University of Connecticut

ENERGY FORUM

DISCUSSIONS PROMOTING ENERGY AND SUSTAINABILITY

TUESDAY, NOVEMBER 4, 2008

11:00 A.M. - 3:00 P.M.

11:00 - 11:30 A.M. Registration/Lunch

3:00 - 4:00 P.M. Reception

ROME COMMONS BALLROOM

CO-ORGANIZED BY

COLLEGE OF AGRICULTURE AND NATURAL RESOURCES
COLLEGE OF LIBERAL ARTS AND SCIENCES
SCHOOL OF ENGINEERING

Agenda

11:30	Welcome – Suman Singha, Senior Vice Provost and Interim Vice President for Research & Graduate Education
11:35	President Michael Hogan
11:45	Greg Weidemann, Dean, College of Agriculture and Natural Resources
11:50	Jeremy Teitelbaum, Dean, College of Liberal Arts and Sciences
11:55	Mun Choi, Dean, School of Engineering

Technical Session

12:00	Steven Suib
12:05	Harry A. Frank
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12:15	Jose A. Gascon
12:20	Pu-Xian Gao
12:25	George A. Rossetti et al.
12:30	Ali Gokirmak and Helena Silva
12:35	Marty Fox et al.
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12:45	Yi Li, Mary Musgrave and John Blasiak
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1:00	Penny Vlahos et al.
1:05	Allison MacKay
1:10	Baikun Li
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1:25	Ramamurthy Ramprasad, T. Sadowski and S. Yadav
1:30	James F. Rusling
1:35	Bryan Huey
1:40	William Mustain
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1:55	Benjamin Wilhite
2:00	Sanguthevar Rajasekaran, Reda Ammar and Ian Greenshields
2:05	Peter Luh
2:10	Peter Luh and Laurent Michel
2:15	Krishna Pattipati
2:20	J. Kuzovkina
2:25	Doug Cooper
2:30	Eric Jordan
2:35	Amvrossios Bagtzoglou et al.
2:40	Carol Atkinson-Palombo et al.
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2:55	Fred V. Carstensen and Peter Gunther
3:00	Concluding Remarks: Dr. Suman Singha

List of Abstracts

Chemical and Materials Approaches to Sustainable Energy

Steven L. Suib
Chemistry, University of Connecticut, Storrs, CT

Abstract: Our research involves several aspects of synthesis of novel materials for enhanced sustainable energy. Such projects involve solar energy conversion of chemicals; new processes for synthetic fuels; and preparation of catalysts for biomass conversion. Ongoing state-of-the-art research involves synthesis, characterization, and catalytic studies of solar photocatalysts; Fischer Tropsch catalysis; and studies of esterification and transesterification of biomass feeds. The impact of this work in the areas of energy, kinetics and catalysis, petrochemical materials, and materials science is significant. Other areas of impact include indoor air quality and environmental cleanup of water and gas environments. Some of the challenges include enhancing the arte of absorption of solar energy by photocatalysts; enhanced efficiency of solar photocatalysts; clean and green catalysts for synthesis gas processes; and generation of environmentally friendly and efficient catalysts for conversion of biomass. We are collaborating with several groups of researchers in these areas including solar (Harry Frank, Jim Rusling, VJ Kumar); synthesis gas (several companies); and biomass conversion (Richard Parnas, Yi Li, Fred Carstensen, Xiusheng Yang).

Energy and Electron Transfer in Photosynthesis: Lessons on Solar Energy Conversion from Nature

Harry A. Frank
Chemistry, University of Connecticut, Storrs, CT

Abstract: Research in our group is focusing on the molecular details of energy and electron transfer in photosynthesis with particular attention being given to the various roles carotenoids play in the process. These include light-harvesting, photoprotection, singlet oxygen scavenging, excess energy dissipation, protein structure stabilization, energy flow regulation, and acting as redox components. We use steady-state and time-resolved molecular spectroscopic techniques to probe the energies and dynamics of the excited states of the protein-bound carotenoids and chlorophylls. The overall goal of the work is to understand the relationship between the structure of the photosynthetic apparatus and its physiological function of converting solar energy into chemical potential.

DNA-Based Artificial Light Harvesting Complexes and Vectoral Energy Transport

Challa V. Kumar
Chemistry, University of Connecticut, Storrs, CT

Abstract: Solar energy is one of the ultimate sources of abundant, renewable, carbon-free energy sources which can meet the world’s demand for energy in the new millennium. In fact, our planet receives enough solar energy in one hour which can meet all the energy needs of the world for one whole year. However, one major problem with solar energy is that it is distributed over a wide area and in a wide range of wavelengths. Therefore, green plants use light harvesting units (LHUs) to absorb solar energy over the blue and red regions of the solar spectrum and funnel the energy to the reaction centers, where it is converted into chemical potential (fuel). Therefore, construction of artificial LHUs is critical for efficient capture, conversion and storage of solar energy for practical purposes. Our current efforts which focus on constructing DNA-based artificial LHUs will be described.

First Principles Calculations as a Guide to Design Artificial Photosynthesis

José A. Gascón
Chemistry, University of Connecticut, Storrs, CT

Abstract: The synthetic production of oxygen in the atmosphere is the result of the photochemically driven reaction in which water splits into dioxygen, protons and electrons. This oxidation process is catalyzed by the Oxygen-Evolving Complex (OEC) in the protein Photosystem II, formed by a tetra-manganese cluster. So far, no reaction has been accomplished in a laboratory that synthesizes oxygen with near the efficiency in which this reaction occurs at the OEC. We will show how high level Quantum Mechanical calculations can guide the understanding of the OEC's structure and mechanistic properties, and the design of artificial water-splitting photocatalysts.

Functional Oxide-based Nanostructures for Sustainable Energy and Environment Applications

Pu-Xian Gao
Chemical, Materials and Biomolecular Engineering, University of Connecticut, Storrs, CT

Abstract: In our group, rational assembly and integration of functional oxide-based nanocomponents are being actively pursued involving nanoparticles, nanowires, and nanofilms. In the meantime, using these unique nanostructures, we are seeking potential benefits to the energy and environmental field in solar cell, catalysis, optoelectronics, and sensing applications. Two examples initiated from our lab will be presented including composite nanodendrite arrays and multispectral nanowire arrays respectively for catalysis and energy harvesting applications.

Electrocaloric Materials for Advanced Cooling Applications

George A. Rossetti, Jr. and S. Pamir Alpay
Chemical, Materials and Biomolecular Engineering, University of Connecticut, Storrs, CT

Abstract: Solid-state heat pumps offer efficiency, size, weight, and device integration benefits relative to conventional vapor compression systems. Electrocaloric materials exhibit an adiabatic change in temperature in response to an applied electric field. Recent advances in the growth of thin film electrocaloric materials have demonstrated the potential to achieve cooling capacities that are comparable to those of other solid-state devices utilizing magnetocaloric and thermoelectric technologies. Using a comprehensive model for coupled thermal, electrical and mechanical interactions in dielectric media we are investigating the candidate materials, operating conditions, architectures, and challenges associated with realizing practical cooling capacities in solid-state electrocaloric device applications.

Thermoelectric Effects in Micro and Nanometer Scale Structures

Ali Gokirmak and Helena Silva
Electrical and Computer Engineering, University of Connecticut, Storrs, CT

Abstract: We study the fundamentals of thermoelectric transport in electric current stressed quasi-1D silicon nanostructures, namely, electronic convective heat transport and phonon-drag (electron-phonon scattering) components of Thomson effect. Our findings can be applied towards design and realization of higher efficiency thermoelectric devices for power generation from wasted heat and solid-state cooling. The electrical stressing technique we use can be used for fabrication of novel nanostructures for energy conversion, sensors and information processing.

Microalgae for Bioremediation and Biofuel

Senjie Lin
Marine Sciences, University of Connecticut – Avery Point

Abstract: Growing biomass for fuel using human waste can serve to purposes: clean up the environment and produce energy. Microalgae have the potential to remedy both problems. Theoretically microalgae can be grown in bioreactors, with waste water as nutrients to serve as a water treatment plant and biomass as the output for fuel (and other valuable compounds). Many institutions in the US and abroad have been exploring microalgae for fuel; however, to my knowledge, no system is in place to integrate biomass growing with environmental cleanup. To grow algae for biomass, light supply is the critical limiting factor. Collaborating with small business, we demonstrate that light supply issue can be solved. Further research is urgently needed to determine achievable growth rate and cost effectiveness. [Not Presented]

UCONN Electric Drive Initiative

Martin D. Fox, Adnan Abdulally, Jan Khan, Matthew Shakun and Brian Poeltl
Electrical and Computer Engineering, University of Connecticut, Storrs

Abstract: Recent shortages and increases in oil prices have shown the need for a way to retrofit vehicles with a clean, efficient electric drive. Existing electric drive conversions have been inadequate in range and cost effectiveness. The purpose of this project is to utilize existing automotive alternators in motor mode to provide a cost effective and energy efficient means to electrify our present vehicular fleet. At current prices, this will reduce the fuel cost per mile by approximately a factor of 10, and will also make critical transportation services less dependent on unreliable and expensive fossil fuels.

Cellular & Metabolic Engineering for BioHydrogen Production

Ranjan Srivastava
Chemical, Materials and Biomolecular Engineering, University of Connecticut, Storrs, CT

Abstract: A critical need for the *hydrogen economy* to become a reality is to have a source of clean "green" hydrogen. A possibility we are exploring is the use of bacteria to generate hydrogen. Rapid advances in both biotechnology and computational technology have made it possible to carry out *in silico* experiments, allowing us to determine how best to manipulate bacterial metabolic pathways to produce hydrogen. With these simulations as a guide, we can genetically modify the bacteria to enhance hydrogen production. Details on how this approach is implemented will be provided.

Optimizing Plants for Biomass Production

Yi Li, Mary Musgrave and John Blasiak
Plant Science, University of Connecticut, Storrs, CT

Abstract: A reliable supply of organic material that is high in quality, low in cost and easy and safe to grow is essential to any sustainable biomass production system. Utilizing traditional and modern breeding techniques, we are developing bio-energy crops that are high in energy content, fast growing and non-invasive. A centerpiece of our work is gene-deletor technology that eliminates the concerns currently associated with bio-engineered energy crops.

Our work is directly applicable to the "Healthy Highways Initiative," a proposal to exploit under-utilized highway verges for biomass production.

Hydrogen from High Temperature Bioprocessing

Kenneth M. Noll
Molecular and Cell Biology, University of Connecticut, Storrs, CT

Abstract: The production of molecular hydrogen drives the physiology and bioenergetics of many microorganisms in hydrothermal environments. It is important to understand how the growth substrates of these microbes affect the cells[1] disposition of electrons derived from their catabolism and the subsequent formation of molecular hydrogen. My work focuses on bacteria called Thermotogales, fermentative anaerobes that produce hydrogen from simple and complex carbohydrates. We are setting out to examine how sugars are catabolized to hydrogen and how hydrogen yields are influenced by carbon source, catabolic waste products and alternative electron sinks. We hope to learn which cellular processes can be eliminated or augmented to optimize or increase the rate of hydrogen generation during bioprocessing of agricultural or waste feedstocks.

Engineering Osmosis for Sustainable Power

Jeffrey R. McCutcheon
Chemical, Materials and Biomolecular Engineering, University of Connecticut, Storrs

Abstract: Non-carbon based energy technologies are needed for energy sustainability and security. Solar and wind offer alternatives but are costly and often geographically separated from where electricity is utilized. *Osmotic power,* an emerging energy generation technology is a sustainable alternative which can be collocated with urban centers along coastlines (especially those near rivers). This technology utilizes osmotic pressure gradients between freshwater and seawater, converting the chemical potential of seawater into useful work. For either naturally occurring or engineered osmotic gradients, a new generation of composite polymeric membranes must be designed to accommodate the needs of osmotic power systems. This task is the focus of my work.

Algal Biofuels: Optimization and Production

Penny Vlahos, Pieter Visscher, Claudia Koerting and David Cady
Marine Sciences, University of Connecticut, Avery Point

Abstract: The next generation of alternative fuels will require a high energy yield product that is generated under practical timescales with minimal costs. Algae are good candidates for both transportable and continuous energy sources due to short doubling times and potentially high energy content. High volume per area yields and relative ease of growing conditions also make algae realistic and cost efficient candidates for alternative energy sources while generating a zero net atmospheric carbon source on short timescales. Optimization of growth conditions for large scale algae production and methods to control energy yields are considered.

Fate of Contaminants and By-Products of Energy Generation in Environmental Systems

Allison MacKay
Civil and Environmental Engineering, University of Connecticut, Storrs

Abstract: Energy generation has a legacy of environmental impacts, beyond resource depletion from the extraction of fuels. Historically, environmental engineers have been concerned with the carcinogenic hydrocarbons from combustion and coal gasification. The development of alternative energy sources may bring new contaminants of concern in environmental systems as new materials are used for fuel generation and storage. An overview of contaminant fates in environmental systems will be provided, with emphasis on energy generation, to highlight complementary expertise for other university initiative in energy production.

Production of Electricity in Anaerobic Wastewater Treatment

Baikun Li
Civil and Environmental Engineering, University of Connecticut, Storrs

Abstract: Wastewater contains enormous amount of high-energy compounds (i.e. protein, hydrocarbon, fatty acid) that can be used as energy sources. This study investigates novel microbial fuel cells (MFC)—granular activated carbon MFC (GAC-MFC) to improve power generation and enhance wastewater treatment efficiency. Based on the lab-scale results, cost-effective electrodes will be developed, pilot-scale tests will be conducted in wastewater treatment plants.

High Efficiency Tandem Solar Cell Structures

F. Jain, R. Setya, and E. Suarez
Electrical and Computer Engineering, University of Connecticut, Storrs

Abstract: Tandem cell structures harness solar energy efficiently by absorbing different energy photons in semiconductor layers having matching energy gaps, thereby reducing the excess carrier energy losses. Since the development of a two-junction 25.7% GaAs-based cell over a decade ago, Bett. *et al.* have reported a 37.9% cell under 10 x sunlight concentration [2006]. Dimroth and Kurtz recently reported tandem cell structures built on Ge substrates, potentially producing efficiencies up to 63.1%. Various approaches resulting in efficiency improvement will be reviewed. Results on the modeling of Si/SiGe tandem cell structures under high concentration will be presented. Experimental work on II-VI/Si solar cells will also be described.

Voltaics and Hydrogen Splitting

Robert R. Birge, Rickinder Grewal, Brian Huta, Anu Nellissery, Megan Nollenberger, Matthew Ranaghan, Daniel Sandberg, Nicole Wagner
Chemistry, and Molecular and Cell Biology, University of Connecticut, Storrs

Abstract: The archaean *Halobacterium salinarum* has used 3.5 billion years of evolution to optimize a rugged photosynthetic protein called bacteriorhodopsin. This protein converts sunlight to energy with 65% efficiency. We propose photovoltaic devices that use this protein to create both electricity and to split water into hydrogen and oxygen. We compare the efficiency of these cells to the commercial competition with favorable results.

Next Generation Photovoltaics Through Computational Design

R. Ramprasad, T. Sadowski and S. Yadav
Chemical, Materials and Biomolecular Engineering, University of Connecticut, Storrs

Abstract: Through atomic level quantum mechanical modeling, we aim to aid in the design of semiconductor nanowire (NW) based high efficiency photovoltaic systems. The attractiveness of semiconductor NWs arises from their ability to both support a large number of electron-hole pairs (excitons) and allow for the enhanced transport of dissociated charge carriers. The crucial step of dissociating excitons to free carriers may be accomplished by suitable interfaces within the nanowires, for example, through a core-shell structure. Optimization of the materials on either sides of the interface (i.e., in the core and shell regions), the NW size, the nature of the interface, and strain are critical quantities to be optimized through computations, and parallel experiments.

Solar Production of Hydrogen, Solar Batteries and Biofuel Cells

James F. Rusling
Chemistry, University of Connecticut, Storrs

Abstract: In the 1990s we developed solar cells for pollutant decomposition and chemical synthesis with simultaneous generation of hydrogen and electricity. With Suib we explored interactions of photoactive MnO_2 nanoparticles with proteins and in electrosynthesis. Rusling and Frank achieved the first direct electrochemical communication between electrodes and redox centers in photosynthetic plant proteins Photosystems I and II. Rusling and Kumar developed films of enzymes and poly(lysine) (PLL) on electrodes and nanoparticles that are thermally stable at 90 ^{o}C. The Rusling/Suib/Frank/Kumar team plan to apply these methodologies to Photosystem I to produce hydrogen photochemically using nanomaterials. Simultaneously, Rusling and Vaze are developing biofuel cells utilizing glucose.

Direct Nanoscale Characterization of Photovoltaics

Bryan D. Huey
Chemical, Materials and Biomolecular Engineering, University of Connecticut, Storrs

Abstract: A novel combined Atomic Force Microscope and Optical Microscopy platform has been installed in the Institute of Materials Science. With the added expertise of local potential and current measurements, as well as a recent in-house advance allowing image acquisition rates 1000 times faster than is typical, this system is ideally suited for photovoltaic research. Examples of surface potential maps, the influence of light exposure (duration, intensity, and/or or wavelength can be controlled), and static and dynamic measurements will be demonstrated.

Novel Cathode Catalysts for PEM Fuel Cells

William Mustain
Chemical, Materials and Biomolecular Engineering, University of Connecticut, Storrs

Abstract: Proton exchange membrane (PEM) fuel cells represent one of the most promising technologies for portable power generation in the 21st century. PEM fuel cells offer safe, reliable power with efficiencies twice that of their fossil fuel counterparts. Unfortunately, this high efficiency comes with a prohibitively high material cost for state of the art components, including platinum in the catalyst layers. Therefore, work in this area is focused on i) reducing

the platinum group metal loading using surface functionalization techniques and ii) developing high activity, platinum-free catalysts for the oxygen reduction reaction at the PEM cathode in order to reduce cost.

Experimental Study on Clamping Pressure Distribution in PEM Fuel Cells

Bi Zhang
Mechanical Engineering, University of Connecticut, Storrs

Abstract: To study the effect of internal pressure distribution on the performance of a PEM fuel cell, a pressurized endplate was designed and fabricated. The endplate had a built-in hydraulically pressurized pocket with a thin wall facing the fuel cell assembly. Pressure sensitive films were used to measure the pressure distribution for both conventional and newly-designed end plates. Fuel cell performance tests were conducted under selected conditions. It was found that the pressure distribution for the newly-designed endplates was more uniform than for the conventional end plates, and an improved fuel cell performance was obtained with the newly-designed end plates as well.

Supercritical Fluids and Aerogels for Synthesis of Novel Nano-Materials

Alevtina L. Smirnova
Chemical, Materials and Biomolecular Engineering, University of Connecticut, Storrs

Abstract: Nano-structured materials can be synthesized in different ways but none of them combine the advantages of supercritical (SC) fluids that have the properties of liquid and gas phase allowing for high solubility and diffusivity in absence of surface tension. Supercritically synthesized carbon or ceramic aerogels are gaining more and more interest in very diverse areas of applications including fuel cells, hydrogen storage compounds, supercapacitors, water purification, gas sensors, and biomaterials. None of the existing materials can be synthesized with as high surface areas as aerogels ranging from 500 to 3000m^2/g, interconnected pores structure, and narrow pore-size distribution in the range of a few to a hundred nano-meters which is precisely tunable to 1/10nm. The results in synthesis of aerogels and ternary PEMFC catalysts indicate an exceptional importance to continue this research for promotion of biomaterials, reliable power generating devices and energy security. The financial support of NSF, UTC Power and UTRC is gratefully acknowledged.

Microchemical Systems

Benjamin A. Wilhite
Chemical, Materials and Biomolecular Engineering, University of Connecticut, Storrs

Abstract: Microchemical systems offer significant advantages over their conventional counterparts in (i) heat and mass transport rates, (ii) system redundancy and safety, and (iii) portability and power densities. This combination of advantages opens the door for realizing commercial, cartridge-based fuel reformers for distributed energy production from biofuels. In order to realize this goal, several reaction engineering problems must be revisited. This talk will highlight reaction and diffusion considerations in non-isothermal microreactor and micro-membrane reformers, and heat integration and stability considerations for multifunctional microreactors.

While conventional catalytic reactors often employ packed-beds of catalyst pellets, presenting the classical problem of reaction and diffusion with symmetric boundaries, microreactors utilize layers of catalytic washcoats, presenting asymmetric boundary conditions for both heat and mass transport. This introduces an interesting variant on reaction and diffusion in the presence of heat conduction and/or catalytic generation, and a significant class of problems in the

case of composite-catalytic membranes for combined reforming and purification. In both cases, significant improvement in reactor design can be achieved with appropriate manipulation of reactor and catalyst structures.

Microchemical systems, comprised of large networks of parallel, separate channels promise efficient heat transfer between endo- and exothermic processes (e.g., partial oxidation and water-gas-shift). Selection of appropriate geometries, materials and packaging has significant effects on both thermal efficiency and steady-state multiplicity. Appropriate use of microfabrication techniques further allows coupling of several separate processes in both parallel and series within networks of 10^1 – 10^6 channels; this level of complexity will require a new generation of design and optimization tools for realizing efficient, integrated microchemical systems.

Peta-Scale Simulation for Energy Applications

S. Rajasekaran, R. Ammar and I. Greenshields
Computer Science and Engineering, University of Connecticut, Storrs

Abstract: Modeling and simulations are pervasive in all areas of science and engineering, with simulations built in industry and academia targeting specific application domains. As a result, tools built for one application may neither apply nor perform well in other domains. Further, users face steep-learning curves on simulation environments and programmatic interfaces, leading to inaccurate simulation specifications and results. In this project, we propose to build a suite of easy-to-use, large-scale simulation tools for a broad spectrum of energy sources including the fuel cells.

Efficient and Secure Operations of Electrical Power Systems

Peter B. Luh
Electrical and Computer Engineering, University of Connecticut, Storrs

Abstract: Electrical power systems are a key component of the overall energy system, and have major effects on the economy and well-being of the society. For example, the energy portion of the 2007 New England market is about $10 billion dollars, and a small percentage of improvement would be very significant to the economy and to the environment. Also, failures in systems may cascade, e.g., the August 14, 2003 blackout in US and Canada caused 50 million people to lose electricity and resulted in a major loss to the society.

We have been working on the efficient and secure operations of electric power systems for the vertically integrated systems as well as for the deregulated market environment. Sponsored by NSF, Southern California Edison, ISO-New England, ISO-Midwest, EnvaPower, and Northeast Utilities, we have been working on the optimization of various generators to meet the system demand, buy and sell power among generators, forecast electricity demand and market prices, auction mechamism design for a fair and efficient market, and efficient method to compute power flows for a network with a dynamic topology. Potential partners would include those who are familiar with wind and solar generation so as to harness sustainable energy within power grids.

Electricity Generation and Consumption Forecasting

Laurent D. Michel and Peter B. Luh
Computer Science and Engineering and Electrical and Computer Engineering, University of Connecticut, Storrs

Abstract: While electricity generation and distribution are sometimes taken for granted, the process of matching the end-user demands with generation capacity in an efficient way is a complex problem. Indeed, over-generation

wastes resources and affects market prices while under-generation leads to rolling blackouts. This talk will highlight how short-term and very-short term load forecasting can be used to anticipate demands and optimize energy generation and distribution. Predictive abilities enable better planning, demand response and pricing incentives to more efficiently allocate the energetic resources. The ideas developed in the electricity market context do apply more broadly to emerging energy sources and their management.

Automotive Battery Management Systems

Krishna R. Pattipati
Electrical and Computer Engineering, University of Connecticut, Storrs

Abstract: Battery health management is an integral part of a hybrid vehicle. Its purpose is to protect the battery from damage, predict its remaining useful life, and maintain it in an operational condition. We have developed a prognostic modeling framework based on an equivalent circuit battery model to estimate three critical characteristics of a battery, viz., state of charge, state of health, and the remaining useful life. The models were trained and validated using data from electrochemical impedance spectroscopy and the C1/1 static capacity tests on lithium-ion batteries provided by the Idaho National Laboratory.

Regional Woody Crop Feedstock Development Program

J. Kuzovkina
Plant Science, University of Connecticut, Storrs

Abstract: Short–rotation woody crops such as poplar and willow are the primary focus of investigation as renewable feedstock for bioenergy in the Northeast US. As part of the NE Regional Woody Crop Feedstock Development Program we are establishing a series of research plots at the Plant Science Research Farm of the University of Connecticut to test productivity and energy potential of biofuel crops under the local climatic conditions. Establishment of the varieties trial will allow investigators to conduct research on production technologies for the biofuel crops and it will also serve to demonstrate to commercial producers the most effective production practices.

Adaptive Process Control of a Cogeneration Power Plant

Doug Cooper
Chemical, Materials and Biomolecular Engineering, University of Connecticut, Storrs

Abstract: The UConn Cogen plant must produce sufficient heating, cooling and electricity to meet ever-changing campus demand, but without producing excess electricity because of grid export restrictions. As such, a process control system that can automatically adapt to changing operational requirements offers allure for maximizing a safe and efficient operation.

This work is exploring performance assessment methods to identify underperforming controllers. A novel feature is pattern recognition applied to the autocorrelation of process signals, yielding a performance index that guides controller retuning in real time. This emerging control technology can potentially be applied to a broad range of energy production processes.

Metastable Materials Made by Solution Plasma Spray for Energy Applications

Eric H. Jordan
Mechanical Engineering, University of Connecticut, Storrs

Abstract: Solution plasma spray is a process developed at UConn that can be used to make a wide variety of non-equilibrium ceramics. In the process liquid chemical precursors are injected into a plasma jet resulting in the synthesis and melting of ceramics which are then splat cooled on the substrate. As a result of rapid cooling highly extend solid solubility and highly distorted lattices can be made. The application of this technology to making more contaminant resistant coatings for gasified coal plants with carbon sequestration and the potential application of this to photo catalytic production of hydrogen form water.

An Innovative Small-Scale, Environmentally Friendly, Low-Head Hydropower Concept

Amvrossios Bagtzoglou, Ramesh Malla, Baki Cetegen, Thomas Barber
Civil and Environmental Engineering and Mechanical Engineering, University of Connecticut, Storrs
Joel Douglas - NativeNano, LLC, Canton

Abstract: River, stream flow, wave and current power generation is categorized as low-head hydropower. Other systems developed to date to take advantage of low head water movement require substantial flow rates of water flowing through or pass the low head hydropower generator that would not be available to a deployed buoy. We study an energy extraction system that is based on a modification of the hydraulic sail concept, originally developed by Dr. Herman Sheets (a member of the National Academy of Engineering) while at the University of Rhode Island. This system will be connected to a generator and battery system so that the energy can be stored and discharged to provide power as needed. The system will be capable of providing either AC or DC energy for remote applications. The ability to provide a reliable, low cost, low-head hydropower supply for sensors attached to buoys and other floating systems has been a challenge towards attaining the goal of expanding the remote sensor technology. Expanding hydropower technology to low-head and low flow conditions affords us the potential to generate power in locations that are not suitable today. This opens up the possibility to generate thousands of previously non-harnessed MWs. Historically many systems have been developed to recharge batteries for use by buoys used as navigational aids but these buoys have low power requirements. The systems designed for use in buoys are not suitable for a system requiring the production of power for use in a hydropower application. The difficulty in developing such as system is the ability to produce and store the power so that it can be discharged to support the local power grid needs. To accomplish this, a need for a mechanism to produce the power from the surrounding intermittent movement of the water where the buoy or barge is deployed and a method to store it so that it can be released continuously without power interruption for the specific tasks, is critical. The unique properties of the hydraulic sail make power generation from slow moving water possible as well as the ability to harness fast moving currents therefore extending the range of flow speeds and volumes that can be used to generate power. In this work, we demonstrate the feasibility of developing a river, stream, ocean or estuarine energy extraction system that targets implementation for a variety of sensor power applications used on buoys or barges near river embankments.

New Generation of Joint Economic-Environmental Impact Scenarios
Transportation Research Record: Journal of the Transportation Research Board

Carol Atkinson-Palombo, John Clapp, Robert Cromley and Nicholas Lownes

Geography, School of Business Administration, Finance/Center for Real Estate and Civil and Environmental Engineering, University of Connecticut, Storrs

Abstract: Valuations of the economic impact of transit systems should include "precautionary principal" mechanisms to value the risk of being exposed to higher oil prices, and greenhouse gas reductions. We present the framework for a new generation of models based on scenario analyses of joint economic and environmental impacts, that we term Joint Economic-Environmental Impact Scenarios (JE-EIS). Using the light-rail system in Phoenix, Arizona, as an example, the economic impact is $514 million using current values for oil and greenhouse gas emissions. The benefit rises to $1.3B with a 10% increase in both measures, and rises to $5.4B with 50% increases.

The University of Connecticut Cogeneration Plant

Lee Langston and Ron Gaudet
Mechanical Engineering and Utilities, University of Connecticut, Storrs

Reserve Estimation by Geostatistics and GIS

Chuanrong Zhang and Weidong Li
Geography, University of Connecticut, Storrs

Abstract: Applications of geostatistics are being increasingly considered by reservoir analysts and engineers in generating more accurate reservoir models together with usable measures of spatial uncertainty. Geostatistics provides a probabilistic framework and a toolbox for data analysis with integration of information and has become the major tools in GIS spatial analysis. In this research, we proposed a novel Markov Geostatistics for reserve evaluation and estimation. The proposed method demonstrated their advantages over conventional geostatistical approaches in generating more accurate results. Combining with GIS mapping and analysis tools, the Markov Chain Geostatistics may provide an effective solution for multi-scale data integration and high-resolution reservoir characterization for better planning and management of reserve.

Electrifying Connecticut Automobiles

Fred V. Carstensen and Peter Gunther
Economics and Connecticut Center for Economic Analysis, University of Connecticut, Storrs

Abstract: Connecticut is striving to reduce green house gases and to shift to alternative energy. To evaluate one set of potential energy policies, CCEA has developed a comprehensive dynamic analysis of environmental and economic impacts of a switching to electric powered (plug-in) automobiles, the electricity generated from solar, biofuels, or combined solar-biofuels. Six scenarios (dynamic projections to 2050) show rapidly growing environmental (CO_2 reductions exceeding 225 million tons), economic (growth in jobs and personal income), and fiscal benefits to Connecticut.

Radical Salt-Doped Hole Transporters in Organic Photovoltaic Devices

Fotios Papadimitrakopoulos, SanthiSagar Vaddiraju, Mathew Mathai and Emmanuel Kymakis
Chemistry, University of Connecticut, Storrs
Electrical Engineering, Technological Educational Institute (T.E.I.) of Crete
EstaVromenos P.B. 1939, Heraklion, GR-71 004 Crete, Greece

Abstract: Efficient photovoltaic devices were demonstrated from thick polymer films (2500 Å), using ternary mixtures of C60, a polycarbonate linked TPD (*N*,*N*,*N*¢,*N*¢-tetrakis(phenyl)benzidine)) polymer (PTPD), and a small molecular weight radical salt of a TPD derivative, in an indium tin oxide/blend/Al configuration. The binary PTPD mixtures with salt and C60 were also investigated in a similar device configuration. The addition of the radical salt increases the hole conductivity of the PTPD host matrix and subsequently enhances the photocurrent by 1 order of magnitude. On the other hand, blending PTPD with C60 increases the photocurrent by 3 orders of magnitude to produce a short circuit current (*I*sc) of 0.22 mA/cm2. The incorporation of these two binary systems into a ternary blend shows a further increase in the *I*sc (0.33 mA/cm2) with a power conversion efficiency of 0.47%. To the best of our knowledge this is the first time that a radical salt has been used in an organic photovoltaic device configuration. This study provides insight on the interplay of the three components of this ternary system to both open circuit voltage (*V*oc) and *I*sc. Further optimization in structure and morphology of these devices can lead to significant performance enhancement. [Not Presented]