RUTGERS ECOCOMPLEX
2012 ANNUAL REPORT

CENTER OVERVIEW

The EcoComplex is a multi-institutional, multidisciplinary environmental and alternative energy innovation center that harnesses research and education resources in the development, and industrial application, of innovative environmental and alternative energy technologies. The EcoComplex - "Alternative Energy Innovation Center" – has a mission is to promote economic development in the environmental and alternative energy innovation arenas, including testing and verifying new alternative energy innovations, the remediation and protection of environmental quality, and the compatible sectors of food and innovative agriculture. By targeting these areas with integrated programmatic thrusts in research, education and economic development, the EcoComplex provides a distinctive focus and presents an array of capabilities unique in the nation.

RESEARCH AND RELATED INITIATIVES

BPU/ARRA Electric Vehicle Demonstration: The EcoComplex received $114,000 grant from American Reinvestment and Recovery Act (ARRA) to purchase two electric vehicles (EV) and two electric vehicle chargers. One of the chargers is installed at the EcoComplex and the other is installed at Martin Hall on the Cook Campus to provide more exposure to the students, faculty and staff. This project was completed on April 30, 2012 and the EVs and EV chargers currently are in use. Research projects are currently being developed with numerous Rutgers faculty.

Branch Brook Park Greenhouse Project: The EcoComplex consulted with the Friends of Branch Brook Park Alliance (a nonprofit organization that spearheads new community-based activities at the Branch Brook Park in Newark, NJ) to retrofit two abandoned greenhouses, totaling 7,000 square feet, in the Park's maintenance yard. The greenhouses were converted to year-round hydroponic production systems and in-ground organic vegetable beds. Ten special needs students from Newark High School system provided most of the labor needed to do the retrofitting. Ongoing training for students and adults is being conducted by the Alliance. The vegetables produced in the greenhouse are being used by County run food kitchens for the needy.

EPA Global Methane Initiative, Nigeria Landfill Inventory: The EcoComplex received a $95,000 grant from the EPA Landfill Methane Outreach Program to conduct an inventory of landfills in six population centers of Nigeria. Data collection was conducted by Greenovative Chain Consulting, a woman-owned environmental consulting company based in Nigeria. Information such as landfill volume, waste flow per year, waste characterization, potential to collect methane, local uses of electricity, and GPS coordinates were recorded. The data was placed into a database developed by David Specca and is kept on the EcoComplex website for public use. This information was also presented at a Solid Waste Conference in Lagos, Nigeria in June, 2012.

Revised Biomass Assessment for NJ: The first version of the NJAES Assessment of Bioenergy Potential for NJ was completed in 2007. Due to strong interest in the information from the public and private sectors, the EcoComplex has been updating the entire bioenergy calculator to reflect the most recent data available (primarily 2010 information). This work has been performed primarily with student interns and supervised by David Specca.

NJ Clean Energy Resource Network (NJCERN): The EcoComplex received a grant of $50,000 per year for five years from the NJ Board of Public Utilities to maintain and promote the NJCERN website. This website was developed by the EcoComplex, in collaboration with the Meadowlands Business Accelerator, as a one-stop site for clean energy companies looking to locate to NJ. It includes over 300 federal, state and private resources and funding that can be accessed for assistance in starting or growing a clean, alternative energy business in NJ.

Protection of Environmental Resources through the Implementation of High-Efficiency and Cost Effective Anaerobic Digestion Waste-to-Energy Systems on Equine Farms: David Specca is participating with Spectrum Bioenergy, Dr. Mike Westendorf. Dr. Zane Helsel, Dr. Donna Fennell, and the other Rutgers participants on this project. Spectrum Bioenergy is demonstrating their Anaerobic Digester System at Showplace Farms in Hightstown, NJ. They successfully demonstrated their AD system on food waste in Albany, NY and are now modifying the system for use with horse manure. The EcoComplex is providing experience gained from using horse manure in its AD project and expertise in the challenges of using manure from straw bedding in the AD process. Total project budget is $96,020 of which NJ NRCS is contributing $36,960 primarily for equipment.

Culture of Duckweed Nursery Stock for Bioenergy Production: Davide Specca participated in a research project led by Dr. Eric Lam to produce duckweed in a prototype pond system. Duckweed raised in the Ecocomplex greenhouse was used to 'seed' an experiment at an outdoor pond at Pinelands Nursery in Columbus, NJ. The EcoComplex was responsible for setting up the growing tubs and for daily monitoring of the nursery crop.

Comparison of Greenhouse Gas-Based Life Cycle Assessments of Hazelnut and Soybean Derived Biodiesel: The use of first generation biofuels, such as corn ethanol and soybean biodiesel, have raised numerous environmental concerns, particularly regarding greenhouse gas emissions. Therefore, development of new types of energy crops that can avoid or minimize these issues is essential to an environmentally sustainable, fossil fuel independent future. Hazelnuts are such a potential energy crop. To assess the net impact of one biofuel feedstock over another, it is necessary to understand the environmental footprint of the feedstock. Thus, a lifecycle analysis (LCA) of first generation (soybean oil) and second generation (hazelnut oil) biofuel feedstocks form the basis of this study. The comparison of GHG emissions from hazelnut oil biodiesel and soybean biodiesel life cycle analyses in specifically created scenarios resulted in lower greenhouse gas emissions from hazelnut biodiesel than soybean biodiesel for power generation if fossil fertilizers and pesticides are not utilized. This result suggests that high-yielding selections of hybrid hazelnut, which may have a lesser food and commercial value, but higher oil content, can serve as a sustainable and viable energy crop option for producing alternative fuels for power generation. This analysis was part of a USDA SCRI research project entitled: *Expansion of Hazelnut Production, Feedstock, And Biofuel Potential Through Breeding For Disease Resistance And Climatic Adaptation* led by Tom Molnar.

OUTREACH AND EDUCATION

Conferences, Panels & Workshops: The EcoComplex team gave 14 lectures/seminars and attended/presented at 8 national conferences. In addition, the team participated in numerous panel discussions and webinars as summarized in Table 1.

Table 1. EcoComplex Team's Active Participation at the Conferences and Webinars.

Team Member	Conference Info	Title of the presentation
Serpil Guran	IWES, 4th "Waste Technologies Symposium and Exhibition", November 15-16, 2012, Istanbul Turkey.	***"Solving the Landfill Gas Clean-Up Problem"***
Serpil Guran	12th Annual BioCycle Conference on "Renewable Energy from Organics Recycling" 10/29-30/12, St. Louis/MO	***"Creation of a Clean Energy Innovation Park: Rutgers EcoComplex An "Alternative Energy Innovation Center"***
Serpil Guran	"NJTC and EMP Implementation Symposium" July, 26, 2012 Edison, NJ.	***"EcoComplex: Alternative/Clean Energy Innovation Center"***
Serpil Guran	ICCI, 18th Int. Energy and Environment Fair & Conference, April 25-27, 2012, Istanbul, Turkey.	***"Sustainable Biomass to Clean Energy Pathways: Alternative Energy Innovation Centers"***
Serpil Guran	"Small Business Clinic", March 9,2011, Newark, NJ.	***Panelist***
Serpil Guran	CLEANTECH NJ 2011 Conf. on "The National Renewable Energy Roadmap: Planning, Funding, Developing Technologies" October 25, 2011, Woodbridge, NJ.	***Panelist***
Serpil Guran	Rutgers Engineering Society's Alternate Energy Symposium" October 5, 2011, Piscataway, NJ.	***"Alternative Energy Technologies: An Innovative Tool for Economic Growth & Green Jobs Creation"***
Serpil Guran	NJTC International Clean Partnership –Americas, Webinar, September 11, 2012	***"Biofuels: Problem or Solution?"***
Dave Specca	"Developing Successful Integrated Waste Management Systems in Africa", June 27 and 28, 2012, Lagos, Nigeria	***"Evaluating Project Candidates – Challenges and Benefits of Conducting a Landfill Inventory"***
Dave Specca	"NJ Environmental Stewards Meeting" March 2012, Duke Farms and Warren County RCE	***"Renewable Energy Options for NJ Homes and Businesses"***

Dave Specca	"NJ Agribusiness Association" December, 1, 2011, Burlington County, NJ.	***""Renewable Energy Options for Farms and Rural Businesses"***
Dave Specca	NJTC International Clean Partnership –Europe, Webinar, September 27, 2012.	***"Biofuels: Problem or Solution?"***

Workgroups:

Renewable Natural Gas Workgroup: During FY12, Dave Specca co-chaired and the EcoComplex team participated in "Renewable Natural Gas Workgroup". This workgroup was tasked to provide recommendations to the NJ Board of Public Utilities on revising the NJ Energy Master Plan.

NJ Innovative Energy and Environmental Technologies Workgroup: The team partnered with NJDEP, NJBPU, NJCAT, NJTC and several other state agencies and environmental groups to organize clean energy technology events. A workshop titled "Power Production from Sustainable Biomass" was held on May 7, 2012 at the EcoComplex.

New Jersey Clean Energy Innovation Council: The EcoComplex is taking the lead role in the launch of the "NJ Clean Energy Innovation Council". The kick-off meeting was held at the EcoComplex on October 17, 2012. The team initiated the organization of this council and worked closely with state agencies, other New Jersey Universities and environmental groups to bring together several active or dormant workgroups related to clean energy in the state. This council was formed to help the state implement the NJ Energy Master Plan, to develop a Clean Energy Cluster in New Jersey, and to be a resource to new and existing clean energy companies. The Ecocomplex team members are actively working within this council and are chairing two of its subgroups.

BUSINESS INCUBATION

The Rutgers EcoComplex is a unique business incubator and economic accelerator, specializing in business and technology expertise to start-up and established several alternative energy, energy efficiency and environmental technology companies in the region.

Impacts:

- 13 Incubator Clients, 3 are developing alternative energy technologies, 3 are in energy efficiency consulting, 3 are developing environmental technologies, 1 virtual tenant is working on renewable energy. In addition, the greenhouse is home to 3 incubator companies specializing food and horticultural businesses.
- These companies employ approximately 34 full time equivalent (FTE) staff and generated approximately $3 million in revenue over the past year.
- Two incubator clients of the EcoComplex received third party funding of $24,847 for FY 2012.
- DOE/Clean Energy Alliance Business Development Grant - The EcoComplex received $13,000 from the Clean Energy Alliance as part of a grant program from the DOE for

assisting startup clean energy businesses. The EcoComplex worked with our incubator tenant company Energy Catalysis, Inc. to identify strategic ways to commercialize the coal to liquid fuel technology that they partially developed at the EcoComplex. This assistance included funding for patent fees, attendance at investor forums, and bench-scale research in preparation for additional grant proposals from DOE.

Business Development:
Dr. Kevin Lyons worked extensively with EcoComplex clients and provided the following services:

- Provided market development research and reports on a weekly basis to all Eco clients
- Provided research financial opportunities with potential funders
- Provided Financial Analysis Consultancy and identified a Consultant who is currently working with EcoWalls on accessing their current financials and planning financial reports for financial investors in their new business venture
- Placed an undergraduate research intern with Olive Creek to conduct QCR market research analysis and the development of the QCR infrastructure
- Developed undergraduate and graduate class business case study projects using EcoComplex clients as the subject matter in an effort to solicit research input from supply chain and marketing science students regarding solutions to current incubator challenges.
- Established consultancy agreement to have the Rutgers Camden and Newark Small Business Development Center to provide on-going and cost free business services.
- Developing the first EcoComplex Business Incubator venture capital event for Spring 2013 (targeted potential funders and investors for our Incubation firms).
- Developed a Green Purchasing Certification program for Business Incubation Firms
- Conducted 10 business venture tours (provided tours for potential funders and investors)
- Sample meeting plans and research project develop for clients are attached.
- Developed new business venture concepts for EcoWalls

CONFERENCE CENTER

The EcoComplex conference facility has experienced an increase in usage and revenue generation over the fiscal year 2012. Government, academic and business entities find that the EcoComplex is conveniently located in the State, offers high quality facilities and friendly service.

Conference Center Activity:

- 13,941 people attended 502 events from Oct 2011 – Sept 2012 at the EcoComplex. While the number of people is down slightly from last year, the number of events increased by 10%.
- $48,236 in revenue generated from conference center related activities, up 40% over last year.
- 890 people (46 groups) were given tours of the EcoComplex, Greenhouse, and Landfill Operations. This number is slightly higher than the year before despite school budget cuts for field trips. Tour groups included High School science classes, Master Gardeners, College Engineering, Environmental Science and Horticulture Classes, Longwood Gardens and NY Botanical Gardens students, 4-H clubs, FFA groups, Green Job Training students, Foreign Dignitaries, and the military.

- The EcoComplex hosted Chinese and Turkish Business Delegations on August, 2011 and July, 2012 respectively.
- The EcoComplex hosted 4 Rutgers class field trips in the FY 2012.

Major Events Hosted and/or Organized by the EcoComplex:
- EMP Bioenergy Subcommittee Meetings and Recommendations
- EMP Public Hearings
- Renewable Natural Gas Workgroup meetings
- MBS Entrepreneurs Workshop
- NJAES Board of Managers Meeting
- USDA-NRCS- Energy Training Workshop for staff
- NJ Clean Energy Innovation Council- Kick off Meeting

STATE-LEVEL PROJECTS

Energy Master Plan Input:
2011 Energy Master Plan (EMP) of the State of New Jersey outlined broad goals and a plan of action to "manage energy in a manner which saves money, stimulates economy, creates jobs, protects the environment, and mitigates long-term cumulative impact". The EcoComplex team was heavily involved in the review process of the EMP, and was a major contributor to the biomass to energy component. In addition to being involved with the drafting of the NJEMP, the EcoComplex is currently leading the efforts of NJ Clean Energy Innovation Council which will collaborate with NJBPU in the implementation of the EMP and support new/existing clean energy businesses in the state.

EV Vehicles and Charging Stations;
The transportation sector accounts 27% of U.S. greenhouse gas emissions and 70% of U.S. petroleum consumption. A majority of the oil in the transportation sector is used to power light-duty vehicles such as cars, sport-utility vehicles, vans, and pick-up trucks. Powering vehicles with electricity is of significant interest because of innovation in battery technology. In 2009, the federal government highlighted electricity as a promising alternative to petroleum for transport purposes. Rutgers EcoComplex applied for and successfully secured ARRA funds to purchase two electric cars and electric car chargers to test and demonstrate this technology.

LFG to power and transportation fuels: New Jersey has an abundant supply of landfill gas that can be used to produce electricity, heat and transportation fuels, but it requires a reliable and economical gas cleanup system to remove the impurities generated by the conversion process. The EcoComplex is helping companies to commercialize technologies for LFG cleanup and energy production through education and demonstration projects. These include the direct fired landfill gas boilers, microturbine CHP system, business incubation and many tours and presentations.

Sustainable solid waste management: Solid waste is an opportunity for bioenergy and the largest source of biomass feedstock in the state. Educating the public and state government on the conversion technologies and appropriate feedstocks available will have a significant impact on their acceptance and implementation in the state.

Sustainable greenhouse production: With an ever-increasing demand for locally grown produce, greenhouse production provides a way for NJ growers to extend their harvest season to a year-round supply. However, greenhouses can require a large amount of natural resources, such as energy, water, and plant nutrients, if they are not designed in a sustainable way. The EcoComplex greenhouse is providing a showcase of many sustainable greenhouse production systems and practices such as renewable energy utilization, combined heat and power, energy blankets, bottom heat, recirculating hydroponics, aquaponics and computerized environmental control. These systems and practices are available to see first-hand on tours and through the outreach efforts of the staff.

Urban Agriculture: The EcoComplex has provided information and expertise to private businesses, non-profit organizations and government entities within the cities of Camden, Trenton, and Newark in their efforts to initiate urban agriculture projects. The Branch Brook Park Greenhouse Project is one example of these efforts. The EcoComplex has been meeting with Urban Agriculture project developers and connecting them with the expertise required to move their projects forward. This expertise includes brownfield redevelopment, renewable energy production, contaminated soil remediation, vertical farming design, greenhouse lighting.

GRANT APPLICATIONS

Title: *Turkey's Landfill Inventory and Methane Emissions Assessment: Activities that Reduce Global Anthropogenic Methane Emissions*
Participants: The EcoComplex Team **(Lead)** and Dr. Mark Robson
Funding Agency: US Environmental Protection Agency/Global Methane Initiative
Funding Request: $100,000
Status: Funded

Title*:* *Microalgae for Landfill Leachate Treatment and Biofuel Productio*
Participants: Dr. Jon Reinfelder, Dr. Valdis Kumins (Lead) and the EcoComplex
Funding Agency: Environmental Research & Education Foundation Sustainability Research Program
Funding Request: $86,000
Status: Pending

Title: "*Creating a Sustainable Biorefinery Research Network for Developing Sustainable Biopower and Biofuels Systems"*
Participants: The EcoComplex Team **(Lead)**, Dr. Margaret Brennan-Tonetta, Dr. Eric Lam, Dr. Stacey Bonos, Dr. Donna Fennel, Dr. Zane Helsel, Dr. Henrik Pedersen of Rutgers University. National Renewable Energy Laboratory, Utah State University, University of Sherbrook, Canada, University of Leeds, UK, New Jersey Clean Cities Coalition, NJDEP, NJEDA, NYSERDA.
Funding Agency: for National Science Foundation Sustainability Research Networks Competition **Funding Request:** $12,000,000
Status: Not funded.

Title: *Biofuels from Wastewater- Building a Green Industry by Sustainable Aquatic Agronomy*
Participants: Dr. Eric Lam team (Lead) and the EcoComplex Team
Funding Agency: NSF's Sustainable Energy Pathways Competition
Funding Request: $2,000,000
Status: Not funded
Title: *Achieving Waste Biomass to Transportation Fuels Production via Scale Up and Commercialization of High Pressure Catalytic Steam Gasification Systems*
Participants: EcoComplex team **(Lead)**, Dr. Margaret Brennan-Tonetta, Dr. Gal Hochman, Verdant Aerospace LLC
Funding Agency: USDOE ARPA-e Open Funding Opportunity
Funding Request: $250 K- $10M
Status: Not funded

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Title: *Bio-Refinery Development for Bio-Fuel Manufacturing at the Joint Base McGuire-Dix-Lakehurst*
Participants: The EcoComplex team **(lead)**, Dr. Margaret Brennan-Tonetta & Dr. Gal Hochman, and the Joint Base McGuire-Dix-Lakehurst.
Funding Agency: USDOE and USDA Biomass Research and Development Initiative
Funding Request: $3M-$7M
Status: Not funded.

Title: Critical Material Advanced Research Center (CMARC)
Participants: EcoComplex team along with numerous faculty members of Rutgers University, Princeton Plasma Physics Laboratory, University of Pennsylvania, University of Maryland, Villanova University, Leigh University, Rowan University, Morgan State University, Brookhaven National Laboratory, U.S. Army Research Laboratory
Funding Agency: DOE Energy Innovation Hubs
Status: Not Funded

FY 2013-14 TEACHING, RESEARCH AND DEMONSTRATION INITIATIVES

Online Class Teaching:
Dr. Serpil Guran of the EcoComplex is collaborating with Prof. Paul Gottlieb of SEBS in the development of an online class for the Spring2013 semester titled **"Sustainability as a Decision Making Tool".** The educational goals of the "Sustainability as a Decision Tool" class will be twofold: 1) to teach students basics of sustainability and help them to use it as a decision tool in their daily lives and to increase interaction among undergraduate students on this topic and 2) help students to shape their carrier choices as possible "corporate sustainability officers". This online class and its syllabus are quite varied in its content while focusing on sustainability.

Green Supply Chain Procurement and Sourcing (GSCPS) Training and Certification Program: Kevin Lyons will lead the development of this program that is designed to introduce foundational concepts that align with systems, policies, and procedures that support GSCPS practices and organization sustainability. Using training fee data for similar programs ($2,500 per student for 5 day session) approximately 1200 in-person students could be trained per year = $3,000,000/year (2400 or more students could be trained if we use an on-line web platform

brings the annual gross potential to $6,000,000). Once this market is captured, Kevin will expand the program to include additional business professionals in all sectors, as well as develop a train-the-master trainer program. He will also use his extensive research in supply chain archeology to develop new green supply chain, procurement and sourcing training and certification programs which are specialized (such as renewable energy, clean water, air quality, zero waste supply chain certifications). Our financial goals are to stabilize the program at approximately $1 million per year in order to continuously support the stability and quality of the program with the appropriate staff, merge the program to support other EcoComplex and RBS programs, increase the academic rigor of the program and provide funding for Rutgers Students to intern with the program. The program should be self-supporting and the scope of the program will be adjusted based on annual revenues and projections.

Innovative Siloxane Removal System for Microturbine:
The microturbine system at the EcoComplex, utilizes landfill gas from the Burlington County Landfill. The existing landfill gas cleanup and conditioning system's refrigeration unit chills the landfill gas to condense most of the moisture and siloxanes. The condensate has been deemed hazardous liquid waste by the NJDEP. Solving the condensate removal and disposal problem has become very costly. Therefore, the EcoComplex team is testing a gaseous form of siloxane removal instead of refrigeration. The EcoComplex and Auxilium Energy, a subsidiary of AMCS Corporation, and a tenant at the EcoComplex, are partnering in testing new siloxane removal technology based on a regenerable temperature swing adsorption (TSA) process.

Landfill Assessment in Turkey:
Rutgers University EcoComplex has received $100,000 in funding from the EPA Landfill Methane Outreach Program (LMOP) to undertake a comprehensive landfill inventory and related methane emissions assessment in Turkey. The focus will be to conduct landfill surveys and investigations using experienced solid waste management personnel who are familiar with the complexities and barriers to access for collecting data from Turkish facilities. The research will be based on an EPA LMOP methodology which has been utilized by LMOP in several countries around the world through the Global Methane Initiative. Local capacity building and stakeholder involvement is built into the project design. Selection of innovative solid waste management organizations such as the Turkish National Committee on Solid Waste (TNCSW), as collaborators, will participate in local data gathering along with Rutgers personnel, contractors and local companies. Results will be presented in a workshop setting as part of a relevant conference.

Jerome Goldstein Scholarship:
A scholarship fund in Jerry Goldstein's memory has been established at the EcoComplex. The late Jerry Goldstein graduated from Rutgers University New Brunswick in 1952. The Jerome Goldstein Scholarship for EcoEntrepreneurs will support student researchers at the EcoComplex. The Goldstein family selected the Rutgers EcoComplex as the recipient/manager of this scholarship fund given its focus on composting, anaerobic digestion, compost utilization, agricultural production, renewable energy and enterprise development.

Solar Carport:
The EcoComplex team will be seeking funding opportunities to install a small solar carport to demonstrate an example of renewable energy utilization while combining renewable energy applications.

QuadGen Demonstration:
Based on the findings of the 2008 NE SunGrant project, which performed an engineering and economic analysis for a system that will utilize landfill gas to produce renewable CNG, hydrogen, electricity and heat, the EcoComplex is looking to lead an effort to construct a demonstration project at the facility. This project will require public/private partnerships to construct and operate. Multiple grant and private funding opportunities are being explored.