Our Commitment to Bioenergy Sustainability

***To enhance the benefits of bioenergy while mitigating concerns**, the Biomass Program combines advanced analysis with applied research to understand and address the potential environmental impacts of bioenergy production.*

The Department of Energy's Biomass Program is committed to developing sustainable sources of renewable energy that displace fossil fuels, enhance energy security, promote environmental benefits, and create economic opportunities across the nation. The Program is working with stakeholders to invest in cost-competitive biomass systems with smaller environmental footprints than conventional fuels, from production to end use, while minimizing impacts on food security. The Program is identifying and addressing the challenges for sustainable bioenergy production by working with research partners to conduct field trials, applied research, capacity building, and analysis.

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Environmental, Social, and Economic Dimensions of Sustainability

Economic Sustainability

- **Efficiency and productivity:** Ensuring efficient use of nonrenewable resources and recovery of resources; maximizing conversion efficiency and productivity
- **Profitability:** Improving cost competitiveness and net returns for all stakeholders along the supply chain

Social Sustainability

- **Energy diversification and security:** Reducing dependence on foreign oil and increasing energy supply diversity
- **Energy access:** Increasing access to affordable energy
- **Net energy balance:** Demonstrating positive net energy balance relative to fossil fuels
- **Rural development and workforce training:** Ensuring a trained workforce and promoting rural livelihoods
- **Food security:** Reducing impacts on food prices and access

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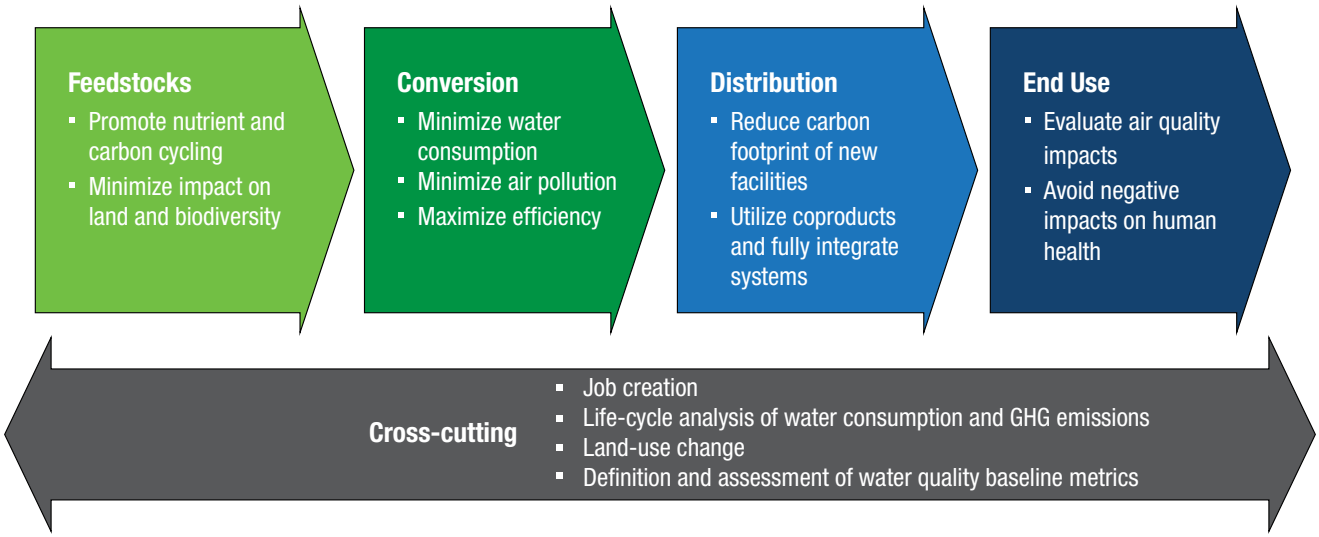
Environmental Sustainability

- **Climate:** Reducing greenhouse gas (GHG) emissions associated with biofuel production
- **Air quality:** Maintaining or improving air quality
- **Soil health and agronomics:** Maintaining or improving soil quality and land productivity
- **Water quality and quantity:** Increasing water use efficiency and maintaining or improving water quality
- **Biological diversity:** Conserving plant and wildlife diversity
- **Land use:** Minimizing negative land-use change impacts

The Biomass Program's sustainability efforts are organized around the environmental, social, and economic dimensions of bioenergy impacts.

Sustainability Efforts Across the Biomass-to-Bioenergy Supply Chain



The Biomass Program addresses sustainability across all supply chain components, from feedstock production and logistics, through consumers' use of biofuels in their vehicles.

Climate Change and Air Quality

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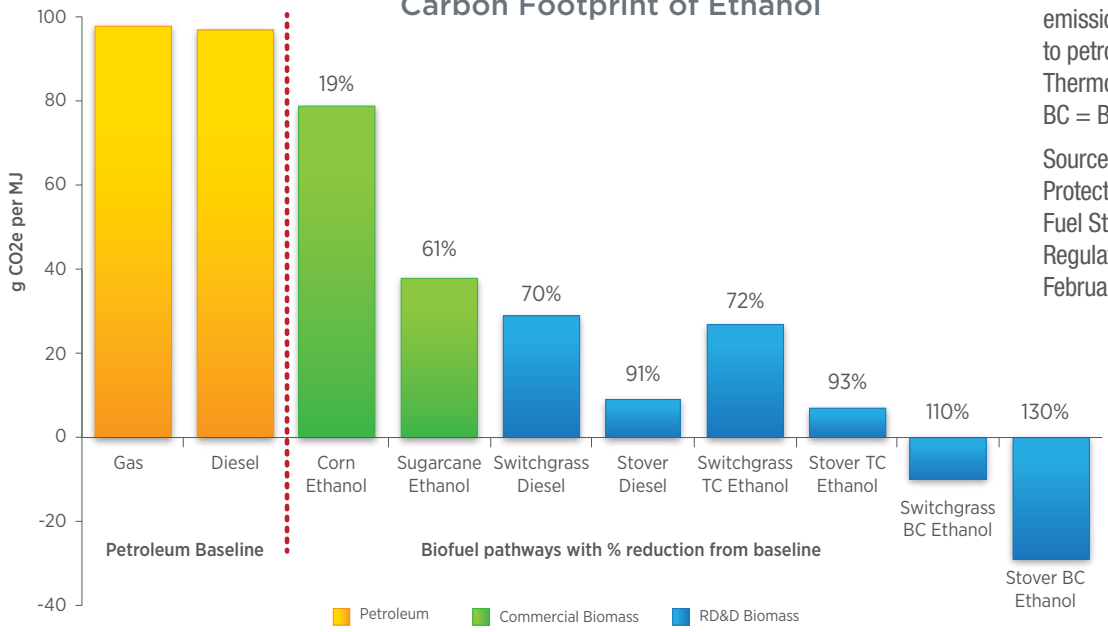
Bioenergy offers significant potential to mitigate climate change by reducing life-cycle GHG emissions relative to fossil fuels. Although producing and burning biomass-based fuel releases carbon dioxide, biomass absorbs carbon dioxide from the atmosphere as it grows. In contrast, using fossil fuels releases carbon that had been sequestered for long periods of time, causing a net positive increase in atmospheric carbon. On the other hand, local air quality can be impacted by feedstock production and biofuel use through the emission of dust and other deleterious compounds.

The Biomass Program supports life-cycle assessments that address the entire bioenergy supply chain—from feedstocks to vehicles—to better understand how bioenergy development affects GHG emissions and air quality. Ongoing analyses by the National Renewable Energy Laboratory are assessing the potential of advanced hydrocarbon and drop-in biofuels for GHG emissions reductions.

Carbon Footprint of Ethanol



Biofuel life-cycle GHG emission reductions relative to petroleum fuels. TC = Thermochemical conversion, BC = Biochemical conversion.

Source: Environmental Protection Agency, Renewable Fuel Standard Program (RFS2) Regulatory Impact Analysis, February 2010.

Soil Health and Agronomics

Growing biomass for fuels and power requires healthy soil that can maintain productivity over time. Sustainable soil health involves minimizing soil erosion, maintaining soil carbon and other essential nutrients, and protecting the soil's physical and biological attributes. Several bioenergy feedstocks currently being considered, such as perennial grasses, already show strong potential for increasing soil carbon and reducing erosion in certain areas. Harvest levels of forest and crop residues should be managed and limited in order to maintain soil quality.

The Biomass Program works with the U.S. Department of Agriculture (USDA), the National Labs, and regional partners to measure soil health and other metrics. Studying the impact of geographic variation and climatic conditions on these soil metrics can help researchers identify management practices that achieve favorable yields while preserving soil health. For example, Idaho National Laboratory is developing a model to determine the amount of corn stover (stalks and leaves) that should be left on the field to maintain optimum levels of soil carbon for different regions.

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Land Use

Managing land resources sustainably requires investigating the links between bioenergy production and land-use change, both domestically and internationally. In addition to direct land-use changes from increased bioenergy production, converting non-fuel agricultural land into bioenergy production may indirectly cause other land to be converted. Studies continue to shed light on the complex and important issue of whether bioenergy production threatens prime farmland, reduces habitat, or increases GHG emissions through direct and indirect land conversion.

The Biomass Program takes an active role in improving the scientific understanding of these links. In conjunction with the National Labs, the Program coordinates with the environmental and scientific communities to assess the model assumptions, available and needed global data sets, and research needs. The Program is committed to using the best available findings to inform decisions and investments that protect domestic and international land resources.

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Water Quantity and Quality

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Expanding sustainable bioenergy production requires consideration of impacts on water quality and the quantity of water needed for growing biomass feedstock and biorefinery operations. Sustainable bioenergy production will rely on aligning water demands with water availability, protecting water supplies and aquatic ecosystems, and maximizing the use of impaired—rather than pristine—water for growing feedstock.

The Biomass Program continues to work with National Labs and other partners to conduct life-cycle analyses of water demand for biofuel production, comparing multiple fuel types such as corn ethanol, sugarcane ethanol, and competing petroleum fuels. Oak Ridge and Argonne National Laboratories are conducting watershed-level analyses on the Arkansas-White-Red, Ohio, Tennessee, and Upper Mississippi River Basins. The research portfolio also includes analysis of crop growth, hydrology, water quality impacts, and the use of marginal land and impaired water for feedstock production.

Biological Diversity

Growing biomass for fuel can either improve or reduce the diversity of plant and wildlife populations depending on where it is grown and the existing land cover and land use. For example, growing native prairie grasses on degraded land can provide improved habitats for wildlife. Alternatively, growing feedstock in place of healthy native habitats can diminish biodiversity.

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The Program supports spatial analyses and in-field research to understand how siting and management of bioenergy crops can maintain or improve biodiversity. For example, the Program has partnered with Conservation International to identify critical habitat areas where bioenergy crops should not be produced, along with more suitable areas for bioenergy crops. The Program also works with diverse partners, such as the Council on Sustainable Biomass Production, to develop principles and standards for bioenergy crop production that conserve biodiversity and maintain ecosystem services.

Green Job Creation

Skilled workers at all levels are critical for the sustainability of the bioenergy industry for producing feedstock, constructing and operating new biorefineries, building distribution infrastructure, and developing new feedstocks and technologies. In 2009, an industry report estimated that bioenergy production, construction, and research supported the creation of 400,000 jobs.[1] The Biomass Program facilitates the growth of these sectors through cost-shared research, development, and deployment, and estimates the job creation impact from our portfolio.

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Economic Sustainability

A key goal of the Biomass Program is to promote an economically viable bioenergy industry. To measure progress towards this goal, the Program monitors and forecasts costs, profitability, productivity, and efficiency across the entire supply chain and for multiple feedstocks and pathways for conversion to energy. These economic benefits are considered together with the environmental and social impacts of bioenergy.

Photo Courtesy of NREL

Enhancing Environmental Benefits

Bioenergy offers the potential to improve the environment by

- Reducing GHG emissions relative to fossil fuels
- Enhancing the ecosystem services of degraded or marginal land by improving habitat value, carbon sequestration, and erosion control
- Making use of degraded water supplies for feedstock irrigation or production
- Displacing fossil fuels, thereby potentially mitigating their environmental impacts.

[1] *Outlook 2009,* Renewable Fuels Association, based on *Contribution of the Ethanol Industry to the Economy of the United States,* LECG, LLC, February 2010, 4.

Cross-Cutting Sustainability Activities

The Biomass Program is involved in cross-cutting activities that integrate multiple dimensions of bioenergy sustainability, including:

- The Biomass Program invests in field-based research that spans the United States in collaboration with USDA, the Sun Grant Initiative universities, and other regional partners. Researchers at these Regional Biomass Energy Feedstock Partnership sites study geographic variations in climate and soil and the impact on nutrient cycling, water quality, GHG emissions, and land use associated with bioenergy crop production.
- With DOE's Office of Science, the Biomass Program supports the Great Lakes Bioenergy Research Center's (GLBRC) sustainability efforts. Those efforts include developing novel production systems for perennial and native grassland systems, as well as integrated landscape management systems. GLBRC also examines the biogeochemical, biodiversity, and socioeconomic responses to expansion and intensification of agricultural and silvicultural practices. Researchers also conduct spatially explicit forecasts and empirical analyses of carbon release and absorption due to land-use change.
- Achieving a sustainable bioenergy industry requires integrating numerous models, datasets, and input from environmental, scientific, and economic experts. To address this challenge, the Biomass Program is coordinating with National Labs, university partners, the environmental community, and industry to collect and integrate geospatial analysis tools and data within the Bioenergy Knowledge Discovery Framework (KDF), developed by Oak Ridge National Lab. The Bioenergy KDF can be used by researchers, policy makers, industry, and consumers to assess the economic and environmental impacts of various options for biomass feedstocks, biorefineries, and infrastructure.

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