



SunGrant *INITIATIVE*

GREAT STRIDES TOWARD A SUSTAINABLE AND MORE ENERGY-INDEPENDENT FUTURE

SUCCESS STORIES OF THE U.S. DEPARTMENT OF TRANSPORTATION'S PARTNERSHIP AND SUPPORT



U.S. Department of Transportation

Why Biofuels?

The Call for Bioenergy

From sedans to tractor trailers, from single-engine jet planes to commercial airliners, from trolleys to trains, and from ferries to freight barges, America's vehicles are propelled by an incredible volume of fuel. The transportation sector is the Nation's second largest energy consumer, and petroleum provides almost all of the energy used.¹

All of this energy consumption brings challenges. Transportation uses two-thirds of all petroleum consumed in the U.S., and transportation accounts for nearly one-third of the Nation's greenhouse gas (GHG) emissions.² The good news is that since 1970 transportation sector carbon monoxide emissions have fallen by 85 percent, and biofuels can help bring that number down even more.³

Biofuels are developed from nonpetroleum biomass resources and can power our transportation system while reducing negative environmental impacts. Biomass comes from biologically produced matter—food-based and non-food-based—that can be harnessed to produce energy.

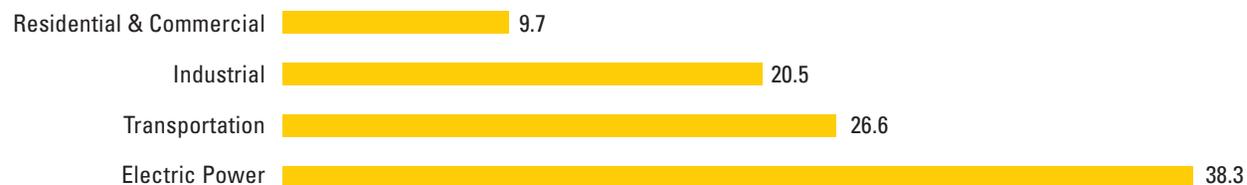
Today's biofuels marketplace is mainly comprised of "first-generation" biofuels, such as ethanol made from corn starch and sugarcane, and biodiesel

made from soy beans, animal fats, and new and used vegetable oils. In 2012, the Nation used over 13 billion gallons of ethanol and more than 1 billion gallons of biodiesel.^{4,5} Biofuels research is now increasingly focused on ways to develop advanced second- and third-generation biofuels. These new generations of biofuels rely on innovative types of non-food-based biomass and provide greater environmental benefits while reducing food versus fuel conflicts.

Biomass resources present new opportunities for all of the Nation's energy demands, including fuel, heat, and power, and for other biobased products such as biochemicals and bioplastics. Approximately 12 percent of electricity in the United States is produced from renewable energy sources—including hydroelectric, wind, geothermal, solar, and biomass such as organic wastes and wood.⁶ Biobased

Primary Energy Use by Sector, 2012 / Quadrillion Btu

The transportation sector was second in energy use in the United States in 2012 behind electric power. Source: U.S. Energy Information Administration, *Monthly Energy Review*, Table 2.1 (April 2013), preliminary 2012 data.



chemicals and plastics, created from renewable biomass rather than petroleum, are also at the forefront of biotechnology.

In addition, biofuels can have positive impacts in the communities where they are produced, including:

- Economic development and new sources of income for rural areas
- Workforce development in emerging biofuel sectors
- Environmental sustainability

The biofuels industry creates job opportunities in many fields, including:

- Farming
- Equipment production
- Chemical, mechanical, and industrial engineering
- Microbiology
- Biorefinery operations and management
- Trucking, barge, and railcar operations

Biofuel Sources Are All Around Us



First-Generation Biofuels

First-generation biofuels, which represent the majority of biofuels used today, include ethanol and biodiesel. These fuels are produced from corn, sugarcane, soybeans, and vegetable oil. Source: iStockPhoto.com/cgbaldauf.



Second-Generation Biofuels

A second generation of biofuels is produced from non-food cellulosic feedstock, including agricultural residue, perennial grasses, short-rotation woody crops, and forestry residue. Source: Oklahoma State University.



Third-Generation Biofuels

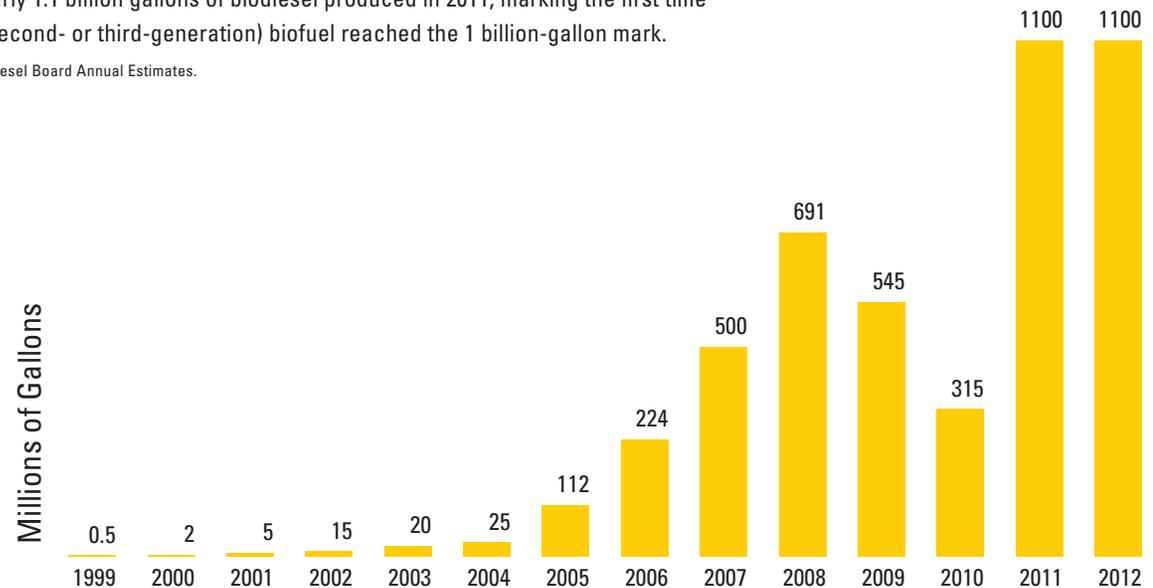
Third-generation biofuels come from non-food sources, such as algae, municipal solid waste, and oils, and aim to minimize environmental impacts and competition between land used for food and land used for fuel.

Source: iStockPhoto.com/busypix.

U.S. Biodiesel Production

There were nearly 1.1 billion gallons of biodiesel produced in 2011, marking the first time an advanced (second- or third-generation) biofuel reached the 1 billion-gallon mark.

Source: National Biodiesel Board Annual Estimates.



Sun Grant Initiative

The Concept

There are almost a quarter-billion cars and trucks used across the United States every year.⁷ With such a large number of vehicles on the road using such a large volume of petroleum, the U.S. Department of Transportation (USDOT) and its partners are working to support research that investigates new alternatives to traditional transportation energy sources.

Sun Grant Initiative

The Sun Grant Initiative is a collaborative partnership among USDOT, the U.S. Department of Agriculture (USDA), and the U.S. Department of Energy (DOE).

Congress authorized the Sun Grant Initiative in the 2002 and 2008 Farm Bills. The Biobased Transportation Research Program—established by the 2005 Safe, Accountable, Flexible, Efficient Transportation Equity Act:

A Legacy for Users (SAFETEA-LU)—authorized USDOT to fund innovation in the transportation sector. USDOT uses a portion of this funding to support the Sun Grant Initiative and the National Biodiesel Board, which promote biobased research on the national level.

The Concept

Research funding through the Sun Grant Initiative advances bioenergy research and fosters collaborations in

the field and among industry leaders. Although the Sun Grant Initiative was not reauthorized in the Moving Ahead for Progress in the 21st Century Act (MAP-21), USDOT funding continues through 2016 to progress this innovative research.

USDOT funding supports five national land-grant universities that double as Sun Grant Initiative Regional Centers. These Centers form the core of the initiative by researching biomass sources that are unique to their regions.

Each Center manages a competitive grants program and distributes USDOT funding to other land-grant institutions and federally funded laboratories within its region.

The five Centers are:

- *Northeast:* Cornell University
- *Southeastern:* University of Tennessee Institute of Agriculture
- *North Central:* South Dakota State University
- *South Central:* Oklahoma State University
- *Western:* Oregon State University
 - *Pacific Subcenter:* University of Hawaii

The Mission

The Sun Grant Initiative aims to:

- Enhance national energy security.
- Provide opportunities for rural economic development in America's traditional agricultural communities.
- Promote environmentally sustainable and diverse production opportunities for the agricultural and forestry industries.
- Encourage collaboration between government agencies and land-grant colleges and universities toward bioenergy research.

The Partnerships

USDOT, USDA, and DOE lead the Sun Grant Initiative. Other program partners include academic institutions, federally funded laboratories, State agencies, public interest groups and advocacy organizations, and the private sector.

Each Federal agency makes important contributions to the Sun Grant Initiative and to alternative fuels research:

- **USDOT** funds the Sun Grant Initiative Regional Competitive Grants Program, which supports the five regional Centers spanning

the United States. USDOT dollars sponsor bioenergy research projects large and small, allow scientists at the five Centers to become regional mentors, and lead to significant discoveries in bioenergy and biofuels. USDOT, along with USDA, DOE, and other Federal partners, also serves as a member of the Biomass Research and Development (R&D) Board, established under the Biomass Research and Development Act of 2000. Through its participation in the Board, USDOT supports research and demonstration activities related to feedstock, biofuels, and biobased products and conducts analyses to determine energy and environmental impacts and promote effective strategies for the biofuels industry.

- **USDA** partners with the Sun Grant Initiative Regional Centers to coordinate data needs. The Centers are working with USDA to develop a database that tracks feedstock

production, logistics, and conversion to establish a robust framework for life cycle analyses of biofuels production. In 2012, the USDA invested more than half a billion dollars into renewable energy research.⁸

- **DOE** and the Sun Grant Initiative Regional Centers established the Regional Biomass Feedstock Partnership to tap into the expertise of nearly 100 scientists who study sustainable feedstock challenges. The Regional Biomass Feedstock Partnership provided data and information to support the DOE Bioenergy Technologies Office's second generation of the Billion Ton Study, which used rigorous data models and sustainability studies to explore how biomass production can meet the Nation's renewable energy needs.⁹ In addition, the DOE Office of Energy Efficiency and Renewable Energy coordinates with USDA to offer funding opportunities.



National Partners and Perspectives

The Sun Grant Initiative is one of several national initiatives that promote biofuels.

National Biodiesel Board

Like the Sun Grant Initiative, the National Biodiesel Board received USDOT funding under SAFETEA-LU to support biofuels research.

The National Biodiesel Board's mission is to sustain growth in the biodiesel industry. The Board serves as the central coordinator for the biodiesel industry and as the primary voice for its diverse members, which include small and large biodiesel producers and State, national, and international organizations with backgrounds in feedstock processing, biodiesel supply research, fuel marketing and distribution, and technology.

The Board projects that by 2022 biodiesel will make up 10 percent of the diesel fuel market.

National Sun Grant Association

The National Sun Grant Association supports research and education programs that advance biobased transportation fuels, bioenergy, and bioproducts. The Association organizes, coordinates, and promotes the work of the five Sun Grant Initiative Regional Centers.

The National Sun Grant Association supports the USDOT mission to minimize the environmental impacts of the Nation's transportation systems. With support from USDOT, each Center has implemented regional peer-reviewed and competitively awarded research grants on biobased transportation fuels.

The National Sun Grant Association communicates its vision, goals, and results through its website, outreach materials, and conferences. In October 2012 the Association organized a national conference on progress in bioenergy research. It also established BioWeb, an educational website that provides up-to-date biomass information and resources.

Environmental Benefits of Biofuels

Biofuels offer tremendous opportunities to reduce negative environmental impacts and provide a sustainable energy option.

High net energy value (NEV)

NEV is the difference between the amount of energy a fuel produces and the energy used to generate it. Biofuels have a desirable, greater than one NEV value, meaning they produce more energy than is used to make them.

researchers expect to gain even more GHG reductions from second- and third-generation biofuel sources.¹⁰

Lower pollution levels

Vehicles that use biodiesel emit fewer particulates than vehicles that use fossil fuels. Biodiesel emissions produce about 47 percent fewer particulates than traditional diesel.¹¹

Reduced GHG emissions

Biofuels offer opportunities for reduced GHG emissions. For example, corn ethanol reduces GHG emissions by nearly 20 percent over gasoline, and

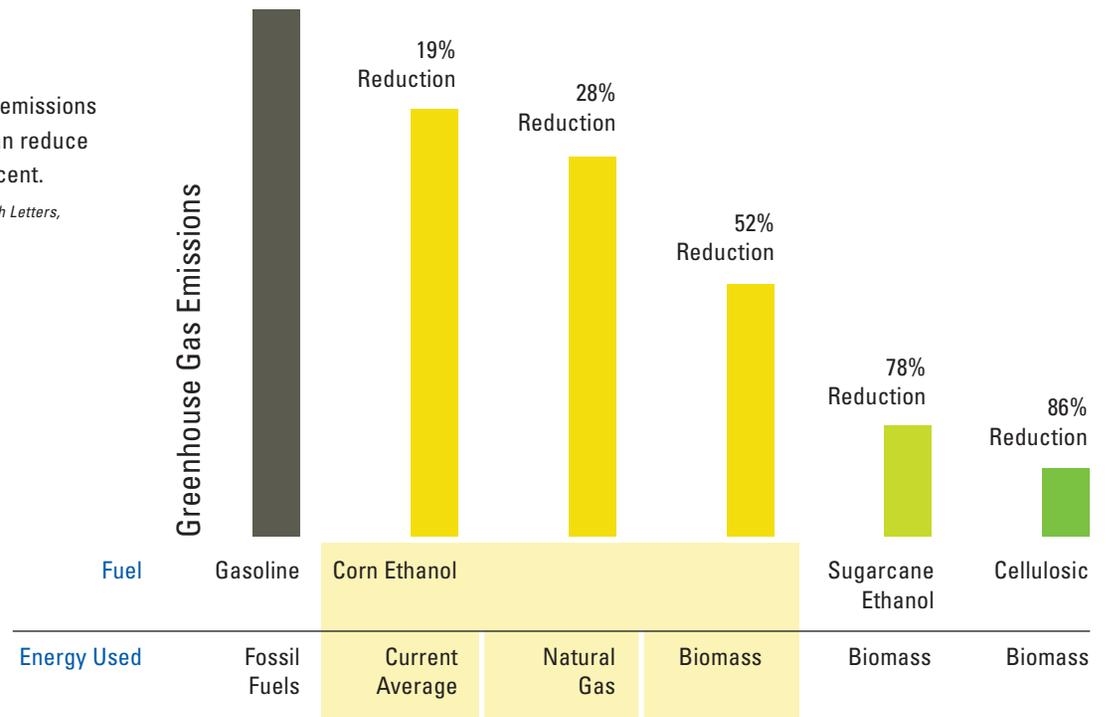


Algae grown at facilities like this one is becoming a significant biofuels source and research focus. Source: ©2012/flickr/Texas A&M AgriLife.

Emissions

Biofuels offer significant GHG emissions savings. Cellulosic biomass can reduce GHG emissions by over 85 percent.

Source: Wang et al, *Environmental Research Letters*, Vol. 2, 024001, May 22, 2007.



A Systems-Based Approach

Improving transportation logistics can help move biofuels from production to distribution. Biofuels are typically produced in rural areas, often far from the places where energy needs are high. One of the major goals that the Sun Grant Initiative Regional Centers pursue is making biomass denser to improve transportation efficiencies and reduce costs.

From chemistry to physics to logistics, the numerous fields of study involved in biofuels production and transport logistics require a multidisciplinary, systems-based approach that accounts for the full life cycle of production, transportation, and usage.

The Sun Grant Initiative provides opportunities for researchers nation-

wide to build on this systems-based approach, explore the critical transportation issues connected to biofuels use and production, and realize the potential of biofuels as a competitive product for the fuel industry. The five Sun Grant Initiative Regional Centers and their partners are committed to improving processes at each stage of the bioenergy production chain.

Life Cycle of Biofuels Production

Feedstock Development

Feedstock Logistics

Conversion

Policies and Economic Impacts

Production

Distribution

End Users

Role of Transportation

The Sun Grant Initiative focuses on all aspects of biofuels production, from its formative stages to end uses.

Feedstock logistics focuses on improving biomass harvest, processing, and handling so that feedstock can be packaged and moved more efficiently.

Federal programs, like the Sun Grant Initiative, and innovative policy, technical, and regulatory frameworks promoted by the National Biodiesel Board help advance the alternative fuels industry.

Truck and rail are the primary transportation modes for moving biomass from areas of production (fields and farms), to conversion facilities (biorefineries), and distributing biofuel products to end users. As the market grows, barges and pipelines are steadily moving more biomass and biofuels as well.

Biofuels can help power many types of transportation, including automobiles, trucks, trains, and even airplanes. Vehicles will increasingly run on biofuels as technologies and efficiencies improve.

The Sun Grant Initiative

A Regional Approach

The Sun Grant Initiative guides bioenergy research so that investigators work near where they live with the feedstock they know best.

USDOT funds five Sun Grant Initiative Regional Centers that manage competitive grants programs for other local land-grant institutions and laboratories. The Centers also perform research and help researchers coordinate biofuels activities with partners in academia and the private

and public sectors. The Sun Grant Initiative supports over 200 projects nationwide, with work underway in 90 percent of the States. USDOT funding supports the Centers through 2016, and the Centers continue to leverage this funding to establish new opportunities and partnerships.



Northeast Region: Cornell University

Building a Regional Network

When States in the Northeast Sun Grant Region plan for their energy future, one major challenge they face is high demand. The region has several major metropolitan areas near one another, including: Boston, New York City, Philadelphia, and Columbus. These and other Northeast cities consume tremendous amounts of energy, with the region accounting for roughly 21 percent of the Nation's oil use—fortunately, the Northeast's feedstock diversity offers opportunities for comprehensive biofuels research.¹²

The Northeast Region uses a multi-disciplinary approach to its biofuels research based on four core concepts:

- *All biomass is local.* Regional resources, from woody feedstock in New England to grasses in New York and Pennsylvania, strongly influence the viability of biofuels in the Northeast. Cornell University and its partners in the Northeast Region focus on a diverse portfolio

of feedstocks. For example, Rutgers University in New Jersey is using USDOT Sun Grant Initiative funds to investigate hazelnuts as a potential, high-oil content feedstock.

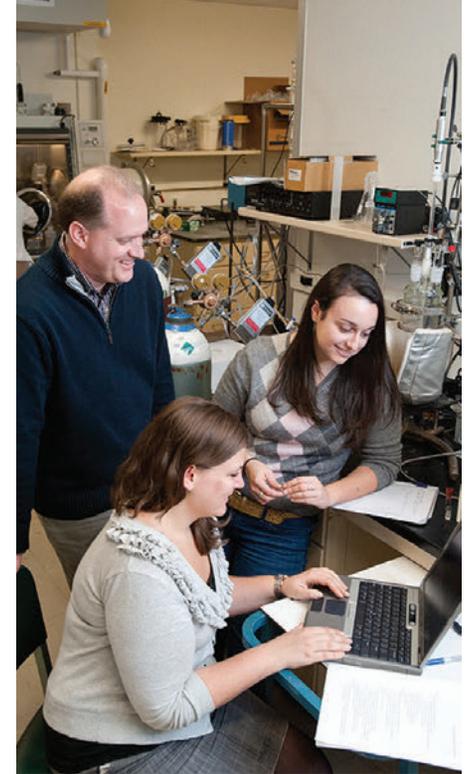
- *Deploy biotechnology and new biology for the global economy.* Universities and industry partners in the Northeast Sun Grant Region use biotechnology to produce fuels from biomass within the region. From exploring novel enzymes that degrade cell walls in plant pathogenic fungi to applying systems biology and investigating new ways to use yeast for biodiesel

production, the Northeast Region emphasizes a systems perspective when deploying these technologies.

- *Education and outreach are crucial.* Cornell University and its colleagues from the region's land-grant institutions frequently engage stakeholders, including the public and advocacy groups, to discuss the opportunities and challenges of creating, distributing, and using biofuels. Cornell University arranges regional meetings each year for researchers and educators to share and discuss ideas, driving the evolution of biofuels.
- *Encourage a sustainable, systems-based approach.* From feedstock to the fuel pump, Cornell University uses a systems-based approach to ensure grantees awarded through the USDOT Sun Grant Initiative program investigate every aspect of biofuels production.

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USDOT funding through the Sun Grant Initiative helps faculty and students advance biofuels research.

Source: University of Massachusetts, Amherst.

“A regional perspective is valuable for biofuels development. As a researcher, I can perform activities in a laboratory but to work with colleagues using a systems perspective and regional resources—this is a level of engagement that funding from USDOT facilitated.”

— Dr. Larry Walker
Northeast Sun Grant
Institute of Excellence Director

Southeastern Region: University of Tennessee

Driving Economic Development and Sustainability

Economic development and environmental sustainability are the twin pillars of the University of Tennessee Institute of Agriculture's (UTIA) work as a Sun Grant Initiative Regional Center.

With research that covers streamlined transportation processes, sustainability, and economic development, the University of Tennessee and its partners in the Sun Grant Initiative regional competitive grants program lead the Southeast in biofuels development and transport.

- The State of Tennessee invested nearly \$71 million in 2007 toward the University of Tennessee

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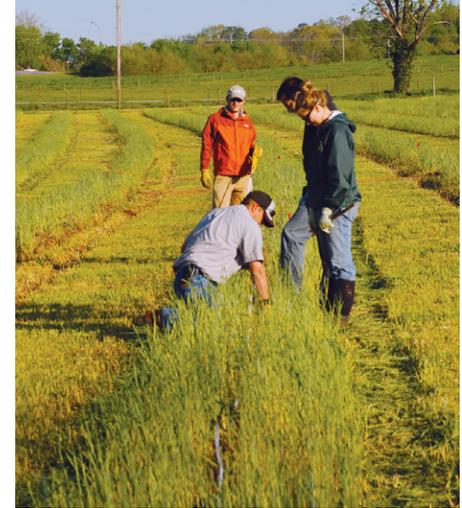
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Biofuels Initiative (UTBI), building on a foundation created by USDOT Sun Grant Initiative funding. UTBI is a farm-to-fuel demonstration developed by the State and UTIA that positions Tennessee as a leader in fuels and chemicals produced from lignocellulosic biomass. With leveraged funds and support from regional partners, UTIA is developing a dedicated biomass supply chain, improving the technology that goes into cellulosic fuel production, and developing a roadmap to commercialization.

- USDOT Sun Grant Initiative funding supports research in the Southeastern Region that focuses on lignin as a low-cost precursor for carbon fiber manufacturing. Researchers at North Carolina State University and UTIA are analyzing manufacturing scenarios and approaches to provide new insights into lignin development. The

projects address low-cost carbon fiber production that can create lighter, stronger materials and, ultimately, lighter vehicles. Lightweight materials require less fuel for transport and reduce maintenance needed for infrastructure.

- UTIA and its regional partners have developed new tools that give State agencies and companies the power to consider transportation logistics when they establish processing facilities. Efficiently moving biomass from production centers to processing facilities helps minimize environmental impacts. One successful UTIA project, the Biofuels Facility Location Analysis Modeling Endeavor (BIOFLAME), is a comprehensive Geographic Information Systems model that assesses potential feedstock and identifies ideal locations for biorefineries and preprocessing facilities. The Biomass Site Assessment Tool (www.biosat.net),



UTIA investigates ways to develop biofuels and chemicals from lignocellulosic biomass.

Source: University of Tennessee.

another valuable resource, provides a web-based economic decision-making tool for agricultural and forestry biomass. UTIA leveraged support for BioSAT from the U.S. Forest Service and Oak Ridge National Laboratory, among others.

“The Southeast is projected to supply almost half of all advanced biofuels. Ultimately, this translates to economic activity in rural areas of the Southeast and will challenge the region’s transportation network. As such, these are major considerations defining the Center’s research and development portfolio.”

— Dr. Timothy Rials
Chair, National Sun Grant Association

North Central Region: South Dakota State University

Expanding Partnerships across States, Sectors, and Disciplines

South Dakota State University (SDSU) has a long-standing reputation as a leader in biofuels research. In the 1970s, SDSU began research on corn ethanol. By the 1980s, SDSU had a switchgrass program to study second-generation feedstock. In the early 2000s, SDSU pioneered the idea of taking a regional approach to renewable energy research, which became the foundation of the Sun Grant Initiative.

Through the years, SDSU has established valuable partnerships in biofuels research with other Sun Grant Centers, academic institutions, and the private sector.

- The Sun Grant Initiative helped establish a partnership between

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SDSU and the University of Minnesota. USDOT Sun Grant Initiative funding for the University of Minnesota led to new insights on thermochemical and pyrolysis processes to convert biomass into biofuels. The University of Minnesota then partnered with SDSU to continue this research and build the expertise and capabilities of both universities.

- Universities participating in SDSU's regional competitive grants program through the Sun Grant Initiative have also found partners in the private sector. Iowa State University, for example, is working with private partners to establish one of the first cellulosic ethanol plants in Iowa by 2014.
- Working with the U.S. Navy and with industry partners, SDSU is developing processes to produce jet fuel from lignin residues, the by-product of treating cellulosic

feedstock with solvents, and from non-food oils extracted from seeds. This research is aimed at advanced biofuels that can be used in today's plane engines and as green diesel fuel.

"In determining regional competitive grants program recipients for the Sun Grant Initiative, there was consideration for the collaborative efforts that would occur. Regardless of who the primary awardee was, more often than not there was at least one additional university, industry, or other partner involved in the project as well."

— Dr. Vance Owens
North Central Regional Center Director



Biofuels can be produced from oilseeds such as sunflower, flax, and safflower (top). A mobile, pilot-scale microwave-assisted pyrolysis system like the one shown here lets the University of Minnesota perform biofuels research outside of the laboratory (bottom).

Source: South Dakota State University (top); University of Minnesota (bottom).

South Central Region: Oklahoma State University *Leveraging Resources and Research*

Oklahoma State University (OSU) supports a breadth of research with its regional competitive grants program funded by the USDOT Sun Grant Initiative.

OSU and its grantees use USDOT funding to advance biofuels research and leverage additional funding opportunities. Many projects funded in the South Central Region are seed projects—projects that kick off research or gather information to compete for more funding.

- Grant recipients through OSU's competitive grants program often use USDOT funding to conduct exploratory research and push preliminary findings to new heights. Researchers have used seed funding to expand their programs by supporting graduate students, purchasing equipment that allows for higher-quality and more advanced analyses, or modifying feedstock to enhance biofuels production.

- OSU has used USDOT Sun Grant Initiative funding to promote 53 projects across the South Central Region, with at least two-thirds of the projects outside of Oklahoma. Much of OSU's research is on biofuels creation, but OSU and regional grant recipients also address the economic, environmental, and logistics challenges that come with biofuels production. For example, Texas A&M coordinated with the University of Arkansas to test ways to package and transport biomass such as switchgrass bales to move materials efficiently from fields and areas of production to biorefineries.
- OSU's dedication to a variety of project sizes, made possible through the USDOT Sun Grant Initiative funding, has produced impressive results. Nearly three-quarters of the 53 projects that have been funded are complete. The 37 completed projects have produced 54 peer-

reviewed publications, 168 presentations, 132 abstracts, 24 Master's degrees, and 21 PhD degrees. These projects have also led to 3 issued patents, 3 provisional patents, and 6 license agreements.

"There are plenty of excellent ideas that need nourishing. The way you nourish those ideas is to offer some funding, even if it is just seed funding, to provide some preliminary data to move them forward."

— Dr. Ray Huhnke
South Central Regional Center
Associate Director

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Dr. Svetlana Oard, Louisiana State University, researches hydrogen biofuels developed from genetically engineered microalgae (top). Dr. Yangi Wu, Oklahoma State University, inspects one of his new switchgrass varieties (bottom). Source: Oklahoma State University.

Western Region: Oregon State University

Fueling a Focus on Sustainability

The Western Regional Sun Grant Center at Oregon State University (OSU) finds purpose and focus in the diversity of the region's feedstock. Researchers in the Western Region concentrate on second- and third-generation biofuels that come from feedstock such as forest and agricultural residues.

The rich variety of vegetation in the Western Region allows researchers to explore the relationship between land used for food and land used for fuel. Second- and third-generation feedstock can be used as a bonus crop in rotation with food crops to minimize conflicts over land use.

- The Western Region includes a Sun Grant sub-center at the University of Hawaii, which is leading research on resilient feedstock like hybrid grasses that can grow well in tropical habitats, and non-food sources like algae and *Jatropha Curcas*, an oilseed shrub.

- Through the Sun Grant Initiative, OSU is investigating how to turn lignin—a complex protein by-product of advanced biofuels production—into drop-in fuels that can be used immediately in infrastructure that runs on diesel and jet fuel, and into chemicals that can replace petroleum. This work creates new transportation fuels that can reduce GHG emissions. Sun Grant researchers anticipate that fuel created from renewable sources could replace up to 30 percent of the transportation fuel used today.
- OSU's investigators ask questions about infrastructure challenges and economies of scale—specifically

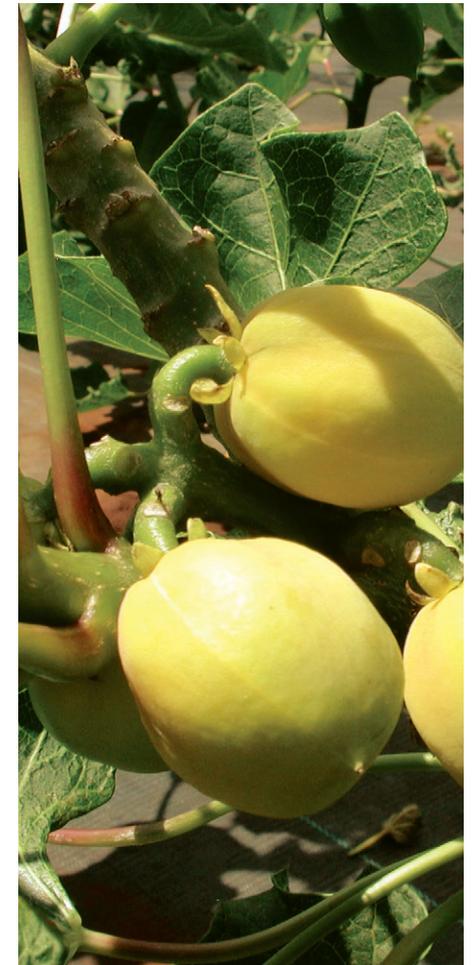
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about finding cost-effective ways to move low-density biomass from rural to urban areas. OSU is starting to look more at how to refine biomass where it is grown, so that species like Western Juniper and Pinyon-Juniper can be harvested, converted to dense bio-oil, and transported as efficiently as possible. OSU research also examines the economic impacts of feedstock production potential to determine how biofuels production affects the broader regional economy.

“Under USDOT’s guidance for sustainability, our central focus has been how we can replace traditional transportation fuels with renewable options that have subsequent beneficial impacts of lower GHG emissions, more sustainable agriculture, and more sustainable communities.”

— Dr. John Talbott
Western Regional Center Director



The *Jatropha Curcas*, an oilseed shrub, is a promising source of non-food biomass.

Source: University of Hawaii.

National Biodiesel Board

Bringing Biodiesel to Market

The National Biodiesel Board is changing the face of the alternative fuels industry with funding from the USDOT under the Federal Biobased Transportation Research Program. Unlike the Sun Grant Initiative Regional Centers, which focus primarily on advancing biofuels research within their regions, the National Biodiesel Board promotes the use of a specific biofuel—biodiesel—across America.

The National Biodiesel Board is the primary trade association for the biodiesel industry in the United States. Started in 1992 by soybean farmers, the National Biodiesel Board drives the policy, technical, and regulatory framework transforming the biodiesel industry. The industry has steadily grown with support from the National Biodiesel Board. More than 1.5 billion

gallons of biodiesel were produced in 2013—up from 25 million gallons 10 years ago—and the Board’s vision includes reaching 4 billion gallons, or 10 percent of the total overall onroad market, by 2022.

USDOT funding through the Federal Biobased Transportation Research Program helps the National Biodiesel Board



advance biodiesel with an industry-driven approach.

- The National Biodiesel Board conducts biodiesel testing with new diesel engine emissions controls, advanced filters, and catalyst technologies. It conducts demonstrations to show that biodiesel is suitable for legacy diesel engines. The Board used USDOT funding to help States establish biodiesel standards and quality-enforcement programs that proactively test weights and measures to ensure that only high-quality biodiesel is produced.
- Soybeans, one of the sources of biodiesel, produce protein, which is typically used for livestock feed, and oil, which can go towards biodiesel. Working with respected research centers and with USDOT support, the National Biodiesel Board

Biodiesel helps fuel a range of vehicles, including school buses.

Source: National Biodiesel Board.

explores ways to generate more oil from soybeans without decreasing protein or yield—which may lead to a half billion more gallons of biodiesel per year. The Board also supports researchers investigating new oilseeds and technologies that may lead to more competitively priced biofuels.

- Several of the USDOT strategic goals—including Environmental Sustainability, Economic Competitiveness, and Safety—drive much of the National Biodiesel Board’s work. The Board has led a national outreach initiative with online, print, television, and radio campaigns that publicize the benefits of using biodiesel. The Nation’s

economic health is critical to the biodiesel industry, so the Board produces surveys that show that jobs grow when biodiesel is brought to the marketplace. The biodiesel marketplace is also diverse, with business models that range from small, family-run companies with a few employees up to conglomerates with thousands of personnel. With safety in mind, the Board partnered with fire chiefs associations across the Nation to train first responders on biodiesel safety. The National Biodiesel Board promotes an alternative fuel that is environmentally sustainable, economically viable, and safe.

“Transportation touches all of us in some way. With diesel fuel, it can be difficult to connect with the standard consumer to demonstrate how it touches them—but it does. Everything they purchase is transported in some way by diesel fuel.”

— Jessica Robinson
Director of Communications
National Biodiesel Board



What is biodiesel?

Biodiesel, a form of diesel fuel, is produced from new and used vegetable oils, animal fats, and soy beans. Biodiesel is similar to petroleum diesel but with fewer air pollutants and lower GHG emissions.

Biodiesel is typically blended with petroleum diesel for all types of road vehicles, and increasingly for trains. Blends include B100 (pure biodiesel), B20 (20 percent biodiesel with 80 percent petroleum diesel), B5 (5/95), and B2 (2/98).

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Biodiesel creates opportunities for industry, infrastructure, and the economy. Source: National Biodiesel Board.

Beyond the Sun Grant Initiative

Expanding Opportunities for Alternative Energy Research

Thank you for your interest in the Sun Grant Initiative, just one of several high-profile programs USDOT supports to advance biofuels and bioenergy research. The following USDOT collaborations also lead to critical alternative energy insights and technologies.

- **University Transportation Centers (UTC) Program**

USDOT's UTC Program, led by the Office of the Assistant Secretary for Research and Technology (OST-R),* provides grants to U.S. universities to cultivate the Nation's technology and transportation expertise, including research on biofuels for light- and heavy-duty vehicles.

- **Alternative Energy Program**

Through OST-R's Alternative Energy Program, American universities put USDOT funding toward alternative energy research—such as testing hydrogen fuel cells and analyzing alternative energy life cycle issues.

- **Biomass R&D Board and Working Group**

USDOT is a committed member of the Federal Biomass R&D Board and chairs the Board's Transport and Distribution Infrastructure Interagency Working Group, which examines infrastructure needs for biofuels distribution and feedstock movement.

- **Alternative Fuel Transportation Optimization Tool (AFTOT)**

The USDOT Volpe Center is developing AFTOT, a scenario-based tool designed to help biofuel producers and researchers understand the transportation opportunities and challenges associated with collecting feedstock, processing biomass, and distributing fuel.

- **National Renewable Energy Laboratory (NREL) Partnership**

USDOT and NREL, DOE's primary national laboratory for renewable energy research,

investigate the optimal deployment of biofuels, electrification, and associated disruptive technologies that will help the transportation sector achieve near-zero emissions by mid-century.

- **Algae-based Biofuels Testing in Commercial Vessels**

USDOT Maritime Administration (MARAD) research focuses on supplementing and replacing traditional marine diesel with biodiesel, examining how algae-based biofuels lower GHG emissions and improve fuel efficiency in commercial vessels.

- **Intelligent Transportation Systems Joint Program Office (ITS JPO) Research**

The USDOT's ITS JPO researches connected vehicles and intelligent infrastructure to enhance safety, mobility, and environmental sustainability.

*OST-R is formerly the USDOT Research and Innovative Technology Administration.

- **FARM to FLY 2.0**

A partnership among the Federal Aviation Administration (FAA), USDA, and industry groups, the FARM to FLY 2.0 initiative encourages alternative jet fuel development and deployment to help the aviation industry meet FAA's Destination 2025 goal of 1 billion gallons of renewable jet fuel by 2018.

- **Commercial Aviation Alternative Fuels Initiative (CAAFI®)**

Co-sponsored by FAA and key aviation industry associations, CAAFI researches alternative jet fuels—including biofuels—shares data, and builds relationships to enhance aviation energy security and environmental sustainability.

These programs complement the important biofuels research going on every day at the Sun Grant Initiative Regional Centers and embody USDOT's commitment to a sustainable energy future.



The Sun Grant Initiative, with funding support from USDOT, provides research opportunities for alternative fuels development.

Source: ©2012/flickr/Texas A&M AgriLife.

Footnotes

- 1 U.S. Energy Information Administration, Energy in Brief: "What are the major sources and users of energy in the United States?" 1 August 2013. www.eia.gov/energy_in_brief/article/major_energy_sources_and_users.cfm.
- 2 U.S. Department of Transportation, Transportation for a New Generation: Strategic Plan for Fiscal Years 2012-2016. www.dot.gov/sites/dot.dev/files/docs/990_355_DOT_StrategicPlan_508lowres.pdf.
- 3 U.S. Department of Transportation, Research, Development, and Technology Strategic Plan: Fiscal Years 2013-2018. www.rita.dot.gov/sites/rita.dot.gov.rdt/files/rdt_strategic_plan_2013.pdf.
- 4 U.S. Energy Information Administration, Frequently Asked Questions: "How much ethanol is in gasoline and how does it affect fuel economy?" 12 April 2013. www.eia.gov/tools/faqs/faq.cfm?id=27&ct=4.
- 5 National Biodiesel Board, Biodiesel FAQs: "How much biodiesel has been produced in the US?" www.biodiesel.org/what-is-biodiesel/biodiesel-faq's.
- 6 U.S. Energy Information Administration, Electric Power Monthly (March 2013). Percentages based on Table 1.1 and 1.1a; preliminary data for 2012. www.eia.gov/energy_in_brief/article/renewable_electricity.cfm.
- 7 Oak Ridge National Laboratory, Transportation Energy Data Book, Table 3.4: U.S. Cars and Trucks in Use, 1970-2011. <http://cta.ornl.gov/data/chapter3.shtml>.
- 8 U.S. Department of Agriculture, Energy Investment Report. "Summary of Investments by Energy Type: 2012." <http://www.usda.gov/energy/maps/report.htm>.
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- 10 U.S. Department of Energy, Biofuels and Greenhouse Gas Emissions: Myths versus Facts. 18 April 2008. http://energy.gov/sites/prod/files/edg/news/archives/documents/Myths_and_Facts.pdf.
- 11 National Biodiesel Board, Biodiesel Emissions Fact Sheet. www.biodiesel.org/docs/ffs-basics/emissions-fact-sheet.pdf.
- 12 U.S. Energy Information Administration, State Energy Data 2011: Consumption. www.eia.gov/state/seds/sep_sum/html/pdf/rank_use_source.pdf.

Additional Resources

For more information about the Sun Grant Initiative, the National Biodiesel Board and other alternative energy activities, please visit these websites:

- Biomass R&D Board: <http://biomassboard.gov>
- BioWeb: www.bioweb.sungrant.org
- CAAFI: www.caafi.org
- DOE: www.energy.gov
- ITS JPO: www.itsdocs.fhwa.dot.gov/its_jpo
- MARAD: www.marad.dot.gov
- National Biodiesel Board: www.biodiesel.org
- NREL: www.nrel.gov
- Sun Grant Initiative: www.sungrant.org
- USDA: www.usda.gov
- USDOT Alternative Energy Program: www.rita.dot.gov/rdt/alternative_fuels
- USDOT Research Hub: <http://ntlsearch.bts.gov/researchhub>
- UTC Program: www.rita.dot.gov/utc

Citations

Page 2: U.S. Energy Information Administration, *Monthly Energy Review*, Table 2.1 (April 2013); preliminary 2012 data. www.eia.gov/energy_in_brief/article/major_energy_sources_and_users.cfm.

Page 3: National Biodiesel Board Annual Estimates. www.biodiesel.org/production/production-statistics.

Page 6: Wang et al, *Environmental Research Letters*, Vol. 2, 024001, 22 May 2007. http://energy.gov/sites/prod/files/edg/news/archives/documents/Myths_and_Facts.pdf.

Page 8: Map of Sun Grant Initiative Regional Centers. www.sungrant.org. Printed with permission from the National Sun Grant Association.

