Cornell University
Center for a Sustainable Future

Academic Venture Fund Awards

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The Cornell Center for a Sustainable Future announces the 2008 awards from the **Academic Venture Fund**. This fund has been designed to stimulate new, original, cross-disciplinary research at Cornell in sustainability science, emphasizing work having the potential to involve external partners such as industry, government, foundations and NGOs. The 35 proposals submitted in response to AVF solicitation represent a vibrant, innovative, interdisciplinary movement at Cornell.

Exceptionally broad representation was seen in the proposals, which included investigators from the Colleges of Agriculture and Life Sciences; Art, Architecture and Planning; Arts and Sciences; Engineering; Human Ecology; and Veterinary Medicine; the Johnson Graduate School of Management; the Faculty of Computing and Information Science; the Schools of Hotel Administration and Law; the Cornell Cooperative Extension; and the Laboratory of Ornithology. Over 70% of the proposals involved investigators from more than one college or school and over 40% included faculty from more than three colleges or schools. The quality of the proposals was very high and the degree of proposed cross-campus collaboration, especially between individuals who had never worked together, was impressive.

To evaluate the 35 submissions, CCSF convened three panels composed of six distinguished faculty. Each proposal received three written reviews in addition to a panel review. The ranked funding recommendations of the three panels were reviewed by the CCSF leadership team and final award decisions were based on the reviews and available funding. Twelve proposals were selected for funding in this first round of the AVF.

Of the twelve proposals selected, five are **workshops** and seven are **research projects**. **Workshops** are designed to bring together Cornell faculty from across the campus to discuss issues posed by specific sustainability challenges, to prioritize needs, and to strategize potential approaches. A workshop may include outside experts and a variety of stakeholders. Workshop outputs might include, for example, a plan for research or for gathering more information; alternately attendees might produce a “white paper” to inform policy makers of options. The objective is to clearly articulate issues and to initiate responses by forming collaborations with appropriate external partners. **Research projects** are designed to demonstrate proof of principle, provide insights and tools that can be used to address needs, or establish new and innovative ideas and approaches to specific sustainability problems. CCSF is particularly interested in promoting a collaborative, synergistic, and integrated system-approach to complex sustainability issues, but also encourages truly paradigm breaking or disruptive ideas.

Many more promising proposals were submitted than CCSF could fund and there are tentative plans to open another AVF competition in the spring of 2009.

WORKSHOPS

- **Cornell Workshop on Large Scale Wind Generated Power**

The development and installation of large wind turbines to produce wind-generated electrical power represents the most rapidly growing renewable energy source in western democracies, including the United States. A plan has been developed by the Department of Energy, with input from Industry and the national laboratories, including the National Renewable Energy Laboratory, to understand the impact of generating 20% of the nation's required electrical power from the wind by the year 2030. Wind power also is an important growth industry for the state of New York, the home of General Electric, the major U. S. supplier of large wind turbine systems, and of AWS Truewind, one of the world's leading companies providing real-time wind and wind resource mapping data. The Cornell faculty have expertise in a wide range of the disciplines central to the further development of the wind power Industry, but to date there has been no concerted effort to apply this knowledge to the problems associated with wind power. Our goal is to form a team of researchers capable of developing a major center at Cornell in this important area of renewable energy. The Cornell Workshop on Large-Scale Wind-Generated Power will bring world-renowned experts in the field to Cornell to help inform the faculty on the critical research issues that must be resolved in order to meet the ambitious goal of "20% by 2030" and, in the process, help Cornell faculty develop the perspective needed to develop a major program in this field. The workshop will consist of plenary lectures followed by in-depth discussions among working groups; the plenary lectures will be aimed at a wide audience, and will be open to all in the Cornell community, as well as local government and industry leaders.

Duration: 6 months
Investigators: **David Caughey** (M&AE), **Zellman Warhaft** (M&AE), **Alan Zehnder** (T&AM)

- **Managing Sources of Uncertainty for Sustainable Resource Management (Workshop)**

Most real world systems are complex, with considerable uncertainty about how the system works, and how it will respond to management actions. A robust framework for making the best decisions possible would acknowledge uncertainty, and would take whatever steps possible to reduce the uncertainty through the management actions. One recent approach to achieving this objective is known as ‘adaptive resource management’ (ARM, for short). ARM is a formalized structure which has been developed to help guide management decisions under uncertainty, while at the same time, learning about the system, which progressively reduces uncertainty, which should lead to better decisions over the long-term. While the basic ideas of ARM are well-established, there remain several important technical challenges, for both describing the uncertainties in a system, and the problem of coming up with the ‘optimal strategy’ given those uncertainties. Our work will bring together researchers from a very wide range of disciplines, to address some of the outstanding, more difficult problems in handling uncertainty. Our goals are to devise a general structure for accurately describing the uncertainties in a given system, and identify the most robust and most efficient methods and tools to come up with optimal decisions given these uncertainties.

Duration: 1 year
Investigators: **Evan Cooch** (NTRES), **Bernd Blossey** (NTRES), **Daniel Decker** (NTRES), **Richard Stedman** (NTRES), **Jery Stedinger** (C&EE), **Jon Conrad** (AE&M), **Cliff Kraft** (NTRES), **Carla Gomes** (CIS, AE&M), **David Shmoys** (ORIE)
External Partners: USGS Biological Resources Division; Fish & Wildlife Cooperative Research Units at Cornell and the University of Georgia and the USFWS Adaptive Management Working Group

- **Building Social Networks for Biological Inventories and Information (Workshop)**

To the degree we understand other organisms, we place greater value on them; they are the core of the life sciences, nature's encyclopedia. Everything else in biology flows from that hub, and without natural history organisms will continue to vanish and society will be worse off. On one hand, there are millions of species and for the vast majority of them we lack any archive. If we had even twenty observations per species, the management and use of that information would have been inconceivable only a decade ago. On the other hand, we desperately need to reconnect humanity with nature, for the sake of the natural world and because in doing so we gain perspective, creativity, and peace of mind. Social networks and information technology are poised to join those two aspects in a global partnership for the environment and society; moreover, partnerships between private and public sectors focused on leveraging social networks constitute a powerful strategy to facilitate positive behavioral changes toward the environment. Our workshop in Spring 2009 will play a central role in developing the first social network for the environment, simultaneously reconnecting citizens with their environment and aggregating biodiversity data for improved management.

Duration: 6 months
Investigators: **Harry Greene** (E&EB), **Janis Dickinson** (NTRES, LabO), **Shorna Broussard** (NTRES), **Josh Donlan** (E&EB), **Geri Gay** (COMM), **Johannes Gehrke** (CS), **Steven Kelling** (LabO**), Kathleen O'Connor** (JGSM), **Brian Wansink** (AE&M)
External Partners: Bank of America, Silver Spring Networks, Microsoft, Inc.

- **Urban Trees for Sustainable Cities: Workshop to Develop an Integrated Social-Ecological Sciences Research Agenda in New York City (Workshop)**

Given that over 50% of the global population lives in cities, addressing urban issues is critical to Cornell's ability to foster regional, national, and global sustainability. New York State, with an urban population of 80%, exemplifies the common paradox wherein cities have extreme environmental footprints extending well beyond their boundaries, yet often are leaders in proposing large-scale sustainability initiatives. The Cornell Urban Trees for Sustainable Cities workshop will bring together urban forestry and sustainability experts from Cornell University, Mayor Bloomberg's PlaNYC, the US Forest Service, NYC Parks & Recreation, NY Restoration Project, Trees New York, the Environmental Defense Fund, and UNESCO-NYC to define a research agenda and methodology for understanding the social and ecological outcomes of urban tree planting in NYC. The workshop is the first step in a larger Cornell Community Forestry initiative, the goal of which is to create an integrated social-ecological systems research and education program that leads to better understanding and practice related to urban tree planting and related urban sustainability efforts.

Duration: 6 months
Investigators: **Marianne Krasny** (NTRES), **Keith Tidball** (NTRES), **Nina Bassuk** (ORIE), **Shorna Broussard** (NTRES), **Janis Dickinson** (NTRES, LabO), **Gretchen Ferenz** (CCE-NYC), **John Nettleton** (HE-NYC, CRP) **Stephan Schmidt** (CRP) **Richard Stedman** (NTRES), **David Weinstein** (NTRES), **Nancy Wells** (D&EA), **Thomas Whitlow** (ORIE), **K**. **Max Zhang** (M&AE)

- **Environmental Sustainability in an Aging Society (Workshop)**

This project responds to the intersection of two critically important trends in American society: the rapidly growing aging population and mounting concern about environmental sustainability. Although population aging has potentially enormous implications for the environment, little research exists on the topic. The project will lay the initial groundwork for a program of basic and applied research on the relationship between environmental and energy issues and aging by creating the Cornell Aging and the Environment Collaboration (CAEC). We will conduct a carefully planned set of developmental activities to accomplish the following aims: 1) Create an interdisciplinary network of Cornell scholars concerned with research on aging and the environment; 2) Develop on-going communication mechanisms among scholars interested in the topic; 3) Sponsor the preparation of several "white papers" to provide an overview of key issues in aging and the environment and lay out components of a research agenda; 4) Conduct a consensus workshop based on the white papers to develop recommendations for a research agenda on aging and the environment, involving Cornell scholars and external partners; 5) Plan next steps for development of the research area, and in particular for externally funded proposals.

Duration: 6 months
Investigators: **Karl Pillemer** (HD), **Linda Wagenet** (DSOC), **Nancy Wells** (D&EA)

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For more information, contact:
Cornell Center for a Sustainable Future
200 Rice Hall, Cornell University
ccsf@cornell.edu
(607) 255-7535

RESEARCH PROJECTS

- **Improving the Stability and Productivity of Algal Bioreactors for Biofuel Production**

As the world faces uncertain crude oil prices and global warming, sustainable and carbon-neutral sources of energy and raw materials are critical. Biomass-derived fuels, or bio-fuels, are seen as a substantial portion of a sustainable energy portfolio. Aquatic microalgae offer several unique features that make them an attractive prospect relative to land plants for biomass production. They can be grown rapidly in reactors or ponds on marginal land. A variety of species produce up to 77% of their total weight as energy-rich oils or carbohydrates. Algae can be grown with less water than agricultural crops, and many species of algae are evolved to thrive in brackish or salty water. Estimates of biodiesel production by algae on a land area basis typically exceed that of traditional crops by orders of magnitude. Despite this potential, no large-scale facilities for commercial algal biofuel production currently exist. Many private companies are currently attempting to commercialize algae production but appear to be facing significant challenges with respect to scale-up and profitability. Using a well-studied algal species *Chlamydomonas reinhardtii*, our research team will address the challenge of profitability by focusing on the simultaneous production of a high value industrial enzyme along with oil and carbohydrate accumulation. We will use established techniques to generate transgenic algae that are able to produce large amounts of a cellulase, a type of enzyme that is projected to limit cellulosic ethanol production and therefore potentially in high demand. We will develop diagnostic proteomic methods for algal culture monitoring that involve rapid detection of specific proteins in a complex background. This new tool will lead us to improved culturing conditions that increase output of both the enzyme and lipids or oil for biodiesel. We will also investigate the effects of water and nutrient recycling on these same parameters.

Duration: 2 years
Investigators: **Beth Ahner** (B&EE), **Ruth Richardson** (C&EE), **Maureen Hanson** (MB&G)

- **Integrated Digital Design Environment for Sustainable Architecture**

Buildings are a leading contributor to total energy consumption in the United States. It is estimated that the combination of commercial, industrial and residential buildings is responsible for 48 percent of the total energy use in our country. Yet consumption will not be a driver of the architectural design of buildings unless architects have appropriate tools to perform lifecycle analysis, material evaluation and energy modeling in the early stages of the design process, when critical decisions that will have far reaching effects on the long term sustainability of built projects are being made. Today, the design and analysis of sustainable buildings requires an unprecedented degree of technical sophistication that demands a new synthesis of art and technology. We propose to develop interactive visual and analytic tools which will integrate architectural form finding and environmental analysis in a seamless three dimensional digital environment. Our proposal consists of five major parts: (1)The design of a comprehensive material database which will allow interoperability between existing simulation programs; (2) The development of an easy-to-use user-interface so that accurate analytical tools can be used at the early stage of design; (3) The refinement of analytical tools to deal with complex geometries which execute at speeds several orders of magnitude faster than today; (4) The creation of new visualization methods so that designers can easily interpret the data

for energy simulations; and (5) Verification of the simulations with field measurements in a number of Cornell's new buildings.

Duration: 18 months
Investigators: **Don Greenberg** (JGSM, ARCH), **Kevin Pratt** (ARCH), **Dana Cupkova** (ARCH), **Ken Torrance** (M&AE)

- **Forecasting Disease and Economic Consequences of Climate Change**

Projected increases in global temperatures driven by increasing carbon dioxide are expected to trigger new outbreaks of disease in diverse communities and biomes. Accurate projections will require remote sensing tools to detect the spatially explicit accumulation of thermal anomalies and project expected disease responses. Our goal is to form a Disease and Climate Network at Cornell University that will conduct research and promote external collaborations to address the critical challenges of climate change on species diversity, conservation and health. The specific goals of our proposal are: (1) Develop algorithms and computational tools to forecast climate-driven disease outbreaks in corals, amphibians, and mosquito-borne infections in humans, which will serve all researchers interested in human and wildlife infectious diseases; (2) Begin to project climate-driven changes in host community structure (loss of biodiversity) and human health and explore microhabitat effects in more detail; (3) Estimate economic impacts of the disease outbreaks driven by climate change; and (4) Support policy change through links with policy-forming units such as the World Bank, International NGOs and Public Interest groups.

Duration: 18 months
Investigators: **C. Drew Harvell** (E&EB), **Laura Harrington** (ENTOM), **Kelly Zamudio** (E&EB), **Stephen Ellner** (E&EB), **Art DeGaetano** (E&AS), **Carla Gomes** (CIS, AE&M), **Katherine McComas** (COMM)
External Partners: NOAA Remote Sensing Program; World Bank; NASA; UNAM, Mexico

- **Environmental, Energetic and Economic Potential of Biochar**

This project seeks to quantify the economic, energetic, and environmental potential of biochar at scales from local to global, through an interdisciplinary team based at Cornell. Biochar is the stable, carbon-rich product produced by thermal decomposition when biomass is heated in an anoxic environment (pyrolysis). First studied in the fertile Terra Preta soils of the Amazon, it can also be produced today in modern bioenergy systems. Its potential uses are directly linked to major global issues of sustainability such as climate change, energy production, fertilizer use efficiency and soil health. However, strong economic, energy, and life cycle analysis studies using specific data, rather than general estimates, are generally lacking in the scientific literature, and are critical for furthering policy discussion or responsibly applying biochar to land at larger scales. To address these critical knowledge gaps, the project will use interdisciplinary integration to create multi-scale energy and economic research to be combined with environmental analysis in order to explore biochar's potential as a new and exciting tool to fight climate change. This will allow research to be extended beyond the fields of soil science and agronomy to a level where strong policy recommendations can be made, based on economics, life cycle analyses, and other modelling tools. The production of a modelling framework will provide for the expansion and development of biochar research that is

necessary to establish it within the dominant and emerging bioenergy technologies as the sole option that currently provides "carbon-negative" energy and safe sequestration of atmospheric carbon dioxide.

Duration: 18 months
Investigators: **Johannes Lehmann** (C&SS), **Norm Scott** (B&EE), **Brent Gloy** (AE&M), **Antonio Bento** (AE&M), **Stephen Younger** (CFNP), **Janice Thies** (C&SS), **John Gaunt** (C&SS), **Lindsay Anderson** (B&EE), **Drew Lewis** (CUAES), **Francis Vanek** (C&EE)
External Partners: BEST Energies, WI; Biomass Energy & Carbon, CO; Dynamotive, Canada; Carbon Consulting LLC; Key Soil Ltd., UK; United Nations CCD; Connecticut Expt. Sta; Rothamsted Research, UK; USDA; U. Florida; International Biochar Initiative

- **Understanding aflatoxin accumulation in maize**

Mycotoxins are toxic compounds produced by fungi. They contaminate an estimated 25% of the world's food supply, and are particularly problematic in developing countries where few safeguards exist to prevent their entry into the food system. Although the acute effects of many mycotoxins are known, the effects of chronic mycotoxin consumption are only now beginning to be understood. Chronic exposure to *aflatoxin*—one of the most potent mycotoxins—has recently been recognized as a cause of immuno-suppression and growth stunting. Thus, aflatoxin exposure has significant implications for the health and well-being of tens of millions of people throughout the tropics, particularly those whose staple foods are maize or peanuts which are particularly susceptible to aflatoxin contamination. This project will bring together researchers from agricultural and social sciences to examine aflatoxins in maize in East Africa as a model for the impact and reduction of mycotoxins more generally. Our ultimate objective is to identify the most effective and feasible interventions to reduce aflatoxin exposure for high-risk populations, with an initial emphasis on low-resource maize-growing farm households. We will develop a holistic, systems-oriented conceptual framework for assessment of intervention strategies to reduce aflatoxin exposure. This will encourage interactions among researchers who focus on different dimensions of the aflatoxin problem, allow identification of knowledge gaps and initial assessment of the cost-effectiveness of intervention strategies. We will also conduct a pilot project in which we will begin to quantify the agronomic, environmental and behavioral factors to determine the relative impact of each on aflatoxin accumulation in maize and exposure in humans. The expected outputs will be a holistic assessment of research needs and intervention strategies to reduce aflatoxin exposure, quantitative tools to predict more accurately the degree of aflatoxin contamination in maize, and increased understanding of the crucial role of human risk perceptions and constraints on behavior to mitigate aflatoxin exposure.

Duration: 1 year
Investigators: **Michael Milgroom** (PLPA), **Rebecca Nelson** (PB&G, PLPA), **Charles Nicolson** (AE&M)
External Participants: Kenya Agricultural Research Institute; Bioscience East and Central Africa; Institute for Meteorological Training and Research, Kenyan Meteorological Department; U. Maryland

- **Vibro-Wind Technology: Alternative Wind Energy Systems for Buildings**

The focus of this proposal is to investigate the principles and feasibility of 'vibro-wind power' i.e. harvesting energy from the wind as it flows around commercial and residential buildings as an alternative to conventional rotary wind turbines. The basic science involves energy extraction from bodies induced to vibrate due to the action of fluid flow and vortices around flexible structures. Our approach will be to consider the effects of wind on single or multiple interacting flexible structures, such as cantilevers mounted to a surface with a wide range of length scales from the millimeter to the meter scale. Impact on Sustainability: Building integrated power generation is an active area of architectural design. In our application the wind might excite dozens or thousands of small vibrating elements on panels attached to the structure converting the kinetic energy into electrical energy that can be used in the operation of the building. We believe that this technology will complement solar energy especially in regions where solar availability is low as in Central New York.

Duration: 1 year
Investigators: **Francis Moon** (M&AE), **Ephrahim Garcia** (M&AE), **Hod Lipson** (M&AE), **Charles Williamson** (M&AE), **Wolfgang Sachse** (T&AM, M&AE), **Kevin Pratt** (ARCH)

- **Plug-in Hybrid Electric Vehicles**

We are witnessing the onset of the electrification of the transportation sector with the entrance of plug-in hybrid electric vehicles (PHEVs) into the automobile market. The primary purpose of this project is to evaluate the effects of electrifying transportation on energy use and emissions. The substitution of electricity, especially the electricity generated from renewable energy, for petroleum represents one of the most promising ways to improve overall energy efficiency and reduce emissions of greenhouse gasses. The overall implication of electrifying transportation is that the oil/gas industry will be displaced in importance by the electric utility industry. We will study the potential of PHEVs as distributed energy systems to accommodate renewable energy and link the transportation, the utility and the building sectors. This proposal addresses the following three areas critical to the future PHEV implementations, i.e., energy, environment and technology development. In addition, we will also organize a symposium on electrifying the transportation sector and its implications on the New York State. We will also use Cornell campus as a testbed to develop the Vehicle-to-Grid/Vehicle-to-Home/Vehicle-to-Building technologies. We are hoping that, as a result of this one-year study, Cornell's presence is recognized in the field of distributed energy systems (DES) research and that the research results influence the state and national energy policies

Duration: 1 year
Investigators: **K. Max Zhang** (M&AE), **Tim Mount** (AE&M), **Bob Thomas** (E&CE), **Lindsay Anderson** (B&EE), **Oliver Gao** (C&EE), **Ying Hua** (D&EA), **Andrew Hunter** (C&BE), **Francis Vanek** (C&EE), **Ray Zimmerman** (AE&M)

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For more information, contact:
Cornell Center for a Sustainable Future
200 Rice Hall, Cornell University
ccsf@cornell.edu (607) 255-7535