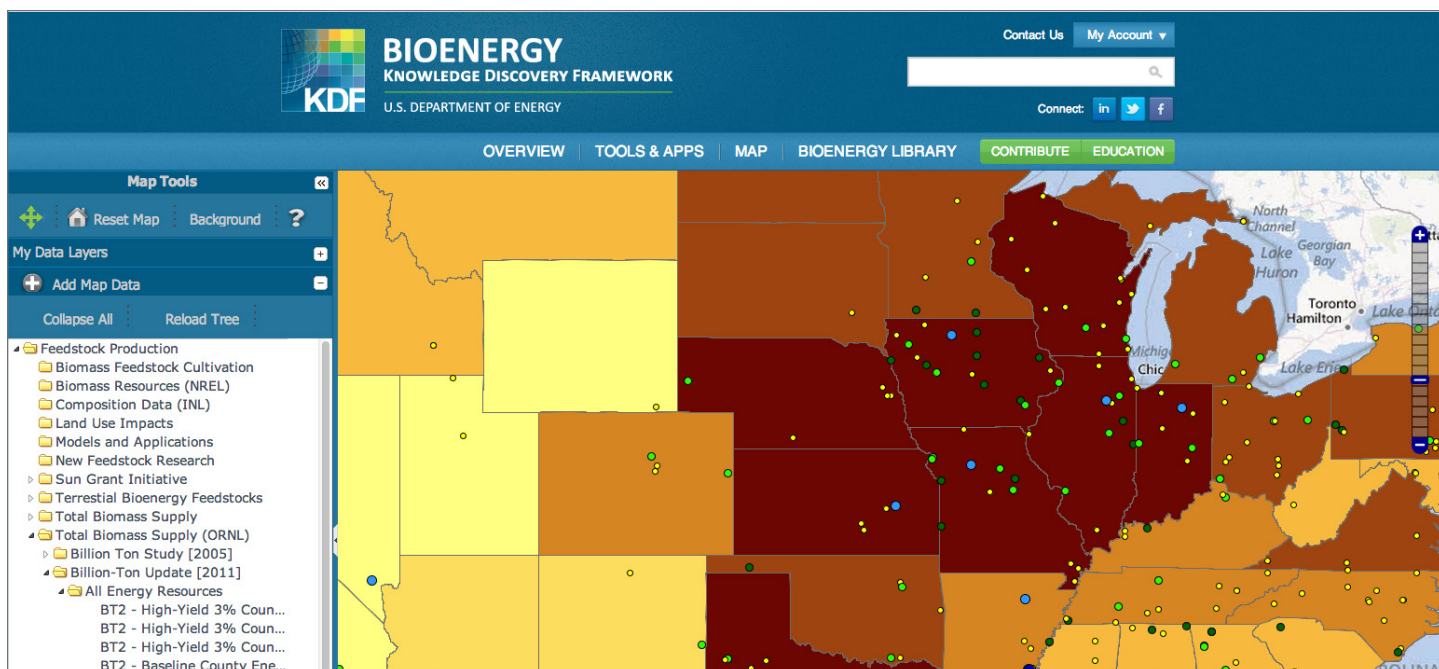
Prepared by Oak Ridge National Laboratory, the 2011 *U.S. Billion-Ton Update: Biomass Supply for a Bioenergy and Bioproducts Industry* report provides county-level data and analyses of biomass feedstock potential nationwide.

### National Biorefinery Siting Model

An initiative involving the Western Governors Association working with federal, national lab, and academic partners to develop a GIS-based, spatially resolved biomass supply and biorefinery optimization model for the United States.

### Alternative Fuels & Advanced Vehicles Data Center

A National Renewable Energy Laboratory-led initiative to support alternative fuels by providing interactive maps of infrastructure, alternative fueling stations, and biomass production. This outreach helps fleets and consumers make transportation decisions and helps educate the public about the accessibility of alternative fuels and advanced vehicles.



A view of the KDF showing biorefinery locations and potential biomass resource availability. Data from many Bioenergy Technologies Office projects can be combined with data from external sources and shared for analysis and visualization through the KDF ([bioenergykdf.net](http://bioenergykdf.net)).

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[bioenergy.energy.gov](http://bioenergy.energy.gov)

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