Bio-Energy Research Projects

High Energy Crops

Energy Intensive Crop Development

PI: Gary Peter, UF

Description: The first step in an integrated bio-energy industry is development of energy intensive crops. This research uses traditional and molecular genetics approaches to discover breakthroughs in identification of Florida energy crops and cultivars, and to develop best agricultural practices for production. The research advances our knowledge of how plants partition carbon, identifies genes to breed plants that are more readily extractable/digestible to increase conversion efficiency, establishes best agricultural practices for production of Florida energy crops, and develops economic models to estimate costs and identify improvement opportunities.

Water-Use Efficiency and Feedstock Composition of Candidate Bioenergy Grasses in Florida Environments

PI: Lynn Sollenberger, UF

Description: Florida ranks first in the USA in annual growth of plant biomass because of a large cultivatable land area, high rainfall, and long growing seasons. Development of high-yielding production systems for Florida-grown energy crops is essential for establishing a sustainable biomass-to-energy industry. Long-term availability of reasonably-priced biomass in sufficient amounts is crucial to determining the need and location of new bio-fuel and bio-energy facilities. Because of Florida's size and large number of climatic zones, there are large regional differences in what energy crops can be used at various locations and how they will perform. In this project, we conduct applied research at locations throughout Florida with sweet sorghum, sugarcane, energycane, giant reed, miscanthus, and elephantgrass to elicit important information for Florida growers, bio-energy producers, and policy makers on agronomic practices, yield, water use, and chemical composition. This information supports decision-making regarding which crops are adapted to specific environments, which are best suited to particular management practices (e.g., irrigation or none), and which have the desired chemical composition for the intended bio-energy use.

Constructal Optimization of Solar Photo-Bioreactors for Algae Growth

PI: Juan Ordonez, FSU.

Description: This project focuses on the optimization of photobioreactors for maximum algae growth. The optimization approach combines techniques based on thermodynamics and constructal theory. We target the optimization of all applicable life support systems for micro-algae and address the system and subsystems structures for optimal performance.

Bio-Energy Research Projects

Energy From Algae

Establishment of the Center for Marine Bioenergy Research

PI: Joel E. Kostka, FSU

Description: This research center blends fundamental and applied research to develop sustainable, biologically-based fuel alternatives and renewable energy strategies, and to capture, recycle or mitigate greenhouse gases, excess nutrients, and other environmental pollutants associated with energy production and use. Biosolutions will be incorporated rapidly into the solid waste treatment and power plant industries. The research team will partner with other groups to promote awareness that the near-term realization of clean, cost-effective energy alternatives will occur only through a multidisciplinary systems-based approach from research to planning and implementation.

Seeding Biofuel Entrepreneurship in South Florida

PI: George Philippidis, FIU.

Description: This project identifies fast-growing, high-lipid-content native algae that will form the basis for lipid conversion to biofuels. We are screening a collection of Florida algae to select those with promising growth and lipid potential. Growth conditions are manipulated to understand the effect of key process variables of lipid productivity. Cells will be harvested for lipid extraction and conversion to biodiesel using FIU's pilot-scale transesterification system. In parallel, biofuels courses will be introduced into the FIU curriculum to seed the development of a workforce skilled in renewables.

Biogasification

Integrated Biofuel, Hydrogen and Electricity Cogeneration from Biomass and Solid Waste

PI: Bill Lear, UF

Description: The goal of this project is to provide the underlying research and demonstration of a novel technology which would enable the economic utilization of dispersed biomass and solid waste resources to produce electric power, cooling, heat, and transportation fuels. This integrated gasification and power generation system combines University of Florida advances in high-temperature gasification, hydrogen generation and separation, and advanced gas turbine systems. Their integration is expected to result in significant improvements in the cost, emissions, feedstock flexibility, and water requirements, all in a relatively compact, modular plant system. This in turn will enable much greater utilization of renewable energy supplies, which would help the development of a sustainable energy supply infrastructure.

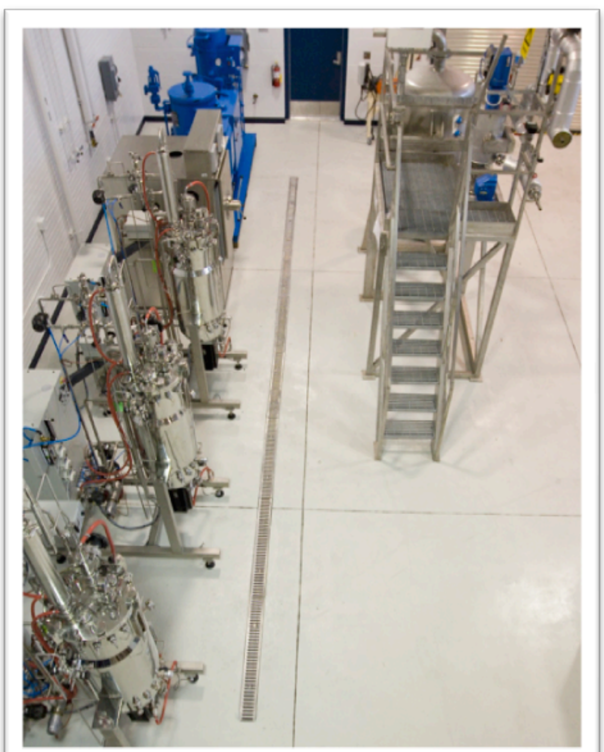
Bio-Energy Research Projects

Biochemical Conversion

Biochemical Conversion of Florida's Cellulosic Biomass to Liquid Fuels and Chemicals

PI: Pratap Pullammanappallil, UF

Description: This project develops and demonstrates an integrated, multi-product biorefinery at a precommercial scale to support a full economic and technical feasibility analysis for the use of Florida-grown feedstocks. The goal of this facility is to evaluate, validate, and improve processes, improve efficiency and decrease complexity, and accelerate commercialization of cellulosic ethanol in Florida. This facility represents a complete test bed for new trial crops as well as existing municipal, forestry, and agricultural residues, and completes the renewable cycle by converting solar energy stored in biomass into automotive fuels and chemicals to replace petroleum. The biorefinery integrates processing and utilization of waste streams to additional fuels and byproducts. Together with energy crop production, this project provides a comprehensive demonstration of a "Farm to Fuel"/"Fields to Wheels" biorefinery to facilitate commercial development of renewable fuels in Florida.



Dr. Lonnie Ingram in the UF Biofuel Pilot Plant that was built as part of the $4.5 million Florida Center of Excellence. The pilot plant is used to develop and improve conversion processes and to assist industry in the validation and use of diverse Florida feedstocks. In addition, the Florida Legislature awarded UF $20 million for the construction of a fully integrated biofuels facility to demonstrate the production of cellulosic ethanol.

FESC Bio-Energy Research Projects

Assessment and Development of Pretreatment for Sugarcane Bagasse to Commercialize Cellulosic Ethanol Technology

Sugarcane Bagasse

PI: George Philippidis, FIU

Description: The project's objective is to identify a biomass pretreatment process that can cost-effectively convert sugarcane bagasse to an enzymatically digestible and fermentable mix of sugars as a means for determining the commercialization potential of Florida biomass conversion to ethanol fuel. The key objectives are: (1) Assess the lab-scale efficacy of pretreatment processes on sugarcane bagasse; (2) Scale up the most promising bagasse pretreatment process based on the lab scale results; (3) Optimize the pretreatment process to derive design and operation data for commercial-scale bagasse-to-ethanol facilities; and (4) Integrate the critical unit operations to assess the techno-economic feasibility of the bagasse-to-ethanol technology.

FIU-ARC's Biochemical Research Laboratory: (Left) A fermentation system is employed in the biochemical production of renewable fuels, such as ethanol and hydrogen from cellulosic biomass. (Right) An anaerobic chamber is used to study the genetics and physiology of anaerobic microorganisms that show promise for production of renewable fuels.

Bio-Energy Research Projects

Thermo-Chemical Conversion

Production of Liquid Fuels from Biomass via Thermo-Chemical Conversion Processes

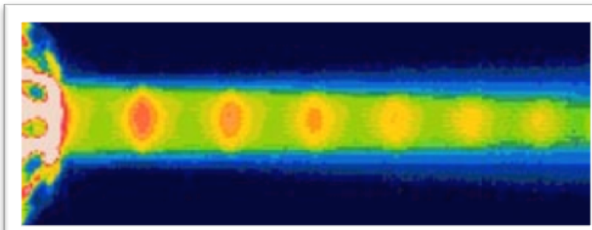
PI: Babu Joseph, USF

Description: The overall objective of this project is to develop technology for the economical thermo-chemical conversion of lignocellulosic biomass (non-food grade biomass such as agricultural waste, switch grass, municipal green waste, etc.) to clean burning liquid fuels. There are two competing routes to production of liquid fuels from biomass: biochemical route via fermentation to alcohols or the thermochemical route to syngas followed by Fischer-Tropsch (FT) synthesis to produce diesel, jet fuel, gasoline or similar hydrocarbon fuels. We have chosen to focus on the thermochemical route because of its versatility and wide applicability. One of the key technological components of the thermochemical process is the catalyst used for FT synthesis. The specific objective of this task is to investigate the development of novel catalyst and support material that is critical for the FT synthesis. We have successfully synthesized Cobalt nanoparticles for FT synthesis catalysis. A bench scale reactor is being set up to test biomass derived syngas conversion to liquid fuels. The next step is to test the catalyst performance.

Biofuels Through Thermochemical Processes: a Systems Approach to Produce Bio-jet Fuel

PI: Anjaneyulu Krothapalli, FSU

Description: This program addresses the emerging needs for the aviation industry for cost-effective alternative liquid transportation biofuels. The main objectives are to produce bio-jet and bio-diesel fuels from cellulosic biomass and nonedible bio-oils and demonstrate that they have cost structure and product quality comparable to petroleum-based fuels. Novel processing concepts, reactor design and catalyst systems are employed in this integrated approach to convert any cellulosic biomass and any nonedible bio-oil into bio-jet fuel. Feedstock flexibility offers significant cost and logistic advantages to this approach. Unlike other processes which use only the oil derived from a plant, the entire plant can be used as feedstock source. This approach can also convert the more challenging lignocellulosic component. Through molecular manipulations, this approach allows the production of “designer” biofuels. The technology offers a means to tailor product properties through saturation of double bonds to give better shelf life, cleaving long chain hydrocarbons to maximize the yield of the jet cut, controlling the aromatics content of the jet cut for better combustion characteristics, and isomerization to improve ignition characteristics and for better cold flow properties of the fuel. Successful deployment of the research program in biofuels can mean billions of dollars per year in fuel cost savings for aviation industry. It also opens the door for energy independence and distributed fuel generation capability.



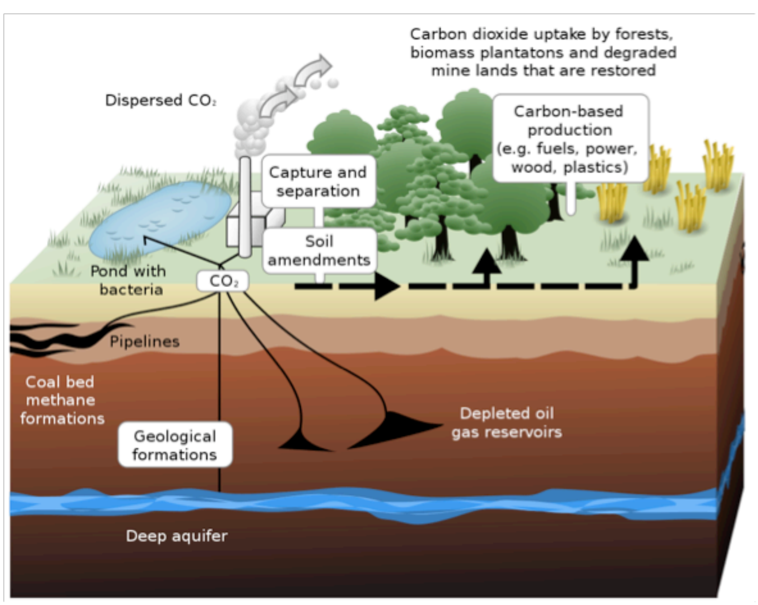
High-speed jet exhaust

Bio-Energy Research Projects

Integrated Florida Bio-Energy Production with Carbon Capture and Sequestration

PI: A. T-Raissi, UCF/FSEC

Description: This project will produce liquid hydrocarbon fuels derived from Florida grown biomass utilizing a two-step process. In the first step, pre-treated biomass is gasified with oxygen (instead of air) to a synthetic gas (syngas) comprised of mostly hydrogen, carbon monoxide and a carbon rich residue (char). Furthermore, in the first step, a solar (PV) powered water electrolysis system is used to provide oxygen for the biomass gasifier and hydrogen needed to elevate H_2 concentration in the syngas. Use of oxygen for gasification of biomass significantly improves the overall energy-conversion efficiency of the process eliminating the need for an air separation unit. In the second step of the process, hydrogen-enriched synthetic gas from step 1 is fed into a Fischer Tropsch (FT) synthesis unit to generate a liquid hydrocarbon fuel, such as diesel. The process is applicable to any lignocellulosic material such as crop residues, grasses, yard clippings, landfill gas, municipal solid waste (MSW), etc. FSEC has developed a robust FT synthesis catalyst capable of converting syngas to liquid hydrocarbon fuels. The technology also provides a means for not only converting biomass feedstocks to valuable liquid hydrocarbon fuels but also sequester carbon in the form of a high-value soil enhancing bio-char (terra preta).



Terrestrial and geological sequestration of carbon dioxide emissions from a coal-fired plant. (source: http://www.ornl.gov/info/ornlreview/v33_2_00/research.htm)

UCF Labs, bacteria sampling