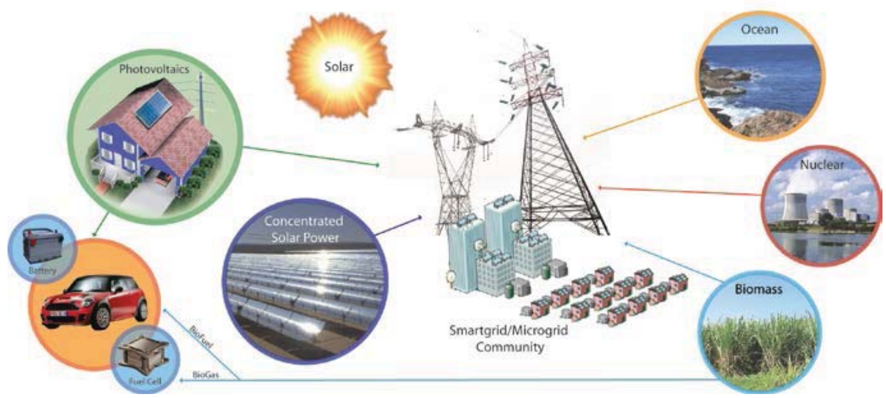
Florida Energy Systems Consortium
Semi-Annual Report
to
Dr. David Norton, Vice President for Research, Chair of the Oversight Board

May 2012

Reporting Period: Nov 1, 2011 – May 1, 2012



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EXECUTIVE SUMMARY

Overview: The Florida Energy Systems Consortium continues to produce results in energy research, technology transfer, education, and outreach activities. We are successfully facilitating interactions among Florida's energy industry and researchers in the 11 state universities, Florida's State and Community Colleges, and Florida Institute of Technology. FESC coordinated research teams to develop and submit a significant number of joint proposals, many of which were funded as a direct result of being able to assemble a diverse set of experts and resources among FESC partners. One notable recent example is that a UF-led team received an award to form a Joint Clean Energy Research and Development Center (JCERDC) in biomass. This 5 year $125M project is aimed at reducing energy consumption, cutting dependence on petroleum products and increasing use of renewable fuels. (http://news.ifas.ufl.edu/2012/04/20/uf-led-research-team-selected-for-125-million-joint-u-s-india-energy-project/). FESC continues to contribute to energy education and outreach programs, and initiated the planning of the joint Florida Energy Summit with the Florida Energy office. The FESC web site continues to be a widely used tool by energy specialists worldwide. Based on a Google Analytics report, the FESC web site was viewed by 8,577 (77.25% new visitor and 22.75% returning visitor) Google visitors during the period Nov 1, 2011 to May 1, 2012. The viewers visited 21,145 pages. Viewers were from various countries, including US, India, China, Germany, Turkey, Hungary, Mexico, France, and Brazil.

Research Highlights: The Principal Investigators of the remaining ~50 FESC-funded research projects continue to make considerable progress on their research. A brief description of each FESC supported research project, including the completed ones, is provided in Appendix A. These projects are also posted on the FESC website http://www.floridaenergy.ufl.edu/. During this reporting period, FESC distributed over 70 announcements of funding opportunities with the goal of leveraging state funds. Appendix B contains the list of announcements. All funding opportunities were also posted at the FESC web site. Although the FESC office only collects data on proposal submission and funding once a year, we have summarized information on notable proposals that were significantly supported by FESC, with the details given in the "New program Development" section of this report (p. 12). The FESC office facilitates proposal development in a variety of ways beyond solicitation awareness, including identifying leaders, communicating with external partners in industry, national labs and other non-SUS universities, providing professional technical writing help, arranging telecons, and assisting with cost share development, budgets and boiler plates.

A key team formation effort occurred in response to the US DOE Energy Storage Innovation HUB call for $125M funding. FESC formed a core planning team a year ago in anticipation of this funding opportunity. The core team members communicated with potential partners during this time and the final team was formed by the time the call for proposals issued by the US DOE. This allowed the team members more time to prepare a quality proposal. The participating institutions include the FESC Universities, Cal Tech, Case Western Reserve, Illinois Inst. Tech., Northeastern U., Notre Dame, Missouri U. of Sci. and Tech., UC Santa Barbara, University of Kansas, University of South Carolina, Univ. Southern California, Vanderbilt, Washington Univ., NREL and SEMATECH.

The FESC leadership visited or communicated via teleconference with the Florida Energy Industry, State of Florida offices as well as the Department of Energy, National Energy Laboratories, NASA Glenn, NASA KSC, Economic Development Agencies, companies from Canada and Israel to discuss potential FESC collaboration on their energy programs.

Technology Transfer: The FESC funded research results generate both additional external funded research as well as innovations leading to commercialization. FESC also has a facilitated technology transfer program that includes business plan/market research development (Phase I) and industry matched funding of early stage development (Phase II). An updated report as of May 1, 2012 is given in the Industrial Collaboration and Technology Commercialization section (p. 14). As evidence of the effectiveness of these combined programs, **nine companies have been formed over the last three years**. The technology of these companies is university developed in areas that include fuel cells (2), coating for battery/fuel cell, efficient light emitters, energy efficiency, bioenergy, and biochemicals, efficient compressors, and H_2 sensor. It is noted that in the this reporting period the FESC Phase I Project entitled as "Milling Technology Leads the Way to Cost Effective Ethanol Production" (PI: Dr. Blair at UCF) was licensed by Thor Energy. This technology embodies a novel milling technology for cellulosic ethanol production. To date FESC has funded 5 Phase II projects of which two are complete. The progress reports for each project are given in this report (p. 17). The two completed ones are the UCF-Harris Corp. joint wave energy project and UF-nRadiance LLC joint fuel cell project. The three active Phase II projects include a low cost concentrator solar energy innovation (D. Van Winkle, FSU) supported by Hunter Harp Holdings, Li-Ion battery (Kevin Jones, UF) in partnership with Planar Energy Devices, and polymer solar cells (Franky So, UF) with Sestar Technologies.

FESC is one of the partners of the FL CAN grant funded by the Economic Development Administration ($1.3M for 2 years). FL CAN links Florida-based universities, incubation networks, investors and industry resources together to create a network of Proof of Concept centers to accelerate the creation and commercialization of innovative clean technology research into new technology companies or to license into existing firms. FESC is uniquely positioned to identify clean technology research with high commercial potential and to facilitate relationships between Florida universities, entrepreneurs and licensees. FESC administration office cataloged all energy and clean technology-related intellectual property developed at Florida universities and NASA Kennedy Space center. The list is given in Appendix C. FESC works with the Technology Transfer directors at each Florida University, FL CAN Market Research team and the mentor networks to assist with technology commercialization. To facilitate the accessibility of a network of university laboratories that are dedicated to energy and clean technology development, FESC administration office developed a catalog of user and lab facilities within the Florida University System, FIT, and NASA Kennedy Space Center. The list is given in Appendix D. Entrepreneurs, students, scientists and established companies interested in developing commercial products based on Florida-based research have access to these user facilities.

Perhaps equally important, the Consortium has established close connections with Florida's energy industry. In particular, we facilitate interactions between our industry and the FESC faculty and their resources. This often results in the submission of proposals for research interactions. FESC is currently in communication with over 150 companies to provide technical assistance. We also work closely with technology transfer and economic development offices in Florida to attract industry to our state.

<u>Education and Outreach:</u> Assisting in preparing a qualified workforce is vital for Florida's evolving energy industry. FESC is strategically focused on workforce preparation for the existing and emerging energy industry. Many energy-industry educational opportunities are available throughout the state, while other exciting opportunities are being developed. FESC is working to coordinate these efforts and ensure that existing distance education facilities at each university will be utilized to make these programs available via on-line courses. The FESC outreach program is using the statewide Agricultural Extension. Over 50 Fact Sheets have been developed for the extension service officers to use as they interface with the public (http://www.floridaenergy.ufl.edu/?page_id=273). Service as well as other avenues provides Florida residents with new approaches to energy efficiency. The progress reports on education and outreach programs are given in this report.

Energy Summit: At Commissioner Adam Putnam's request, the FESC Summit is being combined with the Florida Energy Summit this year to spotlight innovative research efforts at the state universities and to disclose the latest emerging technologies that will have an impact on future energy production. We are assisting the Florida Energy Office in agenda preparation and finding speakers. The Florida Energy Summit is scheduled to be on August 15-17 in Orlando, at the Rosen Shingle Creek.

The Florida Energy Systems Consortium has made significant progress in its research, education, industrial collaboration, and technology commercialization agenda. FESC faculty members statewide are successfully collaborating in research and proposal development. Our responses to Energy Storage Innovation HUB and the Joint Clean Energy Research and Development Center (JCERDC) in biomass grants are some of the examples of our multi-university, industry partnerships. One of our FESC-funded UF faculty was the PI for the JCERDC grant application and received US DOE award to form a joint US-India consortia. In addition, FESC education programs are being readied for Florida's clean energy workforce, and our industry partners are actively participating in technology transfer and commercialization of FESC-developed technologies.

RESEARCH PROGRAM

The FESC research program included 82 FESC funded projects within the seven strategic thrusts. The project descriptions for all are given in Appendix A. Eight projects from FIU (not funded by FESC) and 1 project from UWF (not funded by FESC) are also included. Some of the projects are collaborative multi-university projects; however since funding was appropriated to each institution, only the lead university information is given in the table. The majority of these projects have been completed. Table 1 below gives the list of the active ~50 FESC projects.

2011 Florida Statutes 377.703 "Additional functions of the Department of Agriculture and Consumer Services" states that the department shall serve as the state clearinghouse for indexing and gathering all information related to energy programs in state universities, in private universities, in federal, state, and local government agencies, and in private industry and shall prepare and distribute such information in any manner necessary to inform and advise the citizens of the state of such programs and activities. This shall include developing and maintaining a current index and profile of all research activities, which shall be identified by energy area and may include a summary of the project, the amount and sources of funding, anticipated completion dates, or, in case of completed research, conclusions, recommendations, and applicability to state government and private sector functions. Per energy office's request, the list of energy related projects within FESC universities were gathered, complied, sorted by energy topic, and posted at the FESC web site under "FL University Research": http://www.floridaenergy.ufl.edu/?page_id=9144.

Table 1: Active FESC Projects as of May 1, 2012

Projects	Summary
THRUST 1: Overarching	
	Title: *Power Generation Expansion Portfolio Planning to Satisfy Florida's Growing Electricity Demands* **PI:** Tapas Das, **Co-PI**: Ralph Fehr - USF **Budget:** $71,906 **External Collaborator:** Argonne National Lab
THRUST 2: Enhancing Energy Efficiency and Conservation	
	Title: Energy Efficient Building Technologies and Zero Energy Homes **PI:** R. Vieira, **Co-PIs:** P. Fairey, J. Sonne - UCF/FSEC **Budget:** $1,224,000
	Title: Joint Optimization of Urban Energy-Water Systems in Florida **PI:** James P. Heaney - UF **Budget: $72,000**
	Title: Energy Efficient Technologies and The Zero Energy Home Learning Center **PI:** Stanley Russell, **Co-PIs:** Yogi Goswami **Graduate Assistant**: Mario Rodriguez - USF **Budget:** $344,600 **External Collaborators:** FSU Engineering: Justin Kramer, Brenton Greska; UF Department of Interior Design: Maruja Torres, Nam-Kyu Park; UF Rinker School of Building Construction: Robert Ries; UCF FSEC: Stephanie Thomas Ries; Beck Construction; Hees and Associates Structural Engineers.
	Title: Unifying Home Asset & Operations Ratings: Adaptive Management via Open Data & Participation **PI**: Mark Hostetler, **Co-PI:** Hal S. Knowles, III - UF **Budget**: $24,000 **External Collaborators:** Nick Taylor (Ph.D. Student, UF School of Natural Resources & Environment),

	Jennison Kipp (Assistant In, UF Program for Resource Efficient Communities)
THRUST 3: Developing Florida's Biomass Resources	
Algae	
	Title: Optimization of Algae Species for Biofuels Production Using Genetic Altration **PI:** Ed Phlips- UF **Budget:** $15,000
High Energy Crops	
	Title: Energy Intensive Crop Development **PI:** Gary Peter , Matias Kirst, Don Rockwood - UF **Budget:** $432,000
	Title: Water-Use Efficiency and Feedstock Composition of Candidate Bioenergy Grasses in Florida **PI:** Lynn E. Sollenberger, **Co-PI's:** John Erickson, Joao Vendramini, Robert Gilbert - UF **Budget:** $191,981 **External Collaborators: :** Speedling, Inc., Nutri-Turf, Inc., British Petroleum (BP), and Southeast Renewable Fuels (SERF)
Biochemical Conversion	
	Title: Development of Biofuel Production Processes From Synthetic and Biomass Wastes **PI:** Pratap Pullammanappallil - UF **Budget:** $192,000 **External Collaborators:** University of Central Florida
	Title: Engineering Biocatalysts for Hemicelluloses Hydrolysis and Fermentation **PI:** James F. Preston **-** UF **Budget:** $192,000 **External Collaborators**: Collaborations are in various units within the University of Florida: L.O. Ingram and K.T. Shanmugam, Microbiology and Cell Science; F. Altpeter, Agronomy; G. Peter, Forest Resources and Conservation.
Bio gasification	
	Title: Combined Cooling, Heat, Power, and Biofuel from Biomass and Solid Waste **PI:** William Lear, **Co-PI:** J.N. Chung - UF **Budget:** $576,000 **External Collaborators:** Siemens Power Generation, Florida Turbine Technologies, Energy Concepts Co., Nu-Power Technologies LLC, PlanetGreenSolutions Inc., LPP Combustion, LLC.
Thermo-Chemical Conversion	
	Title: Production of Liquid Fuels Biomass via Thermo-Chemical Conversion Processes **PI:** Babu Joseph, **Co-PIs:** Yogi Goswami, Venkat Bhethanabotla, John Wolan, Vinay Gupta - USF **Budget:** $554,447 **External Collaborators:** Prado & Associates
	Title: Feasibility, Sustainability and Economic Analysis of Solar Assisted Biomass Conversion **PI:** Babu Joseph, **Co-PI:** Q. Zhang - USF **Budget:** $45,238
	Title: Integrated Florida Bio-Energy Industry **PI:** Ali T-Raissi **Co-PIs:** N.Z. Muradov, D.L. Block - UCF/FSEC **Budget:** $648,000
THRUST 4: Harnessing Florida's Solar Resources	
Solar Testing Facility	
Solar Thermal	
	Title: Development of Novel Water Splitting Catalysts for the Production of Renewable Hydrogen

	PI: Helena Hagelin-Weaver - UF **Budget:** $ 100,000
	Title: Enhanced and Expanded Solar Thermal Test Capabilities **PI:** J. Del Mar, R. Reedy - UCF/FSEC (PI use to be J. Walters) **Budget:** $809,295 **External Collaborators:** Solar thermal manufacturers
	Title: Solar Fuels for Thermochemical Cycles at Low Pressures **PI:** David Hahn (used to be Jörg Petrasch) - UF **Budget:** $ 100,000 **External Collaborators:** Wojciech Lipinski, University of Minnesota
	Title: Solar Thermal Power for Bulk Power and Distributed Generation **PI:** David Hahn, **Co-PIs:** James Klausner, Renwei Mei, Helena Weaver - UF **Budget:** $446,400
	Title: Design, Construction and Operation of CSP Solar Thermal Power Plants in Florida **PI :** Yogi Goswami, **Co-PIs:** Lee Stefanakos, Muhammad Rahman, Sunol Aydin, Robert Reddy - USF **Budget:** $882,000 **External Collaborators:** Sopogy Inc. and Gulf Coast Green Energy.
Clean Drinking Water	
	Title: Low Cost Solar Driven Desalination **PI:** James Klausner - UF **Student:** Fadi Alnaimat/ Ph.D **Budget:** $252,000 **University:** UF
	Title: Clean Drinking Water using Advanced Solar Energy Technologies **PI:** Lee Stefanakos **Co-PI's:** Yogi Goswami, Matthias Batzill, Maya Trotz, Sesha Srinivasan - USF **Budget:** $326,756 **External Collaborators:** NA
Low Cost PV Manufacturing	
	Title: Enhanced and Expanded PV Systems Testing Capabilities at FSEC **PI:** S. Barkaszi, **Co-PI:** R. Reedy - UCF/FSEC **Budget:** $196,018
	Title: Development of High Throughput CIGS Manufacturing Process **PI:** Neelkanth Dhere - UCF/FSEC **Budget:** $141,620
	Title: Florida Opportunities for PV Manufacturing and Applications **PIs:** D. Block, J Fenton, P. Fairey, W. Schoenfelds, R. Reedy - UCF/FSEC **Budget:** $81,120
	Title: Development of Low Cost CIGS Thin Film Hot Carrier Solar Cells **PIs:** Gijs Bosman, **Co-PI:** Tim Anderson - UF **Budget:** $450,000
	Title: Solar Photovoltaic Manufacturing Facility to Enable a Significant Manufacturing Enterprise within the State and Provide Clean Renewable Energy **PI:** Don Morel – USF, **Co-PIs:** Chris Ferekides, Lee Stefanakos - USF **Budget:** $1.6M **External Collaborators:** Mustang Solar, a Division of Mustang Vacuum Systems
Advanced PV Device Program	
	Title: Research to Improve Photovoltaic (PV) Cell Efficiency by Hybrid Combination of PV and

	Thermoelectric Cell Elements. **PIs:** Nicoleta Sorloaica-Hickman**,** Robert Reedy - UCF/FSEC **Budget:** $167,820
	Title: PV Devices Research and Development Laboratory **PI:** Robert Reedy **Co-PI's:** Nicoleta Sorloaica-Hickman, Neelkanth Dhere - UCF/FSEC **Budget:** $450,250
	Title: Beyond Photovoltaics: Nanoscale Rectenna for Conversion of Solar and Thermal Energy to Electricity **PI:** Shekhar Bhansali (now with FIU), **Co-PIs:** Elias Stefanakos, Yogi Goswami, Subramanian Krishnan - USF **Budget:** $598,500 **External Collaborators:** Bhabha Atomic Research Center, India
PV Integration	
	Title: PV Energy Conversion and System Integration **PI:** I. Bataraseh, **Co-PI's:** J. Shen, Z. Qu, X. Wu, W. Mikhael, L. Chow – UCF (PI use to be N. Kutkut) **Budget: $1,267,000**
	Title: Non-Contact Energy Delivery for PV System and Wireless Charging Applications **PI:** Jenshan Lin - UF **Budget: $**252,000
	Title: PV Power Generation Using Plug-in Hybrid Vehicles as Energy Storage **PI:** J. Shen, **Co-PI:** I. Batarseh - UCF **Budget:** $380,816 **External Collaborators:** City of Tavares, FL
	Title: Integrated PV/Storage and PV/Storage/Lighting Systems **PI:** Franky So, **Co-PI:** Jiangeng Xue - UF **Budget:** $576,000
THRUST 5: Carbon Constrained Technologies for Electric Power in Florida	
	Title: Biocatalytic Lignin Modification for Carbon Sequestration **PI:** Jon Stewart - UF **Budget:** $200,000
	Title: Database Infrastructure for Integrative Carbon Science Research **PI:** Sabine Grunwald. **Co-PI:** Tim Martin - UF **Budget:** $199,440
	Title: Creation of Carbon Sequestration Data, Technologies and Professional Cohorts for Florida **PI:** Mark Stewart, **Co-PIs:** Jeffrey Cunningham, Maya Trotz - USF **Budget:** $479,640 **External Collaborators:** Tampa Electric Company (TECO); Florida Power and Light (FPL); Environmental Consulting and Technology (ECT), Inc.; Los Alamos National Laboratory.
THRUST 6: Exploiting Florida's Ocean Energy Resources	
	Title: Southeast National Marine Renewable Energy Center **PI:** Susan H. Skemp**, Co-PIs:** Howard P. Hanson, James VanZwieten - FAU **Budget: $8,750,000** **Universities:** UCF, FSU, ERAU, University of Miami, Oregon State University, University of Washington, Pennsylvania State University, University of New Hampshire, University of Hawaii, University of Edinburgh, Heriot-Watt University, Nova Southeastern University, Virginia Polytechnical Institute, Florida Institute of Technology, Embry-Riddle Aeronautical University **External Collaborators:** Numerous industry and State and federal government as well as FFRDCs, such

	as National Renewable Energy Laboratory, Woods Hole Oceanographic Institution, U.S. Department of Energy, U.S. Department of Interior (Bureau of Ocean Energy Management and Regulation and Enforcement), U.S. Department of Commerce (National Oceanic and Atmospheric Administration), and Florida Department of Environmental, Protection, to name a few.
THRUST 7: Energy Storage and Delivery Infrastructure	
	Title: Energy Delivery Infrastructures **PI:** Lee Stefanakos **Co-PIs:** Zhixin Miao - USF (Formerly Alex Domijan (PI) and Arif Islam (Co-PI). Left USF). **Budget:** $485,184
	Title: Secure Energy Systems **PI**: Pramod Khargonekar - UF **Budget**: $220,000
	Title: Optimization, Robustness and Equilibrium Modeling for the Florida Smart Grid **PI:** Panos Pardalos - UF **Budget**: $30,000
Policy	
	Title: Economic Impacts of Renewable Energy and Energy Efficiency Policies **PI:** Theodore Kury – UF (PI use to be Mark Jamison) **Budget:** $150,000
Education and Outreach	
	Title: Florida Advanced Technological Education Center (FLATE) **PI:** Marilyn Barger - UF **Budget:** $300,000 **External Collaborators:** Brevard Community College; Tallahassee Community College; Daytona State College; Central Florida Community College; Polk State College; Florida State College at Jacksonville; Valencia Community College; School District Hillsborough County; Florida Department of Education – Division of Adult and Career Education; West Side Technical School; WFI Banner Center for Energy; Advanced Technology for Energy and Environment Center (ATEEC); University of West Florida, Dept of Construction Technology; WFI Banner Center for Construction; WFI Banner Center for Alternative Energy; USF College of Engineering; Madison Area Technical College ATE project for Alternative Energy certifications; Milwaukee Area Technical College Energy Conservation and Advanced Manufacturing Center (ECAM); Florida Energy Workforce Consortium (FEWC); TECO; Progress Energy; ISTEC (Ibero Science and Technology Education Consortium).
	Title: Outreach Activities for FESC **PI:** Pierce Jones, Kathleen C. Ruppert, Hal S. Knowles III, Nicholas Taylor, Barbra Larson, Craig Miller-UF **Budget:** $497,670 **External Collaborators:** Primarily DCA, FSU, UCF (FSEC), USF, and DEP with many others as well.
	Title: UFTR Digital Control System Upgrade for Education and Training of Engineers and Operators **PI:** Gabriel Ghita – UF (PI use to be Alireza Haghighat; he has left UF) **Budget:** $308,000 **External Collaborators:** Several engineers from AREVA NP Inc & Siemens Corporation
FESC Phase 2 Technology Commercialization	
	Title: Development of a Low Cost Concentrating Solar Energy System Using Solar Sausages **PIs:** David VanWinkle, Sean Barton – UF **Industry Partner:** Hunter and Harp Holdings (HHH)

	Title: Stress Evolution in Solid-State Li-Ion Battery Materials **PI:** Kevin S. Jones – UF **Industry Partner:** Planar Energy
	Title: SWNT Based Air Cathodes for Fuel Cells & Metal Air Batteries **PI:** Andrew G. Rinzler – UF **Industry Partner:** nRadiance LL
	Title: Development of high efficiency polymer solar cells **PI:** Frank So – UF **Industry Partner:** SestarTechnologies, LLC

NEW PROGRAM DEVELOPMENT

The new program development effort aims to facilitate the submission of multi-faculty, multi-SUS university competitive proposals in response to solicitations for major research programs. By collecting the best research expertise in the SUS, competitive funding requests to federal agencies, national and global foundations, and industry can be made. Over 70 funding opportunities were distributed to the FESC faculty during this period. The list of funding opportunities is given in Appendix B. The funding opportunities are also posted at the FESC web site: http://www.floridaenergy.ufl.edu/?page_id=912. Faculty teams were formed to respond to the funding opportunities based on the responses received from the faculty. The FESC office facilitates proposal development in a variety of ways beyond solicitation awareness, including identifying leaders, communicating with external partners in industry, national labs and other non-SUS universities, providing professional technical writing help, arranging telecons, and assisting with cost share development, budgets and boiler plates.

FESC only collects data on proposals submitted or funded once a year (October). However, notable proposals facilitated by FESC during the last 6 months include:

- DE-FOA-0000506, U.S.-India Joint Clean Energy Research and Development Center: One multi university team was formed. The UF led team received an award to form the Joint Clean Energy Research and Development Center (JCERDC) in biomass. The project is aimed at reducing energy consumption, cutting dependence on petroleum products and increasing use of renewable fuels. (http://news.ifas.ufl.edu/2012/04/20/uf-led-research-team-selected-for-125-million-joint-u-s-india-energy-project/).
- DE-FOA-0000651 - Sunshot Incubator program (One industry led team)
- DE-FOA-0000652 - Technologies to Ensure Permanent Geologic Carbon Storage (One university led team).
- DE-FOA-0000559, Energy Innovation Hub - Batteries and Energy Storage (Multi-university team with 15 universities, Sematech and NREL)
- DE-FOA-0000670, ARPA-E (Six faculty led teams)
- DE-FOA-0000675, Advanced Management and Protection of Energy-Storage Devices (One university led team).
- DE-FOA-0000677, Solid State Energy Conversion Alliance (SECA) Core (One university led team).
- BP - RFP-II, Gulf of Mexico Research Initiative (One university led team).
- SN-12-15-PKM, Advanced Drop-In Biofuels Production Project (Two industry led teams).
- NIST: 2012-BCTEP-01, Building Construction Technology Extension Program (BCTEP) Pilot Projects (One university led team).
- The Rural Jobs and Innovation Accelerator Challenge, A Coordinated Initiative to Advance Regional Competiveness (One university led team).
- NSF GOALI (One university led team).
- NSF 12-548, SBIR Program Phase I Solicitation FY-2013 (One industry led team).
- Sandia Energy Storage RFP# 1145 (One industry led team).

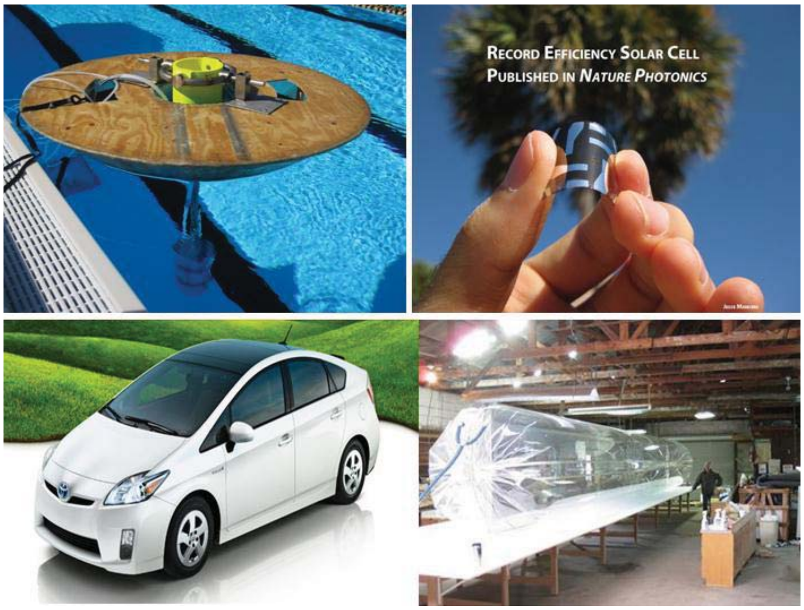
In addition to team formation, the team members were introduced to industry, and industry support letters were collected from the industry partners.

FESC expertise documents in the areas of algae technology, biomass, solar PV, solar fuels, smart grid/energy storage, and building efficiency have been updated and posted at the FESC web site (http://www.floridaenergy.ufl.edu/?page_id=1687). The documents provide the list of faculty and their expertise, facilities, and industry collaboration.

Some of the funding opportunities sent to faculty are given below as examples:

Competitive Funding Opportunities			
Title	**Call #**	**Agency**	**Funding**
Defense Production Act Title III. Advanced Drop-In Biofuels Production Project	SN-12-15-PKM	AFRL	$30M
Energy Innovation Hub - Batteries and Energy Storage	DE-FOA-0000559	US DOE	$120M
Multidisciplinary University Research Initiative: High Operating Temperature Fluids	DE-FOA-0000567	US DOE	$10M
Electricity Delivery and Energy Reliability, Research, Development and Analysis	DE-FOA-0000579	US DOE	$8M
SunShot Concentrating Solar Power Research and Development/ Support of Advanced Fossil Resource Utilization Research by Historically Black Colleges and Universities and Other Minority Institutions Grant	DE-FOA-0000595	US DOE	$850K
Accelerating the Deployment of Energy Efficiency and Renewable Energy Technologies in Indonesia	DE-FOA-0000620	US DOE	
Light-Duty Fuel Cell Electric Vehicle Validation Data	DE-FOA-0000625	US DOE	$6M
Bridging Research Interactions through Collaborative Development Grants in Energy (BRIDGE)	DE-FOA-0000654	US DOE	$9M
Biomass Research and Development Initiative	DE-FOA-0000657	US DOE USDA	USDA-NIFA: $25M; US DOE: $10M
Wireless Charging for Electric Vehicles	DE-FOA-0000667	US DOE	$12M
National Clean Diesel Funding Assistance Program, FY 2012 Request for Proposals (RFP)	EPA-OAR-OTAQ-12-05	EPA	$20M
Energy and Climate Partnership of the Americas/ Caribbean Region Climate Adaptation Partnership Initiative	ECPA/CRCA Partnership Initiative	HED/USAID	$770,500
Building Construction Technology Extension Program (BCTEP) Pilot Projects	2012-BCTEP-01	NIST, DoC	$1.33M
Sustainable Energy Pathways (SEP)	NSF-11-590	NSF	$34M
Academic Liaison with Industry (GOALI)	NSF12-513	NSF	$5M

INDUSTRIAL COLLABORATION AND TECHNOLOGY COMMERCIALIZATION



FESC's industrial collaboration program promotes exchange between the universities and industrial partners from small, medium, and large companies, as well as other organizations such as incubators, research parks, investors, entrepreneurs, and government laboratories.

FESC has an Industrial Partnership and Innovation Strategy that assures active collaboration with the private sector and other partners that support and guide FESC's vision, collaborate with FESC in our research, education, innovation, and outreach programs.

FESC Technology Commercialization Program Description

FESC has devised a multi-tiered approach to investing its limited technology commercialization resources. In devising this strategy, FESC is focused on 1) fully complimenting the existing resources across the SUS and state of Florida's economic development community, 2) providing the maximum potential return / economic impact to Florida's economy on our investment, 3) maximum leveraging of FESC resources with industrial support, and 4) a focus on driving later stage energy technologies in the FESC university research portfolio toward commercialization. This has led to development of a two-tiered program as outlined below:

Phase I: Early Stage Market Research / Business Plans – Recognizing that a number of FESC funded technologies may have unknown, or at least undocumented, commercial potential and also recognizing that university licensing offices and technology licensees (entrepreneurs, SMEs, large corporations) alike are looking for a greater depth of understanding of potential applications of some of FESC's later stage technologies in order to optimize technology licensing and the path to market, FESC initiated a funding program of business plans and market research studies for select FESC technologies. This program was completed and program details were reported in previous reporting period.

Phase II: Matching Funds R&D Program – The second tier of the FESC technology commercialization funding program is modeled on the very successful Florida High Tech Corridor Council Matching Grants Research Program which has been ongoing at USF and UCF since 1996 and at UF since 2005. This second tier also builds off of the results of the first tier as the business plans and market research studies in tier 1 above will provide for more complete information in attracting industrial partners and selecting appropriate projects for funding in tier 2. In this program, FESC core universities will propose energy related projects for FESC funding that is matched on a 2:1 basis by industry funds. This model serves a number of purposes: 1) industry partners are by definition highly engaged in the development process in the university as they are co-funding the R&D package, 2) this provides at least a 2X leveraging of FESC funds on each project, 3) a natural pipeline of the technology deployment to the private sector partner is established as they are typically working on development aspects in parallel with the university research on the project, and 4) the FHTCC program has proven time and again that this model spawns new and long lasting R&D collaborative relationships between companies and SUS university researchers. FESC envisions providing up to $50K in matching funds for each project and with industry match (summarized in table below) on each project, attracting in excess of $500K of industry support to these FESC funded projects.

FESC Phase I Project - Tech Transfer

FESC Phase I Project titled as "Milling Technology Leads the Way to Cost Effective Ethanol Production" (PI: Dr. Blair at UCF) was funded to perform an analysis of commercialization and economic prospective. This technology was licensed by Thor Energy recently. This company is also interested in two UF IP. The company was put in touch with UF OTL.

FESC Phase II Projects

Two projects have been completed:

- UCF and Harris Corp. Joint "Wave Energy Project" led by Dr. Zhihua Qu: *The University of Central Florida and Harris Corporation have joined efforts to design, build and analyze a wave powered abandoned oil well monitoring system for use in the Gulf of Mexico. This system proposes a fully automated oil leak detection system which is self-powered by the local ocean energy which is converted to electricity, conditioned and sent from the surface buoy to the ocean floor to supply power for an abandoned oil well monitoring system.* The final report was included in FESC Nov 2011 report.

- UF and nRadiance LLC (portfolio company of Nanoholdings LLC) led by Dr. Andrew Rinzler: *The project focus is single wall nanotube (SWNT) based cathodes in metal-air batteries and SWNT based fuel cells. The FESC funded part of the project has been completed; however the research team is continuing the work with funding from the industry partner.* The final report is given in this report.

The active projects are listed below:

University	Title	PI	Company
FSU	Deployment of a Low Cost Concentrating Solar Energy Systems Using Solar Sausages	David Van Winkle	Hunter Harp Holdings, LLC
UF	Stress Evolution in Solid-State Li-ion Battery Materials	Kevin Jones	Planar Energy Devices Corp.
UF	Development of High Efficiency Polymer Solar Cells	Franky So/ John Reynolds	Mike Starks, CEO, Sestar Technologies, LLC.

The project progress reports are given at the end of this section (p. 17).

The Florida Cleantech Acceleration Network (FL CAN- http://www.flcleantech.com/)

FESC is one of the partners of the FL CAN grant funded by the Economic Development Administration. FL CAN links Florida-based universities, incubation networks, investors and industry resources together to create a network of Proof of Concept centers to accelerate the creation and commercialization of innovative clean technology research into new technology companies or to license into existing firms.

FESC is uniquely positioned to identify clean technology research with high commercial potential and to facilitate relationships between Florida universities, entrepreneurs and licensees. FESC administration office cataloged all energy and clean technology-related intellectual property developed at Florida universities and NASA Kennedy Space center. The list is given in Appendix C. FESC works with the Technology Transfer directors at each Florida University, FL CAN Market Research team and the mentor networks to assist with technology commercialization.

To facilitate the accessibility of a network of university laboratories that are dedicated to energy and clean technology development, FESC administration office developed a catalog of user and lab facilities within the Florida University System, FIT, and NASA Kennedy Space Center. The list is given in Appendix D. Entrepreneurs, students, scientists and established companies interested in developing commercial products based on Florida-based research have access to these user facilities.

The FL CAN services available for entrepreneurs & CleanTech Companies are:

- CleanTech IP Catalog – A focal point for accessing a catalog of all energy and cleantech research conducted at Florida universities and NASA KSC.
- Lab Network – statewide network of laboratory facilities that are available to mature promising research into commercial prototypes
- Mentor Network – statewide network of business mentors, industry experts, and investors to assist in business strategy, financing, and management for new technology ventures
- Market Research – A dedicated market research team that can assist with market evaluation and business plan development
- Entrepreneurship Development – Educational programs that focus on new venture creation, financing, growth, and offer support for developing SBIR proposals that utilize university clean technology research
- Gap Fund – Gap Fund that can be used for pre-seed funding of commercial prototype development, business planning, market research, and industry expertise
- FL-CAN Showcase – Annual showcase to highlight innovative, high-growth clean technology companies in Florida and to broker introductions to investors and industry partners

Industrial Collaboration Project Examples

In addition to the above mentioned EDA funded effort, FESC has been actively pursuing research, infrastructure improvement, and economic development collaborations with multiple companies and other entities to assure that the Consortium's research and education agenda are in tune with industry's needs and to move FESC technologies quickly to serve Florida's industry and economy. Outlined below is a sampling of specific of collaborations that FESC is fostering.

- Introducing Florida University Energy Programs to FL industry
  FESC programs have been introduced to numerous companies for potential partnership, collaborative proposal efforts, and technology transfer. These include Applied Research Associates (ARA), Extreme Power, Excellatron, Culturing Solutions, Renewable Energy Strategies, Trane, Mesdi Systems Inc., Appollo Energy Systems, Mainstream Eng., Alim Innovations, SebaiCMET, Inc., Thor Energy, INEOS, JDC Inc., Hydro Energy Solution, Xerolet, Genomeprairie (Canadian company), Biofuels Digest, Composite Innovation Center Manitoba Inc., MTN Consulting Associates, Himark BioGas Inc., Green Crop Network at McGill, and Centurion Biofuels. FESC faculty members were introduced to some of the industry members.

- Collaborations in Energy Storage Programs
  SAFT built 235,000-square-foot Li-Ion rechargeable battery plant in Jacksonville FL. FESC faculty who has expertise in Li-Ion batteries were introduced to SAFT technical team. FESC office worked with SAFT team to submit a proposal to Sandia National Lab in collaboration with the FL Energy Office.

- Energy Innovation Hub "Battery and Electrochemical Storage Technology Hub"
  Funding: $125M for 5 years
  FESC Universities: UCF/FSEC (Lead), FSU, and UF.
  Other Partners: California Institute of Technology, Case Western Reserve University, Illinois Institute of Technology, Northeastern University, Notre Dame University, Missouri University of Science and Technology, University of California, Santa Barbara, University of Kansas, University of South Carolina, University of Southern California, Vanderbilt University, Washington University, St. Louis and NREL and SEMATECH

This represents only a small set of examples of the industrial collaborations that FESC has initiated.

FESC Technology Commercialization Phase II Project Progress Reports

1. *Deployment of a Low Cost Concentrating Solar Energy Systems Using Solar Sausages, By Dr. David Van Winkle, FSU; Industry Partner: Hunter Harp Holdings, LLC*

Summary of Progress

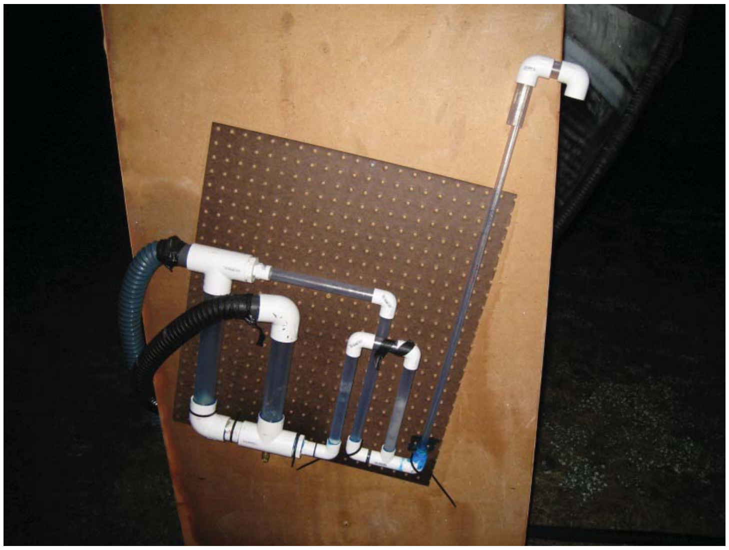
Three sites are being developed to produce power with photovoltaic devices mounted on top of 15 m long × 1.8 m diameter clear Mylar cylinders with a reflective Mylar film in the middle which focuses the incident sunlight on the 20 cm wide PVDs. Solar Sausages have been constructed and deployed at Sites 1 and 2 (336 ea and 281 ea). The first Sausages are being deployed at Site 3 beginning May 23, 2012, with a planned capacity of 1800 ea. A significant portion of the efforts of Dr. Barton during this update period have involved designing and testing passive pressure regulation systems that allow the Sausages to remain inflated and maintain the 1 part in 200 differential pressure required to regulate the optic, while ambient conditions vary. Variations can be quite abrupt, for example when morning sunlight first hits the Sausages or when afternoon thunderstorms cool Sausages by up to 20 °C in a few minutes. Additional progress has been made in designing and testing the PVD collection and heat dissipation system that allows for standard 1 Sun PVDs to be used for the 8 Sun concentrated intensity. Significant progress has been made on hardware and software development to control the Solar Sausage's orientation via actuator arms. One control system can now control 12 actuator arms, each orienting 4 Solar Sausages.

Progress

The three separate Sites contain many similarities and many differences. Site 1 was developed as a proof-of-concept site. Cost issues were not foremost in mind. Solutions were developed that were not scalable. For example, the Sausage inflation system involves blowing air through staged diameter pipes specifically chosen to match the number of sausages being inflated. Centralized air-supply and centralized differential air regulation were used to simplify the system. Cost of the approach has proven to be large mainly because of the large amount of ducting required to carry such large quantities of air such large distance while maintaining precise pressure differences. Thus Site 1 motivated the need for distributed regulation of the differential air pressure. While Site 1 has eight regulation points, Site 2 has 60, allowing for distributed production of air and attendant cost reduction in ducting. Maximum duct diameters have been reduced from 10 inches to 2 inches and the total length of ducting has also been reduced. Site 2 also attempts to use the balloons themselves as air ducts by creating air-supply daisy chains, i.e. supplying a first balloon with air and attaching a second balloon to the other end of the first. Up to four sausages have been joined in an air-supply daisy chain.

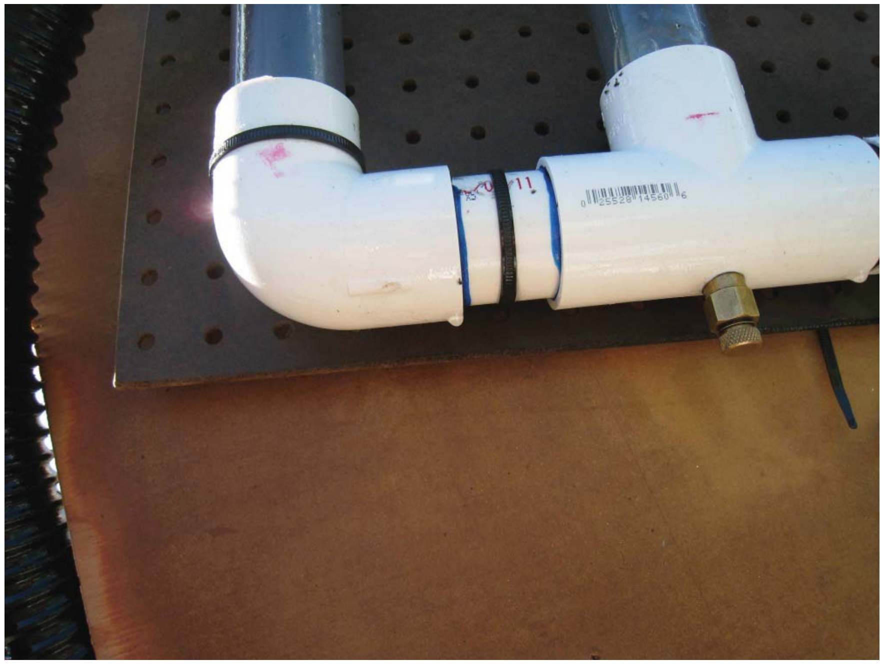
While the increase in the density of air-regulation points has greatly reduced the cost of the system, the larger number of points requires a less expensive mechanism for the regulation. We have employed the principles of analog pneumatic/hydraulic computing to successfully create a regulation point that is formed only of standard polyvinyl chloride pipe and hydraulic fluid. The regulation point has no moving parts. It acts as a pressure sensor, computer, and valve set to allow air in and out of the balloon as necessary to maintain the optic and optimal sunlight concentration. Much of the effort of the principals has involved developing a passive but robust pressure regulation system. Pictures of the various attempts follow.

View of the Site 1 (Yulee St.) populated with balloons but no photovoltaic modules



A view of the first neumatic/hydralic regulator ("bubbler"). The left three columns act as a pressure signal deamplifyer/inverter. The right three colums perform the same functions. Air from the top of the balloon is attached to the first column (from left). Air to the bottom of the balloon is attached to the second column. The sixth column is open to atmosphere. The first three columns share a volume of hydraulic fluid. The last three do as well. A small intentional air leak is placed in the connection between the 3rd and 5th column. The net action is to allow air to pass from the top of the balloon to the bottom of the balloon only when the pressure in the bottom of the balloon is less than 15/16 of the pressure in the top of the balloon (all pressures relative to atmosphere).

Ice on the balloons early in the morning. Air volumes required to overcome ambient temperatures changes exceed the leak rate of the balloons by a factor of 2 during the evening and by a factor of 8 or more during the passage of a cold front.



hydraulic fluid leak from improperly bonded PVC. The brass "pinch" plug on the right is used to calibrate the hydraulic fluid volumes.

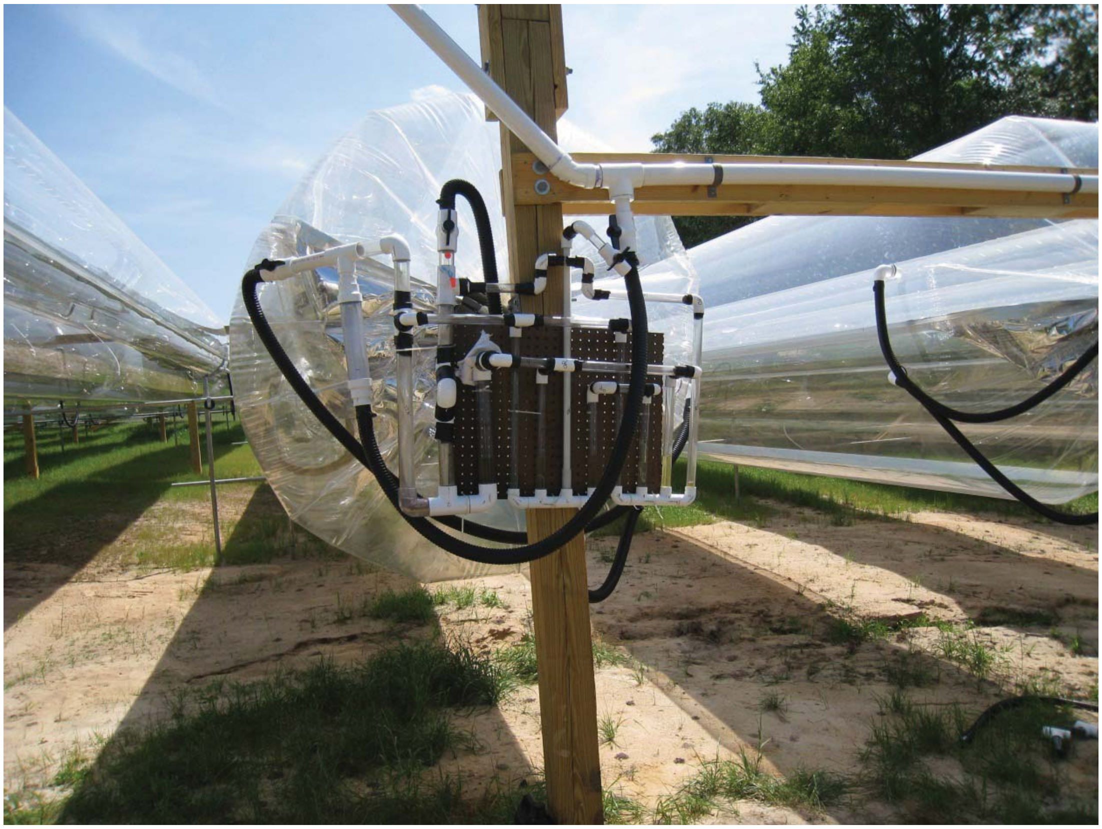
Telephoto image of a distant reflection in a balloon showing the optical quality of the mirror.


Solenoid type bubbler under construction. The juction in the second column (from left) acts as a solenoid valve. It is flooded with hydralic fluid to close.


The 10-column "amplifiying" bubbler. Again with solenoid action in column 2.

Current-voltage and power-voltage curves of a typical PV cell under 1000 watt per meter square radiation intensity.


Posts installed at Site 3 (for 1800 balloons covering about 20 acres).


11-column non-amplifying "feedback loop" bubbler employing "time integral" "reset" regulation

2. *Stress Evolution in Solid-State Li-ion Battery Materials, By Dr. Kevin Jones, UF; Industry Partner: Planar Energy Devices Corp.*

Summary of Progress

A series of Zn_xCu_yS (y < 0.3, x = 1 – y) powders were synthesized using the solvothermal approach. The powders were characterized using secondary electron microscopy (SEM), transmission electron microscopy (TEM), x-ray powder diffraction (XRD), and energy dispersive x-ray spectroscopy (EDX). The Zn_xCu_yS powders are manufactured as cathodes in coin cells to test their viability in Li-ion batteries. The initial comparison is between cathodes prepared at Planar Energy using the streaming protocol for electroless electrochemical deposition (SPEED) and tape-cast cathodes using polyvinylidene (PVDF) as a binder. Results show SPEED cathodes having a lower initial capacity but improved cyclability.

Progress Report

Zn_xCu_yS powders have been fabricated by solvothermal synthesis in a Teflon lined pressure vessel. Precursors to the synthesis include zinc nitrate, copper nitrate, thiourea, ammonium hydroxide, ethanol, and water. The solution is heated in the pressure vessel for 3 hours at 160 °C. After being collected through the use of a centrifuge, the resulting powder is then rinsed and dried in air at 110 °C. The powders Zn_xCu_yS each contain particles that range from 10 nm to a few micrometers in size, although morphologies differ as seen by SEM in figure 1. Powder XRD and selected area electron diffraction (SAD) were utilized to identify the structure of the sulfide particles. The Williamson-Hall method of determining particle size from peak broadening suggests that particle size is on the order of 20 nm. The fine particle and grain sizes were confirmed by TEM shown in figure 2. In figure 3, the use of scanning transmission electron microscopy (STEM) and EDX revealed the distribution of Zn_xCu_yS particles from an intended $Zn_{0.9}Cu_{0.1}S$ solution.

The Zn_xCu_yS powders were then used to form a cathode for a lithium ion battery. The theoretical capacitance of ZnS is 550 mAhr/g based on the complete conversion of ZnS into Li_2S. The sulfide batteries were discharged to 0.5 V and charged to 2.5 V. The cathode was prepared by adding together 85 wt% Zn_xCu_yS, 10 wt% carbon, and 5 wt% PVDF. The product was then ball-milled for 2 hours. After ball-milling, the product was added to 1-methyl-2-pyrrolidinone, which acts as a solvent to form a slurry. The slurry was tape-cast onto a Cu substrate. The tape-cast slurry was then dried in air at 110 °C overnight. The cathode and Cu current collector were placed into a coin cell opposite of Li metal with a Celgard between. The electrolyte used is a solution of 1 M LiPF6 in 1:1 ethylene carbonate (EC):dimethyl carbonate (DMC) solvents. With the assistance of Planar Energy, alternate cathodes were also fabricated using SPEED. These cathodes use the same powders from the solvothermal synthesis; however, the composition of the slurry is different and proprietary. The slurry created at Planar Energy is then spray deposited onto a stainless steel substrate and annealed in a sulfur ambient atmosphere at 325 °C for 5 min.

The annealed cathode is then prepared into a coin cell as the previously explained.
Since much of the testing is currently in progress, this next section will focus on the testing of ZnS cathodes between the PVDF and SPEED cathodes. A ZnS-PVDF type cathode was tested at a current of C/20 with an initial discharge capacity of 335 mAhr/g discharged to 0.5 V. The cyclability of the cathode is very poor in the liquid electrolyte as seen in figure 4. A ZnS-SPEED cathode was tested at a current of C/40 with an initial discharge capacity of 214 mAhr/g discharged to 0.5 V. Currently there is no C/20 data to compare with the ZnS-PVDF cell. The cyclability is greatly improved with the SPEED cathode despite the lower initial capacity as seen in figure 5. The improved cycability is also seen at C/5 rates, despite the initial

capacity dropping to 100 mAhr/g. An important difference between the two cathodes is the currently unidentified electrochemical process that occurs at 2 V during charging for the SPEED cathode.
In parallel to the coin cell testing with liquid electrolyte, ZnS-SPEED and $Zn_{0.7}Cu_{0.3}S$-SPEED cathodes are currently being sprayed with an $AlGaSPO_4$ solid state electrolyte by Planar Energy. Those cathodes will be tested in a completely solid and hybrid cell configuration to compare with ongoing liquid cell testing.

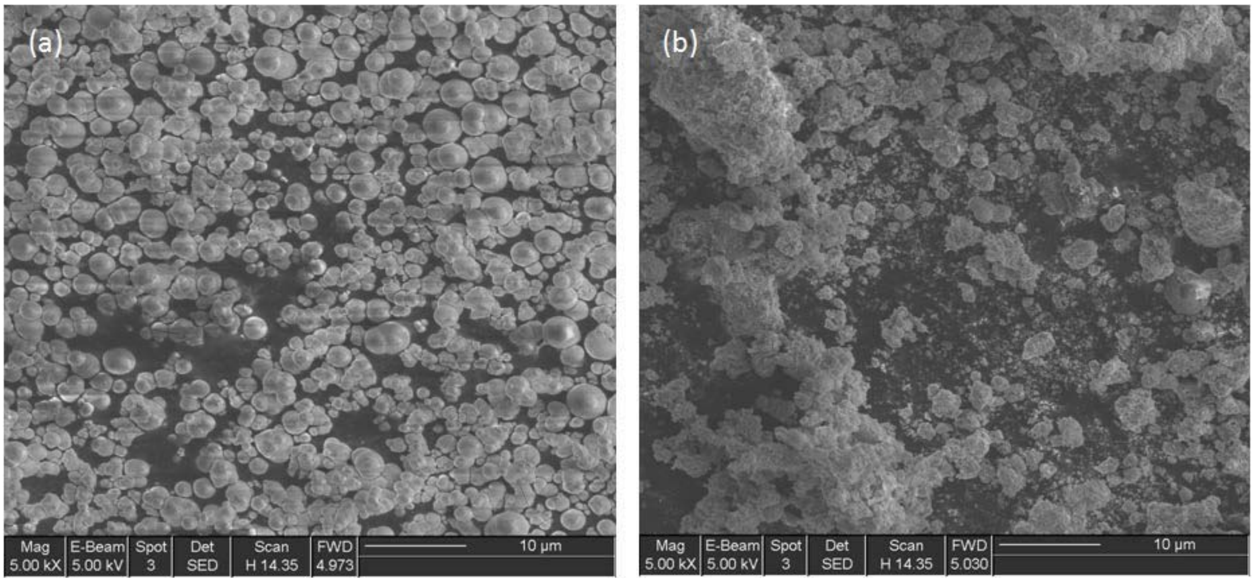


Figure 1. Top-down SEM images of (a) ZnS and (b) $Zn_{0.7}Cu_{0.3}S$

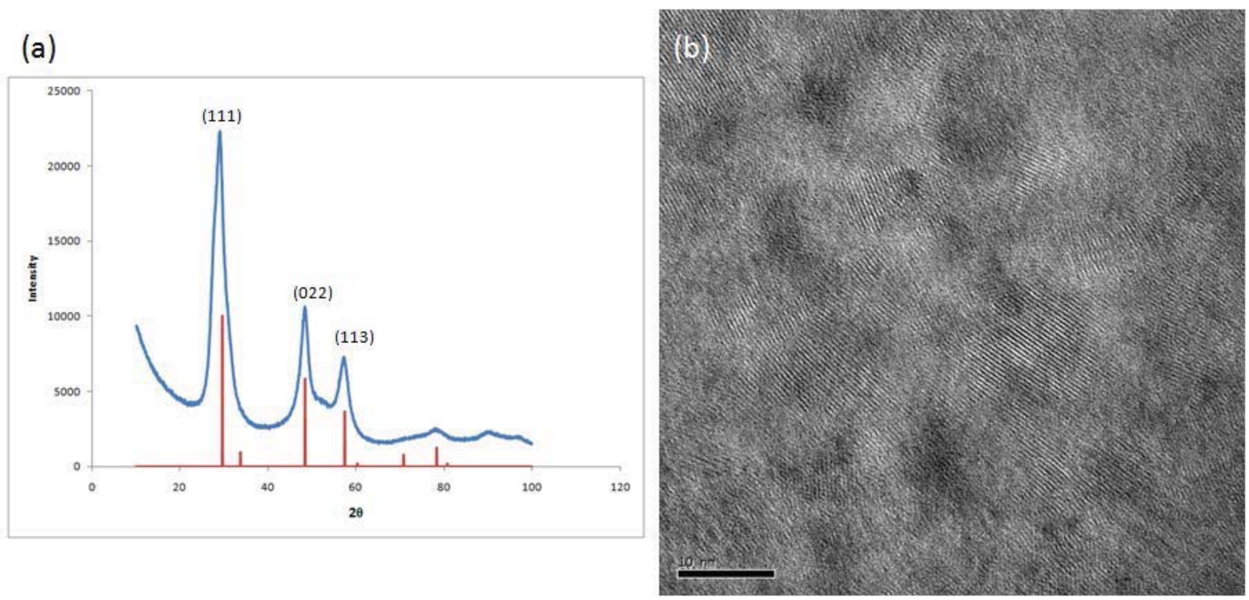


Figure 2. (a) XRD of synthesized ZnS and sphalerite reference pattern, (b) bright field TEM of synthesized ZnS show small crystal size

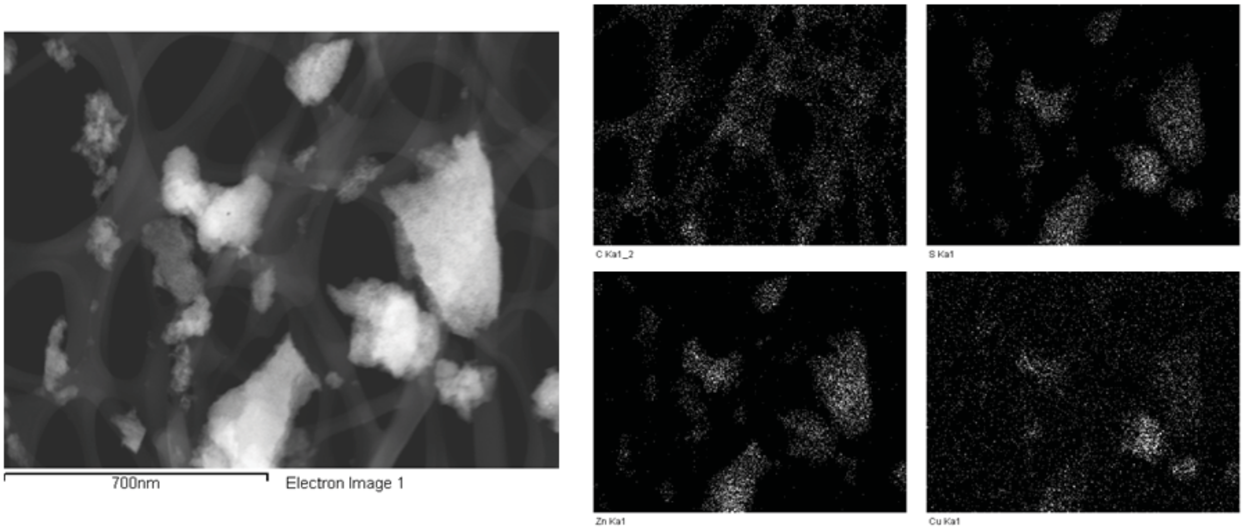


Figure 3. Dark field STEM and EDS of $Zn_{0.9}Cu_{0.1}S$ on a lacey carbon mesh

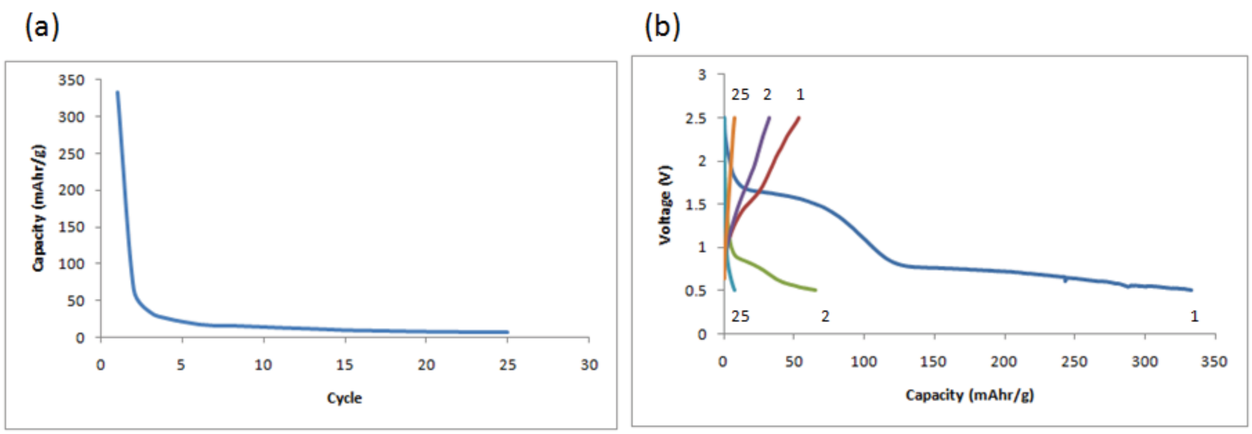


Figure 4. (a) Cycle life of ZnS-PVDF battery, (b) Charge/Discharge profile of ZnS-PVDF battery at C/20

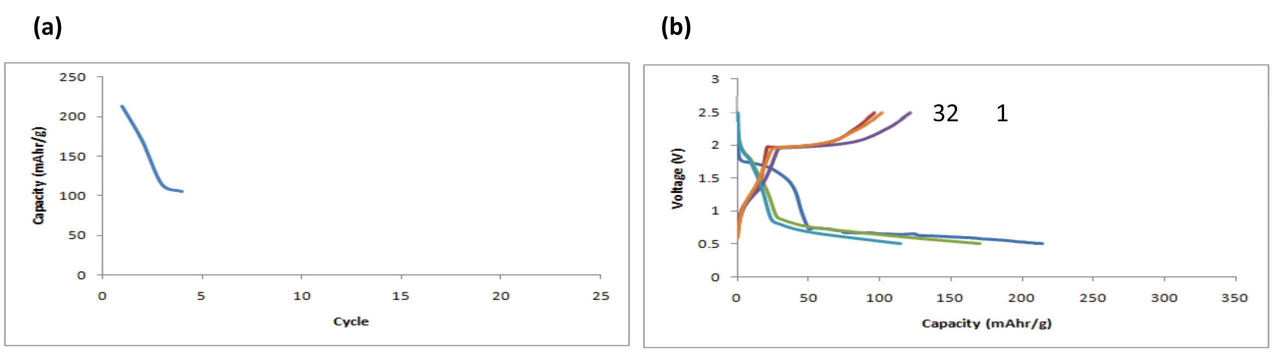


Figure 5. (a) Cycle life of ZnS-SPEED battery, (b) Charge/Discharge profile of ZnS-SPEED battery at C/40

3. ***High Efficiency Black Polymer Solar Cells, By Dr. Franky So; Industry Partner: Sestar Technologies, LLC.***

External Collaborator: Dr. John Reynolds, Georgia Tech
Students: Cephas Small and Song Chen

Description

The objective of the proposed project is to synthesize broadly absorbing, black colored (PBLACK) polymers with especially high charge mobilities and to fabricate the highest performance polymer solar cells possible. Specifically, we will synthesize polymers with absorption band ranging from 400 nm to beyond 1 [illegible] m with carrier mobilities higher than 10^{-4} cm^2/Vs. Polymer-fullerene (both $PC_{60}BM$ and $PC_{70}BM$ along with more recently developed derivatives) blend morphology will be optimized using different solvent/heat treatments as well as additives to the blends. The final device will be enhanced using anode and cathode interlayers to enhance carrier extraction to the electrodes. With the ability to synthesize broadly absorbing polymers, control the donor-acceptor phase morphology and engineer the device structure, it is expected that the power conversion efficiency of polymer solar cells can reach 10% at the end of the two-year program.

Progress Summary

During the first 5 months of this project, we focused on the synthesis of a new dithienogermole (DTG) containing conjugated polymer for solar cell fabrication. Stille polycondensation of a distannyl-DTG derivative with 1,3-dibromo-N-octyl-thienopyrrolodione (TPD) results in an alternating copolymer which displays light absorption extending to 735 nm, and a higher HOMO level than the analogous copolymer containing the commonly utilized dithienosilole (DTS) heterocycle. When polyDTG-TPD:PC70BM blends are utilized in inverted bulk heterojunction solar cells, the initial cells display average power conversion efficiencies of 7.3%, compared to 6.6% for the DTS containing cells prepared in parallel under identical conditions. The performance enhancement is a result of a higher short-circuit current and fill factor in the DTG containing cells, which comes at the cost of a slightly lower open circuit voltage than DTS based cells. Upon further process optimization, the power conversion has been enhanced to 8.1%.

Progress Report

In our efforts to improve upon these materials, we hypothesized that the substitution of the bridging carbon or silicon atoms for the larger germanium atom would result in a further enhancement in ordering, since the long C-Ge bond lengths would further remove the bulky side chains from the planar heterocycle and allow even stronger pi-stacking interactions to occur. Figure 1a shows an MM2 optimized geometry of the Si and Ge bridged heterocycles with methyl substituents, where the bond lengths and angles of the interior ring are consistent with single crystal X-ray structures of known group 14 metalloles. The Figure shows that the C-Ge bond length is indeed longer, as the substituent methyl group is 3.11 Å away from the nearest thiophene carbon atom in DTS, whereas the methyl group is 3.27 Å from the nearest thiophene carbon in DTG. The space filling models show that the methyl groups are further displaced from the conjugated backbone, supporting the idea that the out-of plane alkyl groups can allow a larger surface for π-stacking. Interestingly, the H-atoms of the methyl groups in the DTS derivative adopt a staggered (gauche) conformation, while those in the DTG derivative are eclipsing, suggesting there is a steric relaxation as the methyl groups are moved away from one another.

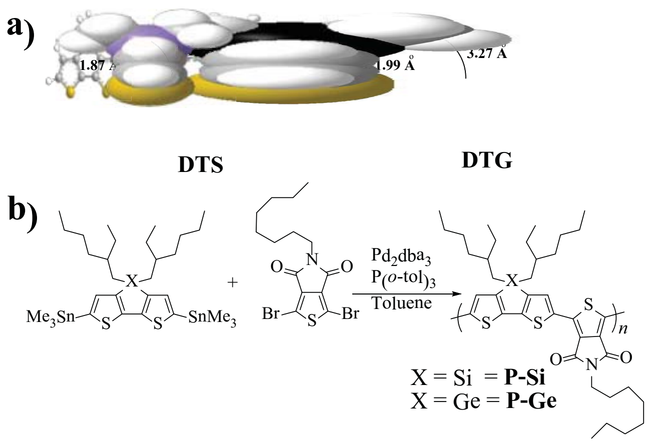


Figure 1. a) MM2 optimized geometries of dimethyl substituted DTS and DTG heterocycles, showing C-X bond lengths, and distance of methyl groups from the nearest thienyl carbon. b) Synthesis of P-Si and P-Ge.

In order to evaluate and compare the performance of the new DTG containing polymer to the well-established DTS containing polymer, we synthesized ditin substituted DTS and DTG derivatives to be used as comonomers in Stille polymerizations with 2-ethylhexyl groups as solubilizing side chains, as shown in Figure 1b. Although we, as well as other groups, have had difficulty purifying ditin derivatives, we found reverse phase preparative HPLC to be an effective method of separation to give very pure ditin monomers. The C-18 functionalized, endcapped silica did not significantly remove tin groups from the DTG and DTS heterocycles in contrast to normal phase silica. We chose to polymerize these systems with *N*-octyl-theino[3,4-C]pyrrole-4,6-dione, (TPD), as several groups recently showed that this acceptor results in high open circuit voltages (V_{oc}) and fill factors when incorporated in bulk heterojunction (BHJ) solar cell donor p-type polymers. In particular, the N-octyl TPD derivative gave superior performance to branched derivatives.

Figure 2 shows thin film UV-visible absorption spectra (drop cast from toluene solutions onto glass slides) of **P-Si** and **P-Ge**. **P-Si** gave absorption peaks at 611 and 670 nm, with an estimated bandgap of 1.73 eV, consistent with previous reports. Upon substitution of the silicon atom for germanium in **P-Ge**, a red-shifted absorption spectrum was observed with respect to **P-Si**, with peaks at 618 and 679 nm and an estimated bandgap of 1.69 eV.

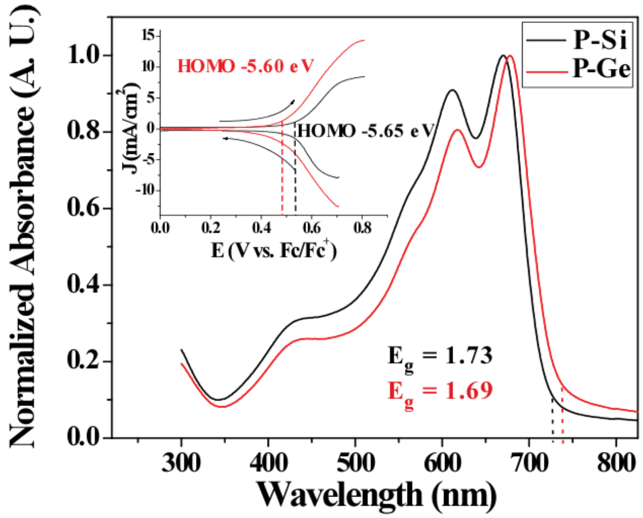


Figure 2. Thin film UV-visible absorption spectra of **P-Si** and **P-Ge** on glass. Inset: differential pulse voltammetry (step size 2 mV, step time 38 ms, pulse amplitude 100 mV) of thin films of P-**Si** and **P-Ge** on 0.02 cm^2 Pt disc electrodes in 0.1M Bu_4NPF_6/acetonitrile, using a Ag/Ag^+ reference electrode (0.01 M $AgNO_3$, 0.1 M Bu_4NPF_6/acetonitrile) and Pt wire counter electrode. Arrows indicate direction of scan.

Of vital importance for BHJ solar cells are the HOMO and LUMO energy levels of the polymers, as the energy offset between p-type material HOMO and fullerene LUMO is a critical parameter in determining the open circuit voltage (V_{oc}) of the cells. The LUMO energy is also important as sufficient driving force for electron transfer from the excited state polymer (related to LUMO level of polymer) to PCBM is necessary for charge transfer to occur. In order to estimate HOMO-LUMO levels from redox onsets of the polymers thin films of **P-Si** and **P-Ge** were drop cast from toluene solutions onto Pt disc electrodes, and subsequently studied using cyclic voltammetry (CV) and differential pulse voltammetry (DPV). The oxidative differential pulse voltammagrams of **P-Si** and **P-Ge** are shown in the inset on Figure 2, demonstrating that the onset of oxidation for **P-Si** (0.53 V vs. Fc/Fc^+) is about 50 mV higher than that of **P-Ge** (0.48 V vs. Fc/Fc^+), giving estimated HOMO levels at -5.60 eV and -5.65 eV respectively (assuming SCE to be -4.70 eV vs. vacuum, and Fc/Fc^+ to be +0.38 eV with respect SCE). The potentials of oxidation for **P-Si** are slightly lower than the previously reported values obtained by CV, which is expected since DPV generally provides higher sensitivity and more well-defined redox onsets due to reductions in capacitive charging currents. These findings are also consistent with calculated values for group 14 metalloles, where germole containing oligomers were found to have slightly higher HOMO levels than the silole analogues. The reduction potentials of the polymers are nearly identical, with both measured at -1.62 V vs. Fc/Fc^+ by DPV giving LUMO levels of -3.50 eV, which can be expected as the reduction potentials of the polymers are likely controlled by the TPD acceptor.

Bulk heterojunction solar cells were then fabricated using **P-Si** and **P-Ge**:$PC_{70}BM$ blends as active layers in inverted device architectures ITO/ZnO/Polymer:$PC_{70}BM/MoO_3$/Ag, and the results are presented in Figure 3. We chose to utilize the inverted geometry for device fabrication to avoid the most common problems experienced with conventional devices, such as rapid oxidation of low-work function metal cathodes and etching of ITO by the acidic PEDOT:PSS layer. Figure 3 shows illuminated (A.M 1.5) J-V curves of both polymers, with and without diiodooctane (DIO) as a processing additive. It can be seen from the Figure that the performance of both polymers is greatly enhanced using 5% DIO, as both the currents and fill factors significantly increased. On optimization, **P-Si** achieved an average short-circuit current density of

11.5 mA/cm^2, open circuit voltage of 0.89 V, and 65% fill factor resulting in an average power conversion efficiency (PCE) of 6.6%. The DTG containing polymer **P-Ge** gave a higher short-circuit current density (12.6 mA/cm^2), and fill factor (68%) than **P-Si**, with a lower V_{oc} of 0.85 V, for an average PCE of 7.3 %. The lower V_{oc} of 40 mV for **P-Ge** is in excellent agreement with the DPV measurements, which showed that **P-Ge** has a higher HOMO level by 50 mV.

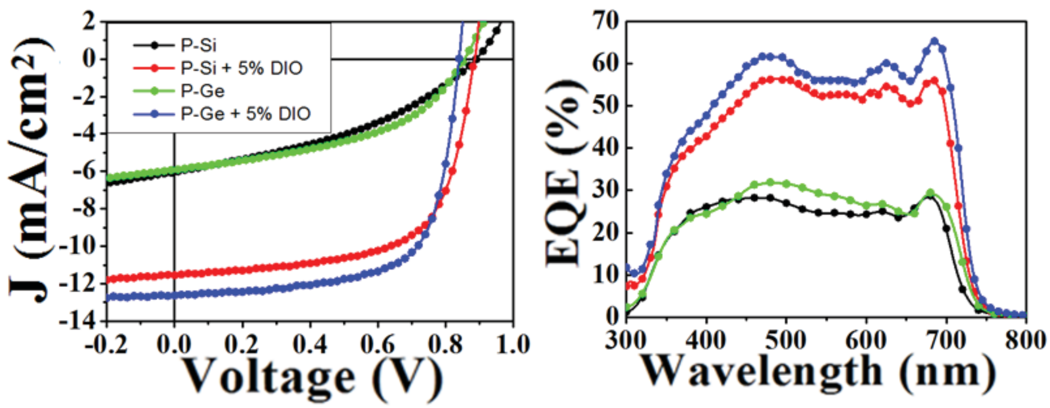


Figure 3. Left : illuminated J-V charachteristics of solar cells using ITO/ZnO/Polymer:$PC_{70}BM/MoO_3$/Ag device architecture, with and without DIO as a processing additive. Right: EQE spectra of solar cell devices utilizing **P-Si** and **P-Ge**.

The EQE spectra of the devices are also shown in Figure 3, and it can be seen that without DIO both devices display fairly low quantum efficiency across the visible region. With DIO as a processing additive, the EQE of devices using **P-Si** and **P-Ge** increases dramatically, with a broad spectral response. The EQE across the visible region of **P-Ge** ranges from 55 to 65% while that of **P-Si** ranges from 50 to 56%, with **P-Ge** also extending to longer wavelengths. This is consistent with the slightly red-shifted absorption spectrum of **P-Ge** with respect to **P-Si**.

The morphologies of the polymer:$PC_{70}BM$ blends were imaged using tapping mode atomic force micrsocopy (AFM), top-down bright field transmission electron microscopy (TEM), and cross-sectional TEM. The TEM images are all presented at similar defocus values such that the contrast between phases is enhanced without overly large fringing effects. The cross-sectional TEM samples shown in Figure 4 were prepared through the use of focused ion beam (FIB). The cross-sectional samples show the multilayer structure which consists of glass/ITO/ZnO/ Polymer:PCBM/MoO_3 (too thin to be clearly observed in the TEM images)/Ag. For the cross-sectional samples an additional protective layer of carbon was deposited on top of the Ag, followed by a protective Pt layer. The cross-sectional TEM images shown in Figures 4 show a morphology with domains appearing 100-350 nm in lateral dimension and ~45-65 nm in vertical dimension. These large dimensions are much greater than typical organic exciton diffusion lengths of ~10 nm, and thereby severely limit device performance. The low J_{SC} observed in the devices processed without DIO are attributed to this large scale phase-separated morphology, where only a small fraction of generated excitons diffuse far enough to reach a polymer:$PC_{70}BM$ interface.

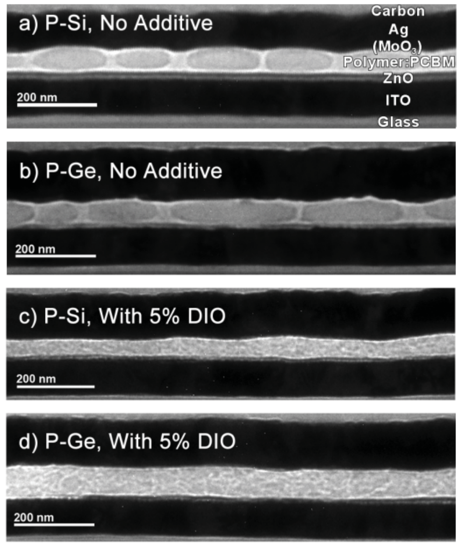


Figure 4. Cross-sectional TEM images of **p-Si**:$PC_{71}BM$ and **pGe**:$PC_{71}BM$ based PV cells without any additives (top) and with 5% DIO (bottom).

Upon addition of 5% DIO a significant reduction in phase separation is observed for both polymers. After the addition of 5% DIO, phase separation is observed to be on the order of 10s of nms, with no large aggregates of $PC_{70}BM$ or polymer observed. This small-scale phase separation is on the order of the exciton diffusion length and correspondingly large J_{SC} values are observed for these devices. The cross-sectional images also show a fairly random morphology with no preferred horizontal or vertical alignment of phases. However, both top-down and cross-sectional TEM images show a fairly interconnected morphology that is necessary for efficient charge transport. The morphology of both polymers both with and without additives appear nearly identical, thereby the performance differences of the DTG and DTS devices is likely attributed to the slightly red-shifted absorbance of the DTG analogue and possibly also to the difference in intermolecular packing.

In conclusion, we have synthesized the first dithienogermole containing conjugated polymers. The use of this heterocycle in donor-acceptor polymers using N-octylthienopyrrolodione (TPD) as an acceptor results in slightly longer wavelength absorption, and higher HOMO levels than do analogous polymers containing its dithienosilole analogues. When utilized in bulk heterojunction solar cells, the DTG-TPD copolymer **P-Ge** displays an *average* PCE of 7.3% when utilized in simple inverted device architectures without interlayers. Upon further device optimization, PCE greater than 8% was achieved using **P-Ge**:$PC_{70}BM$ blends as active layers.

4. *SWNT Based Air Cathodes for FC and Metal Air Batteries, By Dr. Andrew Rinzler, UF; Industry Partner: nRadiance LLC, portfolio company of Nanoholdings LLC*

Final report
December 31, 2011

Project goals

1) SWNT cathode based oxygen reduction activity (ORA) limits:

Establish the comparative performance of the SWNT oxygen reduction activity (per unit mass & volume) versus an optimized, commercial platinum loaded cathode in a hydrogen-oxygen fuel cell (FC) where the hydrated (but non-liquid saturated) environment allows higher currents to be drawn. These tests will either establish the limits of the oxygen reduction activity of the SWNTs or demonstrate their competitiveness versus Pt based electrodes at current densities where other processes (e.g. mass transport limits, proton transport limits, series resistance etc.) set the limits to the current in both types of electrodes. Such data is important as a metric of the oxygen reduction activity of the SWNTs for all potential air cathode applications.

2) SWNT based cathodes in metal-air batteries:

Exploit the chemical inertness of the SWNTs and their high oxygen reduction activity in zinc-air laboratory devices to push the technology of metal-air batteries and demonstrate commercially valuable performance.

Summary of research activities and accomplishments

1) SWNT cathode based oxygen reduction activity (ORA) limits

1st Quarter

To evaluate the comparative performance of the SWNT oxygen reduction activity (per unit mass & volume) versus a commercially available platinum loaded cathode in a hydrogen-oxygen fuel cell (FC) as a metric of the oxygen reduction activity of the SWNTs for air cathode applications, the following tests were performed:

- The SWNT air cathode was pressed onto a commercially available pre-built half membrane electrode assembly (MEA) (Electrochem Inc.). Due to the fact that precise parameters of the pre-built MEA were unknown, this procedure left too many variables out of our control;
- An alternative way of adding our SWNT air cathode to the MEA was probed. The MEA was fabricated in our laboratory from the conventional components. The anode side Pt loaded electrode, gas diffusion layer, Nafion PEM, silicon and PFA gaskets, were assembled using designed steel die and fixturing;
- To validate our MEA fabrication procedures this MEA was run in the cell. Our home built Pt-loaded MEA outperformed a standard commercial Pt-loaded MEA (obtained from Electrochem Inc.);
- The SWNT air cathode was then added to the fabricated MEA and tested in the fuel cell. Our first attempt in requesting any current from the fuel cell resulted in a poor cell performance: the cell potential immediately dropped to near zero volts. The reasons include the partial

hydrophilicity of the SWNTs and the Nafion PEM thinning during the hot pressing/MEA assembly causing a wholesale flooding of the cathode side.

2nd Quarter

To combat the hydrophilicity of the SWNTs causing poor cell performance, the following counteractions were fulfilled:

- By mixing hydrophobic MWNTs with the SWNTs the hydophilicity of the SWNT layer could be reduced without giving up much on the conductivity of the electrode or the access of the oxygen to the nanotube surfaces;
- The hydrophobic PTFE resin solution was incorporated into the SWNT layer to tailor the hydrophobicity of the SWNT cathode;
- The Nafion solution was painted onto the SWNT electrode that could also increase the hydrophobicity of the air cathode.

Also, the thicker Nafion PEM was used for the MEA fabrication to prevent flooding of the cathode side.

3rd Quarter

Despite numerous attempts, we were unable to demonstrate the SWNT based air cathode in a PEM hydrogen fuel cell for demonstrating maximum current capabilities. Since the key to maximizing the catalytic activity of the SWNTs toward oxygen reduction reaction (ORR) is understand the mechanism and reaction kinetics on the catalytic sites in the SWNT films it was decided to carry out a set of electrochemical experiments.

4th Quarter

To understand the ORR kinetics on the catalytic sites of the SWNTs the rotating (ring) disk electrode (RRDE) electrochemical method that is based on convective transport of reacting species from the solution to the electrode surface was used. The oxygen reduction proceeding on highly active catalysts (like highly dispersed Pt particles) is usually a 4-electron process with a small amount of hydrogen peroxide produced during the reaction. The RRDE measurements of the oxygen reduction on the free standing SWNT films transferred onto the GC disk electrode gave the following results:

- The RRDE voltammograms obtained at various rotation rates from 200 to 1600 rpm in a 0.1 M KOH O_2-saturated solution showed that the ORR process on the SWNTs proceeds at a high reduction potential (i.e., low overpotential). The onset potential of O_2 reduction on the SWNT film is more positive than that of the polished GC and is very close to the onset potential of the commercially available platinum-loaded carbon, indicating a high electrocatalytic activity of the SWNT cathode;
- The number of electrons transferred per O_2 molecule in the ORR on the SWNT cathode (pH > 7) calculated from Koutecký-Levich equation varies from 2.5 to ~ 3.6 within tested potential range. This result suggests that the ORR on the SWNTs proceeds via a mixed 2- and 4-electron reduction in alkaline electrolytes. In pH = 7 phosphate buffer electrolyte system, the ORR is predominantly a 4-electron process;
- The amount of hydrogen peroxide produced on the SWNT/GC disk electrode is close to that obtained on the platinum-loaded carbon indicating that HO_2^- is converted to OH^- during the ORR.

In general, the data obtained using the RRDE measurements indicate that the SWNT films have a high electrocatalytic activity toward oxygen reduction in alkaline and pH neutral aqueous electrolyte systems. In future, the SWNT air cathodes should be tested in alkaline and microbial type fuel cells.

2) SWNT based cathodes in metal-air batteries

1st Quarter

- Conventional Duracell Activair® 675 button-type Zn-air batteries were purchased and tested at constant-resistance and constant-current discharge modes in order to compare the performance against the manufacturer's claims and for comparison with our SWNT air cathode-based zinc-air laboratory cells. The claimed parameters published in Duracell Zn-air Technical bulletin and experimentally obtained data gave very similar values;
- The reusable Zn-air electrochemical cell that allows loading/reloading of the active electrode components was designed and manufactured in Physics Machine Shop;
- After extensive literature search, the necessary electrolyte, Zn-anode, air distribution membrane, and separator components for the Zn-air battery assembly were selected and procured.

2nd Quarter

- The initial Zn-air battery discharge tests using a 120 nm SWNT film/PTFE membrane air cathode in conjunction with the Zn/alkaline gel electrolyte paste separated by cellulose membrane, demonstrated a poor cell performance. A fast and abrupt voltage drop was observed within first 40 min of discharge. One of the possible reasons for such cell behavior is a H_2 evolution inside the zinc/gel paste pumping electrolyte through the air holes and thus, blocking the excess of air to SWNT cathode;
- A series of modifications was made to the cell to overcome the problem described above: the gas outlet was incorporated into the cell, a 600 nm thick SWNT film was used as air cathode, the Celgard membrane separator was utilized to insure zero shrinkage and prevent electrode shortage. The cell showed an increased open circuit voltage but a rapid voltage drop presumably due to the vigorous hydrogen evolution. The use of a new Zn-gel paste formulation was required to suppress gas formation in the cell.

3rd Quarter

- Since a non-ionic surfactant Triton-X100 is known to be effective in H_2 evolution suppression in alkaline electrolytes, the gel electrolytes containing different concentrations of Tritone-X100 were tested to find an optimal electrolyte formulation;
- The zinc-air cells using the new gel system containing optimal additive concentration were tested under constant current discharge load. Although Triton-X addition to the gel electrolyte slightly decreases the discharge voltage of the cell, the cells demonstrated much longer discharge time (> 70 h);
- To increase cell average voltage and thus, energy, decrease internal battery resistance thin Ni strips onto air-cathode via sputtering using metal shadow mask. Initial tests of the Zn/air cell showed an increase of the average discharge voltage but shorter discharge time;
- The SWNT film preparation procedure was modified to get rid of a residual amount of sulfuric acid which is a source of protons that can be converted to hydrogen. The Zn-air cell with the carefully washed SWNT air cathode demonstrated a higher discharge voltage compared to that of the previously tested cells.

4th Quarter

To increase oxygen access to the air cathode and prevent cathode flooding with electrolyte, the studies focused on increasing the electrode porosity and hydrophobicity were performed.

- Different carbon materials: a) MWNTs (3-10 walls, length 1-10 µm, NanoCyl SA, Belgium); b) carbon nanofibers (CNFs, fiber diameter 100 nm, length 100-200 µm, highly graphitized, from Pyrograf Products Inc.), and c) graphitic nanoparticles (highly graphitized, 400 nm, from Nanoamor

Inc.) were incorporated into SWNT films. Preliminary discharge tests showed superior performance (the highest discharge voltage and long discharge time) of the cells using pure SWNT air-cathodes. Although the discharge voltage of the MWNT:SWNT based battery was the lowest one (~0.62 V), the battery demonstrated more than 105 h of discharge compared to ~ 75 h of the SWNT based cell. It is premature to explain this behavior after first tests.

- To decrease the resistance of the SWNT cathode, the Ni metal meshes with different size openings (calendered and non-calendered) similar to that used in commercial zinc-air batteries were sampled to us by the manufacturer (Dexmet). The first tests of the zinc-air batteries, using these Ni mesh/SWNT electrodes, gave poor performance. Post-mortem film examination showed that the SWNT films partially delaminated from the nickel mesh.

To improve SWNT cathode-based zinc-air cell performance, more studies focused on increasing the electrode porosity and hydrophobicity, modifications of the anode/electrolyte system, and decreasing cell resistance, are necessary in future.

<u>Budget Expenditures</u>

Final cash funds from nRadiance, LLC	\$41,000
Cash funds from FESC (personnel & tuition)	\$41,000
Total funds spent:	\$82,000

The Education program has three focus areas, community college programming at the Associate of Science and certificate level, nuclear energy education, and a Masters degree in sustainable energy.

The Community Colleges offer an opportunity to develop a trained energy workforce through programming for both technician level 2 year students, as well as students planning on completing a Bachelors degree.

FESC works closely with the Florida Community College system as well as with the Florida Advanced Technological Education Center (FLATE), which coordinates the design of industry specific training programs for technicians at the community colleges in Florida. FESC disseminates energy curricula in cooperation with FLATE.

On the Collegiate Level, programming includes curriculum directed at the workforce for the nuclear industry, which now operates five nuclear power plants (FPL and PEF).

University of Florida Nuclear Training Reactor (UFTR) Digital Control System Upgrade for Education and Training of Engineers and Operators, By Dr. Kelly A. Jordan, Director UFTR

Background

The UFTR is being upgraded to a fully digital control system. This makes the UFTR the first operating nuclear power plant in the United States that uses a fully digital control system. This facility will provide for the training and education of the necessary workforce in the area of digital control and instrumentation for nuclear reactors. The UFTR facility will offer training courses for community colleges (Central Florida, Indian River, and Jacksonville) in the State of Florida, personnel from nuclear utilities and government agencies including the Nuclear Regulatory Commission (NRC).

Progress

20-year NRC Relicensing of the UFTR: NRC relicensing, a prerequisite for evaluation of the Digital Controls license amendment, was expected in December 2011. The relicensing has not yet occurred, and is now expected for the end of 2012. Outstanding issues relate to a reworking of the technical specifications for the reactor, a change in the way security procedures are regulated, and analysis of effluent monitoring methodology.

In May 2012, the UFTR was awarded a $180k infrastructure grant for gaseous effluent monitoring equipment from US DOE. This money will resolve the licensing issue.

License Amendment Request (LAR) for a digital controls upgrade: In November 2011, with the advice of the UFTR Advisory board, and due to feedback from the August 2011 NRC audit, it was decided to change licensing strategy away from power reactor space to research reactor space. This means that the UFTR will no longer pursue industrial-level certifications for the equipment. The equipment will be

identical, however the level of QA testing and, for example, seismic qualification will be reduced. This is both a cost-saving measure and will streamline the licensing process with the NRC.
The NRC, up to now, has not had a formal process for licensing digital upgrades in research reactors. New draft regulation – NUREG 1537 – will be released in the next two months, which will formalize the process for approving these upgrades. The switch to a research reactor licensing strategy combined with better definition of requirements from the regulatory agency will enhance our ability to make these upgrades with confidence that they will be accepted by the NRC.
Rebaselining of project with industrial partners: In December 2011 a meeting was held between the AREVA engineering and project management team and the UFTR. This meeting was for the purpose of re-baselining the project in light of the full staff turnover at the UFTR. Negotiations are continuing with AREVA on the best plan forward, including new breakdown of responsibilities for engineering design work and costing. These discussions are ongoing, and a final plan is expected soon.

Florida Advanced Technological Education Center (FLATE), By Dr. Marilyn Barger

Background

FESC partnered with Florida Advanced Technological Education Center (FLATE) to develop statewide curriculum frameworks for technical A.S./A.A.S. degree programs supporting existing and new energy business sectors. FLATE is in the process of developing and processing through the FLUS DOE the industry-validated student competencies of the frameworks. FLATE will also develop new courses required for each new program of study. Additionally FLATE will help state and community colleges implement the new frameworks in their institutions.

Progress

The development of the process for the Florida State College System to respond to FESC's long term strategy to bring energy related technologies out of the Florida University System is well underway. FLATE has the college contacts and process in place to respond to any FESC and/or regional economic development authority request to provide assistance to a designated State College because of a technician workforce development need as identified or triggered by a new or expanding energy related company's operations in the State.

Since October 1, 2011 FLATE achieved several milestones. Together with the National Science Foundation-funded Energy Systems Technology Technicians (EST^2) project team, FLATE has been developing a new Industrial Energy Efficiency specialization for the Engineering Technology (ET) Degree and associated College Credit Certificate. Experts from industry, government and academia have been very involved in this collaborative effort and instrumental in ensuring that the new specialization is directly aligned with current industry needs. The first draft is now complete and the framework will be submitted to the Florida Department of Education in the fall of this year so colleges can implement it in the 2012-2013 academic year.

In March, a short survey was administered to gather data to ensure the new framework is comprehensive and covers all areas necessary to produce the skilled workforce needed in this area. In addition, it provided an opportunity to identify individuals interested in collaborating to work on the new curriculum framework. Occupation respondents intend to train students for included Energy Technicians, Environmental Technicians, Sustainability Planners, Smart Grid Technicians, and Energy Auditors. Generally all individuals involved in developing and implementing Energy Management Programs for their company. The vast majority of respondents were very interested in collaborating to craft the new curriculum framework.

The Industrial Energy Efficiency specialization track comes at a time when interest in reducing operating costs through energy efficiency maximization is growing significantly both in Florida and throughout the nation. The new specialization will be designed to provide the necessary training for technicians in the areas of manufacturing, industrial processing, or any other appropriate area, such as HVAC technicians or electricians, to save energy costs on the plant floor. Upon completion of the program students will be armed with the knowledge and skills necessary to implement energy efficiency strategies in industrial processes/systems, and as a result impact the bottom line.

In October 2011, Nina Stokes joined the team as Project Manager, taking over from Jorge Monreal who left to pursue his education at the University of South Florida.

Last September FLATE and FESC sponsored an energy workshop for high school and college educators at the Center for Innovation and Economic Development at Santa Fe College in Gainesville, FL. Following the success of last year's event, FLATE will be coordinating a second workshop in conjunction with the Florida Energy Summit in August.

Finally, FLATE regularly updates / presents information about energy curriculum and training issues at the statewide Florida Engineering Technology Forum that meets twice per year at various colleges across the state. Many of these schools are looking to add "energy" curriculum and/or programs and are requesting guidance on what industry is asking for across the state and what and how other colleges are implementing credit programs. The goal of these activities is to keep colleges working together and sharing curriculum rather than develop independent programs not properly aligned to statewide frameworks.

Activities for the 2011-2012 year are listed below.

- Worked on Researching and defining energy career pathways. Created and published flowchart illustrating pathways.
- Researched an identified current energy related course articulations.
- Researched and identified all High Schools, Colleges and Universities offering energy-related courses/programs, building on the "Survey of Colleges Offering Energy Programs" administered in January 2011.
- Attended 2011 Beyond Sustainability 36th Annual Conference at Hillsborough Community College, Plant City in November.
- Participated in Sustainability Education & Economic Development (SEED) Webinar- Alternative Fuel Vehicles: New Technology, Refined Workforce Programs in November 2011.
- Attended Sustainability Education & Economic Development (SEED) Webinar-Community Colleges Leading Rural-Based Green Economy Initiatives (December 2011).
- Updated FESC Web Education pages.
- Planning is underway to host a second summer energy program for under-represented middle school students and an Energy-related Professional Development Workshop for middle and high school teachers, in conjunction with the EST2 grant partners (BCC, TCC and FSCJ).
- FLATE hosted the Engineering Technology (ET) Forum in Ft. Pierce in March. (Energy Efficiency Specialization was discussed)
- Participated (remotely) in the FEWC State and National Outreach Meeting (March 2012)
- Attended Train-the-Trainer Energy Workshop at Florida State College, Jacksonville in May, to prepare for Summer Energy Camps.
- FLATE took a delegation of eight students, five faculty members and two administrators from Florida's community and state colleges on a 21 day international technician training program to

Spain. The three week program provides students with an outstanding technical and cultural learning experience. For the second year, students enrolled in the engineering technology A.S. degree program and faculty members at Hillsborough Community College, Polk State College, State College of Florida, and Brevard Community College, will participate in a structured technical education and training experience at IEFPS Usurbil GLBHI—a technical college in the Basque region of Spain.

- From previous reporting period (included in case the link needed): Completed upload onto FLATE's Wiki of course curriculum EST1830 Introduction to Alternative and Renewable Energy made up of 16 individual instructional "modules". Course content is made freely available to self-learners, students and educators. Material is available here: http://flate.pbworks.com/w/page/35326400/EST1830-Introduction-to-Alternative-Energy-Course-Content

Funds leveraged/new partnerships created: FLATE has leveraged its NSF and FESC resources to help Brevard Community College to apply for and be awarded a very competitive NSF grant, $ 500,000, implement two energy related specialization within the A.S. Engineering Technology Degree. In addition, FLATE was able to secure a $ 100,000 award from NSF to develop a faculty/student interchange that will allow Florida to benefit from the well advanced energy related technology educations practices at technology colleges in Spain.

FLATE External Collaborators: Brevard Community College; Tallahassee Community College; Daytona State College; Central Florida Community College; Polk State College; Florida State College at Jacksonville; Valencia Community College; School District Hillsborough County; Florida Department of Education – Division of Adult and Career Education; West Side Technical School; WFI Banner Center for Energy; Advanced Technology for Energy and Environment Center (ATEEC); University of West Florida, Dept. of Construction Technology; WFI Banner Center for Construction; WFI Banner Center for Clean Energy; USF College of Engineering; Madison Area Technical College ATE project for Alternative Energy certifications; Milwaukee Area Technical College Energy Conservation and Advanced Manufacturing Center (ECAM); Florida Energy Workforce Consortium (FEWC); TECO; Progress Energy; ISTEC (Ibero Science and Technology Education Consortium), Usurbil GLBHI (Spain); TKNIKA - Innovation Institute for Vocational Training (Spain); Center for Energy workforce Consortium (CEWD); UF Industrial Assessment Center; CREATE NSF Center for Alternative Energy; EST2 NSF ATE Grant project; DOE's Office of Energy Efficiency & Renewable Energy; Gulf Coast State College; Palm Beach State College; University of South Florida's College of Engineering; University of Miami; University of Alabama; Rutgers University; Energy Reduction Solution, SMC Corporation of America, Energy Conservation Group; Florida Solar Energy Consortium.

OUTREACH

FESC outreach plans leverage the existing network of UF extension offices to reach out to each of our communities. The Florida Cooperative Extension Service has experience developing and delivering educational programs and products related to energy and resource-efficient community development with emphasis on housing. These programs and products include targeted continuing education courses for licensed builders, architects, engineers, landscape architects, interior designers, and others. Also, the UF Program for Resource Efficient Communities is an interdisciplinary group that promotes the adoption of best design, construction, and management practices in new residential master planned developments.

The goal of the program is to develop educational outreach programs and materials designed to deliver practical, applicable information and knowledge on energy-related topics to the general public as well as targeted to specific audiences such as builders, planners, engineers, architects, small businesses, local governments, and utilities through the Cooperative Extension Service and others. By focusing educational programming on climate and efficient use of energy and water, the program aims to provide the knowledge needed by building and energy professionals, local governments, and the general public, to significantly reduce greenhouse gas emissions in Florida.

Outreach Team Members:

- *Dr. Pierce Jones, Director, Program for Resource Efficient Communities (PREC)*
- *Dr. Kathleen C. Ruppert*
- *Hal S. Knowles III*
- *Nicholas Taylor*
- *Dr. Barbra Larson*
- *Craig Miller*
- *Ms. M. Jennison Kipp Searcy*

The progress on the Outreach initiatives is summarized below:

Assistantships

Assistantships funded directly for students working on research projects contributing to promotion of resource efficient design, construction and management of master planned communities: Sarah Dwyer (MS): Use of metered utility data for evaluating residential energy-efficiency program performance; Flavio Hazan (PhD): Developing land planning GIS tools to account for resource consumption and greenhouse gas emissions; Hal Knowles (PhD): Developing internet-based social marketing tools to improve household energy management and applying fractal geometry-based nonlinear time-series analytical methods to diagnose the health of a home and its occupants as a unified system.

External collaborators
Gainesville Regional Utilities (GRU), Clay Electric, Jacksonville Electric Authority (JEA), Orlando Utilities Commission (OUC), Kissimmee Utility Authority (KUA), Osceola County (Osceola Energy Initiative), Florida Progress Energy, City of Tallahassee, University of Central Florida (Florida Solar Energy Center), University of Nebraska, Tampa Bay Water, UF/IFAS County Extension Offices, American Water Works Association (AWWA), River Network, Alliance for Water Efficiency, Florida Section of the AWWA, American Council for an Energy Efficient Economy (ACEEE), St. Johns River Water Management District (SJRWMD), Southwest Regional Planning Council, Florida State University, University of South Florida, Florida A&M University, Florida Atlantic University, Canin Associates, Inc., Indian River State College, etc.

Energy/Climate Awareness Fact Sheets
Revised four fact sheets in the Energy Efficient Homes series that were made available during this reporting period: *Introduction to LED Lighting*; *The Duct System*; *Landscaping*; *Water Heaters*. Two new publications are in development.

Energy Extension Service

- Accepted State Coordinator role for the Sustainable Floridians program with the responsibility to assist county faculty in their training and inspiring of consumers and/or volunteers regarding the significance of sustainability; the value of lifestyle choices and their impact on the environment; and the challenge to share the responsibility for protecting Earth's limited resources. The course continued in Leon, Marion, and Pinellas counties with Lee, Monroe, Osceola, and Sarasota counties expressing an interest in offering the program later this year. Module topics include: *The Case for Change; Principles of Sustainability; Energy; Water; Transportation and Land Use;* and *Leadership and Community*. Development of new modules on such topics as *Food Systems* and *Climate Variability* is being discussed.
- Promoted SAVE (Steps in Achieving Viable Energy) educational materials, designed for youth ages 11 to 13, which explore the different forms, sources and uses of energy, and the effects of our energy use. The curriculum materials include a teacher guide, club leader guide, and youth guide and are available online at http://florida4h.org/projects/SAVE.shtml.
- Conducted twelve invited presentations at the state/regional/local level to groups including the Urban Forestry Institute, Envision Alachua (Plum Creek), Volusia County Commissioners, and the St Johns River Water Management District. Also to UF classes in Architecture, Building Construction, Soil and Water Science and Law.
- Updated and made available for purchase the book *Energy Efficient Building Construction in Florida* to be current with Florida's revised building code.
- Working with a Marion County Extension Agent to produce an online training course on green building certifications, which is expected to be available in summer 2012.
- Conducted nine *Save Money on Your Electric Bill* homeowner education seminars for 45 participants in Osceola County.

Demand Side Management
Retrofit and DSM program analysis: contracted with the Utilities Commission of New Smyrna Beach; Analyzed program impact of weatherization for low income families by local non-profit Community Weatherization Coalition; Working with UF Shimberg Center and Alachua County Housing Authority to analyze impact of water heater retrofits in subsidized housing; FL DCA WAP analysis: working with utilities and municipalities across the state to gather data.

Analysis of impact of Florida HERS (article in review): Residential green building program analysis and consultation for Austin Energy under contract; Working with JEA to analyze residential energy audit program; Working with Alachua County to develop a residential green building designation.

Worked with OUC and Accelerated Data Works to create a website (http://ouc.toolsfortenants.com/) that provides multi-family housing *Tools for Tenants* to save energy, and thus money, through comparative feedback and conservation advice. The tool is based upon work supported in part by GRU, the City of Gainesville, OUC, the US DOE (via both SBIR and ARRA funding), and the Florida Department of Agriculture and Consumer Services Office of Energy (under grant agreement number ARS 134). This tool serves as a complement to a multi-family housing energy-efficient building improvement and performance analysis project backed by $429,000 in grant funded OUC rebate incentives for five apartment complex owners.

Continued work on the OEI Energy Efficiency Finance Program (EEFP) including the procurement of a financial consultant to assist with the solicitation and contract negotiation of a single local financial institution to leverage $100,000 in grant-funded credit enhancement and to partner with UF/PREC on the design and implementation of the residential sector loan program. The OEI EEFP will include unique integration of UF/IFAS Cooperative Extension capacities including the following:

- Prescreening/performance M&V via Community Baselines© (Dr. Pierce Jones, Mr. Nick Taylor, Ms. Jennison Kipp)
- Contractor networking & building science technical training via *Energy Efficient Building Construction in Florida* (EEBCF) program (Mr. Craig Miller)
- Financial literacy outreach via *Florida Master Money Mentor* (FMMM) program (Dr. Michael Gutter)
- Lifestyle management and empowerment via *Home Flow* program (Dr. Randy Cantrell)

Taylor, Nicholas W.; Pierce H. Jones; M. Jennison Kipp; Craig R. Miller worked on publication *Evaluating Ten Years of Energy Performance of HERS-Rated Homes* to submit to *Buildings and Energy*.

Jones, P.; N. Taylor; and J. Kipp (accepted), April 2, 2012 titled *Housing Stock Characterization Study: An Innovative Approach to Measuring Retrofit Impact* submitted to Building America, Building Technologies Program, Office of Energy Efficiency and Renewable Energy, U.S. Department of Energy.

Continuing Education:

- A 6-hour, CEU approved, *Greenhouse Gas Reductions and Energy Conservation* (GhGREC) employee and citizen educational workshop was delivered to 19 participants on December 02, 2011 from 9:00 am to 4:00 pm. This GhGREC workshop included local government staff from the City of Kissimmee, the City of St. Cloud, and Osceola County.

- Conducted three *Remodel Green* contractor training CEU programs for Pinellas and Sarasota County Block Grant Programs for 31 licensed contractors.
- The *Conserving Biodiversity in Subdivision Development* four-webinar series is now available online for CEU's for Board of Landscape Architecture, Board of Architects and Interior Designers, and the American Institute of Certified Planners.
- The following *Green Advantage* or *Energy Efficient Construction/Retrofitting* CEU programs have been scheduled for delivery prior to August 31, 2012:
    - June 14, Pinellas County
    - June 27, Osceola County
    - July 20, Sarasota County
    - July 24/25, Broward County
    - August 7/8, Escambia County
    - August 9/10, Liberty County
    - August 14/15, Osceola County
    - August 16/17, Pinellas County
    - August 23/25, St. Johns County

Workforce Development:

- Continued working on the US DOE (Weatherization Assistance Program Training Center) grant including Development of the Certification Training and comprehensive review of same. Corresponding training-the-trainer materials were also reviewed. Test questions were developed and prerequisites are being established with Workforce Florida and various Technical/Vocational Training Centers for student recruitment. Pilot test of the materials was conducted.
- The basic weatherization course that was developed for in-person training is being developed as an online training opportunity that will be available in summer/fall 2012.
- Developed training materials for commercial energy analysis (including commercial lighting, plug loads, and motors) for a curriculum being developed with the University of Nebraska to train commercial energy auditors. The training will be able to be used in Florida in the future. Also, developing part of the training as a series of online modules.
- Twelve (12) students successfully completed a 4-week (120-hour) *Weatherization Fundamentals/Technical and Intermediate/Technical* training for OEI. These students have been paired with an OEI participating licensed contractor to gain field experience through a 12-week job-site apprenticeship stage of the training program. They are being assessed weekly by the instructor in consultation with the contractor. Preliminary feedback indicates that <u>all</u> the students are performing above expectations. A second group of students (20-25) will begin the training starting May 29 – June 22, 2012 and will complete the training by August 31, 2012. Several "post training" evaluations meetings have been held and adjustments made to the training schedule based in part by student evaluations/feedback as well as instructor input.
- Presented *Cost-Effective Weatherization in Hot Humid Climates* at the National Weatherization Training Conference in New Orleans, LA.

Collaboration on New Initiatives:

- With Florida State University's Institute for Energy Systems, submitted a grant proposal to EDA and USDA titled *Florida Rural Regions Job Accelerator* to train farm energy auditors.
- With Evident Energy, submitted proposals to the Energy Trust of Oregon and to the Ontario Power Authority to perform energy-efficiency measurement and verification services.

- Worked on development of a proposal in response to an RFP from the Vermont Department of Public Service Planning and Energy Resources Division entitled "Evaluation of Energy Efficiency Programs and Market Research in Vermont's Single Family Existing Buildings Market." PREC would be a project partner and would provide measurement and verification services related to the Home Performance with Energy Star in Vermont.
- Collaborating with UF's College of Design, Construction, and Planning to seek funding for development of computer-based tools to demonstrate energy and water impacts of planning scenarios.
- Collaborated with the College of Design, Construction and Planning and Plum Creek in offering the Practicum in Sustainability and the Built Environment (DCP 4941) six-hour credit course for undergraduate students during Fall 2011 term. The end result was a report (*From Food to Community: A Systems Perspective for Urban Development*) on the energy, water, and material resource considerations of how residents might optimally eat, move, dwell, and commune within the 23,000 acre Plum Creek parcel under evaluation for development in Eastern Alachua County. Also, as a result of offering the course, one of the students received a summer 2012 internship in the area of sustainability with the Pinellas County Extension Service Office in Largo.
- Collaborated with private and public sector leaders on the Alachua Clean Energy (ACE) effort to catalyze a local energy finance framework for energy-efficient building improvements and renewable energy implementation in the residential and commercial sectors.

FESC Web Site (www.FloridaEnergy.ufl.edu) continues to be an important communication tool for our program. It is updated regularly to remain current and to better serve our users. FESC distributes electronic newsletters by email and available on the FESC web site. Based on a Google Analytics report, the FESC web site was viewed by 8,577 (77.25% new visitor and 22.75% returning visitor) Google visitors during the period Nov 1, 2011 to May 1, 2012. The viewers visited 21,145 pages. Viewers were from various countries, including US, India, China, Germany, Turkey, Hungary, Mexico, France, and Brazil.