Sun Grant Initiative

DOT Biobased Transportation Research Program
2007 Regional Competitive Grants

The Program

The Safe, Accountable, Flexible, Efficient, Transportation Equity Act: A Legacy for Users (SAFETEA-LU, Public Law 109-59), enacted in 2005, authorized funding for each of fiscal years 2006 through 2009, to carry out biobased research of national importance [Section 5201(m)]. This legislation provides funding from the Department of Transportation (DOT) to each of the five regional Sun Grant Initiative (SGI) Centers. The SGI Centers have developed a Scope of Work to address DOT biobased transportation research priorities, through a mixture of national, regional, and Center lead projects. Seventy-five percent of the funds received by the SGI Centers are allocated through regional competitive grants programs.

Regional Competitive Grants

Each of the five SGI Centers managed its own regional competitive grants program, to best meet the challenges of bioenergy and biomass research and education needs within their respective regions. As part of the development of the Regional Competitive Grants Program, each of the SGI Centers developed a solicitation for their region, consistent with national priorities identified by an ad hoc federal agency panel led by DOT/RITA with representatives from DOE, USDA, EPA and DOD. These national priorities for renewable transportation fuel development included: biofuel feedstock development; biofuels conversion processes; biofuel system analysis; economics, marketing and policy; and, environmental impacts. These national priorities were considered in the context of the unique biomass and biomass resources and challenges within each of the regions.

Each of the five regional Sun Grant Initiative Centers announced its regional competitive grants program in a Request for Applications (RFA) released in later February through early March of 2007. The RFA was sent to research and extension director's offices at agricultural colleges in each state and territory, to participants in regional SGI biomass events, and posted on the regional SGI Center web sites. The RFA outlined the research priority areas and instructions for using the online application system for submitting letters of intent and proposals. The online application system was tailored for applications for each region, but a single integrated system was developed and managed by the Western Regional SGI Center at Oregon State on behalf of all of the regions. Each region developed peer review panels with representatives from academia as well as specialists from national laboratories and federal agencies with appropriate subject matter expertise. Projects were selected on the basis of scientific merit, novelty, probability of success, timeframe for results, and priority for the region. Each of the regions developed their own award portfolio, based on the needs and the characteristics of their regions. Given a longer history of pertinent research, the North Central SGI region funded a smaller number of larger and longer term projects. With a more diverse biomass resource base, the Western and North Eastern region funded a larger number of smaller "start-up" and exploratory grants. All of the regions completed their award process by the summer of 2007.

Awards

A summary report from each of the five regions follows. These reports describe in more detail each regions grant award process, the number and characteristics of the grants selected, and the importance of these grants to the respective regions. For each of the selected projects, there is a listing of the title, the principle investigators and their affiliation, funding, start and end dates, objectives, methodology, and expected outcomes. Across the

five regions, over 300 proposals were received with requests for funding of about $70 million. The titles of the selected projects are listed below, with the Principle Investigator (PI) and their institution, the amount of funds provided by DOT and the total funding provided (including matching nonfederal funds.. A summary sentence explanation of the title fuller descriptions in the following reports. Proposals were received from most states in the country.

North Central SGI

- Sustainable Cropping Systems for Harvesting Corn Stover for Biomass
  - Ken Moore; Iowa State University (3 year project; $728,074 DOT, $924,652 Total Project)
  - Developing a cropping system for growing corn biomass along with a perennial ground cover in order improve the sustainability of utilizing corn stover for bioenergy.
- Develop Sustainable Renewable Energy Systems for Practical Utilization of Bulky Biomass
  - Roger Ruan; University of Minnesota (4 year project; $945,158 DOT, $1,186,084 Total Project)
  - Development of scalable, thermochemical technologies for converting bulky biomass to products with higher energy density on the farm.
- Diversifying Midwestern biofuel feedstocks: An evaluation of nitrogen-fixing Alnus and Salix germplasm
  - Stan Hokanson; University of Minnesota (4 year project; $480,744 DOT, $648,884 Total Project)
  - Evaluating and developing woody feedstocks, such as hybrid poplar and hybrid alder, for the North Central Region to augment Cellulosic feedstock production.
- Developing a sustainable feedstock and next-generation processing technologies for biofuels production
  - Bill Gibbons; South Dakota State University (4 year project; $1,012,243 DOT, $2,231,110 Total Project)
  - Development of prairie cordgrass as a herbaceous feedstock for marginal lands and biochemical processes to improve its conversion to biofuel and bioproducts.
- Novel Recoverable Enzyme Nanoparticles for Cellulose Hydrolysis
  - Patrick Johnson; University of Wyoming (4 year project; $284,600 DOT, $483,872 Total Project)
  - Developing a method to capture and reuse cellulose enzymes to improve ethanol conversion efficiency.

North East SGI

- Biomass Feedstock Production in the Northeast: Economic and Environmental Implications
  - Tom Richard, Pennsylvania State University in collaboration with Michigan State, Cornell, USDA-ARS, Univ. Maryland-Eastern Shore (2 year project, DOT $439,000, Total project $ 526,800)
  - This policy and economics project will examine the economic and environmental impacts and opportunities from a range of feedstock production systems relevant to the Northeastern US at the field level, whole-farm level, biorefinery and watershed-level, and the Northeast Sun Grant region level.

- Improving woody biomass separation by enzymatic means
  - Nancy Kravit, University of Maine in collaboration with Tethys Research (2 year project, DOT $90,581, Total project $259,650)

- This conversion process project will devise a method to isolate and identify 3 microorganisms in a collection with the ability to break an important chemical bond in woody tissues (enzyme type: hemicellulose:lignin etherase (HLE) bond broken: galactomannan-lignin ether bonds).

- Development of a temperature-phased anaerobic digestion process for enhanced conversion of solids in livestock manure and food wastes to methane
  - Zhongtang Yu, The Ohio State University. (2 year project, DOT $100,000, Total project $120,000)
  - This conversion process research project will improve the efficiency of solids consumption in an anaerobic digestion process by optimizing the temperature for different microbes at different time-points in the digestion process and identify the key microbes/enzymes involved in the process through genomics.

- Influence of alternative pretreatment strategies on cellulosic ethanol production using simultaneous saccharification and fermentation of high solids concentrations
  - James Gossett, Cornell University. (2 year project, DOT $99,999, Total project $160,068)
  - This conversion process research project seeks to improve the efficiency of ethanol production from Switchgrass through basic research into the inhibitory by-products that build up during the conversion process.

- Developing the potential of hazelnuts as a feedstock for biodiesel and other oleochemicals in the Northeast
  - Thomas Molnar, Rutgers University. (2 year project, DOT $58,062, Total project $71,766)
  - Hazelnuts produce nearly twice as much oil per acre as soybean, but are susceptible to a blight. This feedstock development project will evaluate up to 200 Eastern Filbert Blight Resistant varieties of hazelnut for oil quality and yield and will establish field trials on the top 10 performers.

- Small farm integrated project
  - Norm Scott, Cornell University in partnership with local Ficken family farm. (1 year project, DOT $75,010, Total project $121,876)
  - Dairy farms with less than 100 cows represent 75% of the dairy farms in New York. This systems-integration and demonstration project will build and demonstrate a simple small farm system to produce both ethanol and methane for electricity production using off-the-shelf materials and technology that will not exceed the normal management skills of a small farm operator.

- A Biofuel screening program for grass feedstocks: diversity, physiological traits and compositional characteristics for optimal yield
  - Jocelyn Rose, Cornell University. (2 year project $100,000 DOT, $120,000 Total project)
  - This feedstock development project will evaluate biomass yield, stand establishment and predicted ethanol yields on a wide range of monoculture and mixed grasses in the northeast region.

- Enhanced microbial cellulose degradation and H2 production above 80 C
  - PI: James Holden, University of Massachusetts. (1 year project, DOT $22,346, Total project $27,980)

- This conversion process research project will screen a culture collection (>25) of microbes from deep-sea geothermal vents for their ability to grow on microcrystalline cellulose.and will determine whether these organisms can degrade cellulose with H_2 as the primary waste product.

South Central SGI

Integrated Projects

- Effects of Syngas Sources on Ethanol Production via Fermentation
  - Mark Wilkins, Oklahoma State University (3 year project; $337,194 DOT, $421,489 Total Project)
  - Analysis of biomass-syngas generated from switchgrass, corn gluten, wheat straw and coal mixed with switchgrass and wheat straw (co-firing).
- Development of a Skid-mounted Gasification System for On-site Heat, Fuel and Power Production
  - Sergio Capareda, Texas Agricultural Experiment Station (3 year project; $279,380 DOT, $ 349,222 Total Project)
  - Develop and evaluate the technical, economic, (including commercialization) and environmental feasibility of on-site thermal gasification systems for biowastes in the region.
- Designer sorghums: Development of high yielding sorghum cultivars with modified endosperm matrices for optimized low energy input ethanol production and high nutrition feed
  - Dirk Hays, Texas A & M University (3 year project; $337,500 DOT, $355,110 Total Project)
  - To develop a systems approach for designer sorghum cultivars to optimize the grain's endosperm matrix for bio-ethanol conversion and distiller's feed for low rain fall Texas environments.
- Evaluation of Sweet Sorghum Hybrids as a Bioenergy Feedstock—Germplasm Development, Agronomic Practices, and Conversion Efficiency
  - William Rooney, Texas Agricultural Experiment Station (3 year project; $327,125 DOT, Total Project $415,339)
  - Breeding, development, and release of sweet sorghum for commercial production. Production, processing, and conversion issues of sweet sorghum cultivars and hybrids.
- Evaluation of the Energy and Cost Advantages of Modules for Packaging and Transporting Biomass Energy Crops
  - Stephen Searcy, Texas Agricultural Experiment Station (3 year project; $246,236 DOT, Total Project $331,319)
  - Address the engineering and economic aspects of using modular packages for switchgrass.
- Evaluation of the Nutritional and Feeding Value of Ethanol By-products for Animal Production
  - Travis Whitney, Texas Agricultural Experiment Station (2 year project; $116,103 DOT, Total Project $145,129)
  - Determine how animal performance, metabolism, digestibility, and wool and carcass characteristics of growing lambs and kids are affected by replacing protein (cotton seedmeal) and energy (milo) feeds with direct distiller's grain.
- Breeding and testing of new switchgrass cultivars for increased biomass production in Oklahoma, Arkansas, Texas and Kansas

- Yanqui Wu, Oklahoma State University (3 year project; $200,000 DOT, $250,000 Total Project)
- Develop switchgrass cultivars with increased biomass yield and wide adaptation through breeding program and testing network throughout region.

Seed Projects

- Cofiring Animal Waste in Low NOx Burners for NOx and Hg Reduction in Coal Fired Plants
  - Kalyan Annamalai, Texas Engineering Experiment Station (2 year project; $70,000 DOT, $87,513 Total Project)
  - Develop new technology and provide additional market for cattle biowaste (manure) as fuel in coal fired plants.
- Advanced technologies for biodiesel production
  - Dorin Boldor, Louisiana State University Agricultural Center (2 year project; $70,000 DOT, $98,844 Total Project)
  - Utilizing batch and continuous microwave technology to extract oil from traditional (soybeans) and alternative (rice bran, Chinese tallow tree seeds) feedstocks and convert oils into biodiesel, and determine the technological feasibility and economic viability of process.
- Vibrio furnissii: a biotechnology platform for biomass bioconversion
  - Paul de Figueiredo, Texas A & M University (2 year project; $70,000 DOT, $89,588 Total Project)
  - Develop an efficient and economical platform for the direct bioconversion of biomass into kerosene and other long-chain alkanes.
- Optimizing a new downdraft gasification system for synthesis gas production from low bulk density biomass materials
  - Krushna Patil, Oklahoma State University (2 year project; $69,997 DOT, $87,496 Total Project)
  - Further developing a unique downdraft gassifer design capable of utilizing low density feedstocks.
- Saline extractive distillation for ethanol separation
  - Peter Pfromm, Kansas State University (2 year period; $69,988 DOT, $87,495 Total Project)
  - Reduce the capital and operating costs, especially energy demand, of the current multi-stage separation process for the recovery of fuel grade ethanol from fermentation broth through the extractive distillation of salt by electrodialysis.
- Breaking the cost barrier for bio-ethanol: reactive adsorption of fermentation broth
  - Mary Rezac, Kansas State University (2 year period; $70,000 DOT, $87,514 Total Project)
  - Developing an ethanol recovery system using reactive adsorption technology that eliminates the highly energy intensive distillation process and makes substantial reductions in the cost of ethanol production.
- Nanoparticle systems for delivery of biological antimicrobial compounds to limit microbial contamination in industrial yeast fermentation
  - Steven Ricke, University of Arkansas (2 year period; $70,000 DOT, $93,638 Total Project)
  - Identify a feasible antimicrobial invention method(s) that can be routinely integrated with economical delivery systems in large scale industrial yeast fermentation systems.
- Biodiesel Feedstock Development for the Southern Great Plains
  - Michael Stamm, Kansas State University (2 year period; $63,680 DOT, $79,916 Total Project)

    - Development of specialty canola cultivars adapted to winter with superior oil quality for production of a high quality feedstock to produce biodiesel.
- Develop Comprehensive Understanding and Utilization of Sorghum Stover and Brown Midrib Forage Sorghum for Ethanol Production
    - Donghai Wang, Kansas State University (2 year period; $70,000 DOT, $89,992 Total Project)
    - Develop comprehensive understanding and utilization of regular sorghum stover and brown midrib sorghum (sorghum biomass) for ethanol production by evaluating the physical properties and chemical composition, pretreatment technologies to increase fermentable sugar yields, increase ethanol yields by identifying and reducing inhibitors and investigate energy balance issues (inputs and outputs).
- A multifunctional frequency-response permittivity sensor for biodiesel concentration measurement and impurity detection
    - Naiqian Zhang, Kansas State University (2 year period; $69,770 DOT, $97,170 Total Project)
    - Developing of a portable sensor for quick and reliable measurement of blend ratio and impurities concentration for biodiesel, and an embedded sensor for use in diesel engines.

South East SGI

Integrated Projects

- Optimization of Pretreatments for the Production of Ethanol from Genetically Modified Hardwoods with High Cellulose and Low Lignin Content
    - Hasan Jameel; North Carolina State University (2 year project; $165,000 DOT, $288,666 Total Project)
    - Evaluating different physical and chemical pretreatment technologies on the enzymatic hydrolysis efficiency of genetically modified hardwoods and to identify the most economical pretreatment.
- Bacterial adaptations for enhanced cellulose utilization: a systems approach
    - Sue Nokes, University of Kentucky (3 year project; $250,000 DOT, $320,576 Total Project)
    - Demonstration of a broad range of metabolic pathway responses of C. thermocellum bacteria using dissolved gas/growth rate as environmental perturbations to improve ethanol production.
- Enzymatic and Multiphase Solution Processing of Lignocellulosic Biomass
    - Subramanian Ramakrishnan, Florida A&M University (3 year project; $250,000 DOT, $351,289 Total Project)
    - Development of an integrated economical process for the saccharification of lignocellulosic residual biomass into energy-related products.
- Mechanisms of Surfactant Effects on Biomass Conversion
    - Maren Roman, Virginia Tech (3 year project; $299,904 DOT, $364,323 Total Project)
    - Development a comprehensive understanding (set of parameters) of the mechanisms by which surfactants enhance the enzymatic hydrolysis of lignocellulosic biomass.
- Comparative Genomics Guided Genetic Modification of Switchgrass Cell Wall for Improved Lignin Characteristics and Increased Cellulose Availability
    - Neal Stewart, University of Tennessee (2 year project; $250,000 DOT, $309,793 Total Project)
    - Identification of key switchgrass genes for lignin down-regulation and develop modified switchgrass plants for future research.

- Development of a microbial factory for efficient conversion of biodiesel glycerol to value-added products
    - Sang-Jin Suh, Auburn University (3 year project; $298,937 DOT, $458,234 Total Project)
    - Development of genetic engineering and metabolic engineering tools that enable the Pseudomonas aeruginosa bacteria to function as microbial factory for converting biodiesel glycerol to value-added products to improve the long-term sustainability of biodiesel industry and to generate new income for farmers and agricultural industries.

Seed Projects

- Identifying novel lignin and lignocellulose degrading enzymes from natural decomposer communities
    - Alison Buchan, University of Tennessee (1 year project; $50,000 DOT, $67,063 Total Project)
    - Establishment of a microbial consortia capable of degrading lignin and lignocellulosic components of switchgrass and determination of rates of switchgrass lignin and lignocellulose degradation.
- Conversion of agricultural materials to biofuels and bioproducts by Thermotoga neapolitana, a hyperthermophilic, anaerobic bacterium
    - Mike Henson, University of Tennessee (1 year project; $49,907 DOT, $61,136 Total Project)
    - Assessment of the production rate of hydrogen from potential bioenergy feed stocks, such as, waste fruits and switchgrass.
- A novel approach to facilitate accessibility of cellulose and hemicellulose: characterization of hybrid poplar transformed with a tyrosine rich peptide gene
    - Haiying Liang, Clemson University (1 year project; $15,714 DOT, $18,810 Total Project)
    - Development of a process for replacing a small fraction of lignin-lignin linkages with lignin-peptide linkages that will not compromise plant fitness but will facilitate the "cracking" of lignin so that the cellulosic components can be more easily hydrolyzed.
- Evaluation of Reduced Lignin Softwood and Hardwoods for Improved Conversion to Bioethanol
    - Gary Peter, University of Florida (1 year project; $49,950 DOT, $60,981 Total Project)
    - Development of a process to increase the amount and efficiency of hemicellulose extraction and an analysis of the yield and efficiency of low-lignin wood conversion to biofuels.
- Use of Complex Fluids for Enhanced Cellulosic Pre-treatment
    - Orlando Rojas, North Carolina State University (1 year project; $50,000 DOT, $66,621 Total Project)
    - Development and analysis of a novel rout using complex fluids, mainly microemulsion systems, for enhanced penetration in the micro- and nano- capillary structure of wood for biomass pretreatment.
- Biological energy production from biomass by wood-feeding termites
    - Jiang-Zhong Sun, Mississippi State University (1 year project; $50,000 DOT, $60,003 Total Project)
    - Evaluation and analysis of hydrogen and methane gas production of different subterranean termite species with their associated symbiotic microorganisms and assembly of a prototype of an energy gas production system utilizing termites in a sustainable to produce hydrogen.

- Agglomeration of Biomass Feedstocks for Bioenergy Applications
    - Oladrian Fasina, Auburn University (1 year project; $49,709 DOT, $70,617 Total Project)
    - Development of farm-level, low-pressure methods for agglomerating biomass feedstocks into forms (cubes/compacts) that are suitable for economical and efficient handling, storage and transportation of biomass.

Western SGI

- Production of Biobased Plastics Using Organic Waste Streams
    - Erik Coats, University of Idaho (2-year project, $254,916 total)
    - Development of new biobased products and processes that utilize biodiesel and manure waste streams in order to improve waste management practices, enhance rural economies and reduce dependence on petroleum-based feedstocks and products.
- Biofuels from Salt Basin Algae: A Renewable Energy Crop
    - John Cushman, University of Nevada (3-year project, $294,173 total)
    - Assessment of salt tolerant algae as a potential biodiesel feedstock through genetic screening and field tests.
- Regional Economic Analysis of Feedstock Production and Processing in the Pacific Northwest: Expected Economic Impact
    - David Holland, Washington State University (2-year project, $200,000 total)
    - Examination of crop and fuel production for biodiesel, corn ethanol, and cellulosic ethanol in the Pacific Northwest using potential price and productivity scenarios.
- Hybrid Poplar as a Regional Ethanol Feedstock: Its Development, Production and Economics
    - Jon Johnson, Washington State University (3-year project, $583,002 total)
    - Analyze hybrid poplar clones to develop ethanol yield data, which will then be used to determine breeding and selection criteria for desired feedstock characteristics.
- Enzyme-Mediated Bioconversion of Lignocellulosic Feedstocks to Ethanol
    - Christine Kelly, Oregon State University (2-year project, $200,000 total)
    - Development of new “accessory” enzymes that will assist available cellulases to increase the rate and extent of converting lignocellulosic biomass, such as forest thinnings or grasses, to ethanol.
- Bio-electrolysis: Novel Technology for Hydrogen Production from Lignocellulosic Biomass
    - Hong Liu, Oregon State University (2-year project, $196,325 total)
    - Development of a bio-electrolytic process to generate hydrogen directly from renewable, abundant and readily available lignocellulosic biomass in a cost-effective manner.
- Development of Camelina as a Low-Input Oilseed Crop
    - Don Wysocki, Oregon State University (3-year project, $295-214 total)
    - Develop cropping systems and practices to incorporate Camelina, a summer annual oilseed crop, into Pacific Northwest crop production systems.