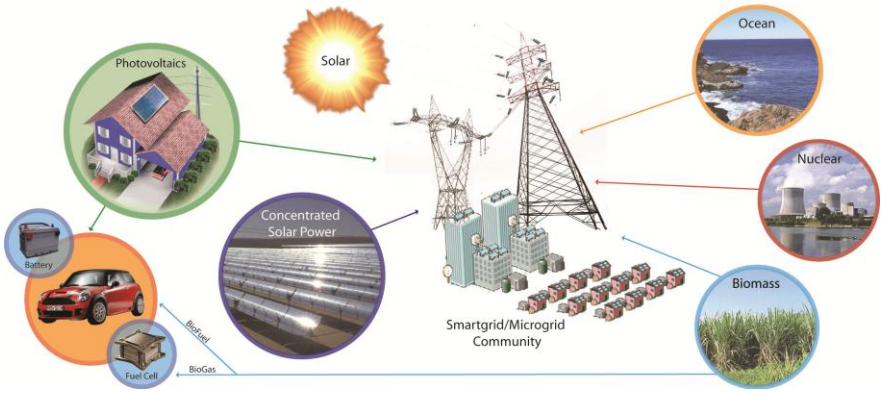
FESC
Florida Energy Systems Consortium

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

May 2013

Reporting Period: Oct 1, 2012 – April 15, 2013



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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. FESC administrative office is 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 have developed over 700 faculty/industry contacts. This comprehensive network enables and facilitates the transfer of FESC technologies quickly for maximum benefit to Florida's economy. FESC coordinated research teams to develop and submit a significant number of joint proposals. FESC continues to contribute to energy education and outreach programs, and in communication with the State Office of Energy for the planning of the joint Florida Energy Summit. FESC office is working with the FESC Steering Committee (SC) members in collaboration with the State Office of Energy to define top five projects in energy area that are strategically critical for Florida's energy security.

FESC technology transfer program includes business plan/market research development (Phase I) and industry matched funding of early stage development (Phase II). 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 research into new technology companies or to license into existing firms.

FESC continues to contribute to energy education and outreach programs. Notably, FESC Workforce education team FLATE, has developed a new Industrial Energy Efficiency specialization for the Engineering Technology (ET) Degree and associated College Credit Certificate in collaboration with the National Science Foundation-funded Energy Systems Technology Technicians (EST²) project team. The progress report is given in the "Education" section of this report (p. 24). Our Outreach team developed the Sustainable Floridians^{SM} Program. The program details are given in the "Outreach" section of this report (p. 29).

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 9,690 (78.33% new visitor and 21.67% returning visitor) Google visitors during the period Oct 1, 2012 to April 15, 2013. The viewers visited 24,146 pages. Viewers were from various countries, including US, Canada, India, China, all European countries, Middle East, Russia, South America, Australia, and countries in Africa. In addition, FESC prepares and distributes electronic newsletters every other month to over 700 FESC industry/faculty contacts. The newsletters are posted at FESC web site.

FESC has a new interim director now. Dr. Tim Anderson, FESC Director, has joined the University of Massachusetts as Dean of College of Engineering effective March 1, 2013. Dr. Jennifer Curtis, Associate Dean for Research, College of Engineering, Distinguished Professor of Chemical Engineering, is now serving as the interim chair of FESC.

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.

Research Highlights: The majority of the initial FESC funding was dedicated to seeding energy research at five of the FESC universities. Most of the FESC research funds were spent and ~80% of the projects have been completed. The Principal Investigators of the remaining 22 FESC-funded research projects continue to make considerable progress on their research. Detailed final reports for all the completed projects were provided in FESC Nov 2012 report. There are a few completed projects during this reporting period. The final reports of the completed projects and the progress reports for continuing projects are compiled in a separate document ("Project Progress Reports") and provided as an attachment to this report. A brief description of each completed and continuing research project is provided in Appendix A of this report. The projects are also posted at the FESC website http://www.floridaenergy.ufl.edu/.

In marine energy area, FAU is working towards getting a lease for testing ocean current equipment. Currently, an Environmental Assessment being conducted by the US Department of Interior's Bureau of Ocean Energy Management (BOEM) is the schedule-driver for SNMREC testing turbines and turbine systems offshore in the Atlantic Ocean. The environmental assessment considers the effects of issuing a lease for testing equipment for public review and input, and is in its final stages of review by cooperating federal agencies. This is the first lease application that the BOEM has received for testing ocean current equipment and if approved would last five years. The SNMREC facility will be the only ocean current testing location in the world. The SNMREC is also preparing a "case study" about the Regulatory Process for Marine and Hydrokinetic (MHK) on the Outer Continental Shelf (OCS), to provide guidance for future applicants based on its experiences.

During this reporting period, FESC distributed over 50 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. 10). 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, arranging telecons, and assisting with cost share development, budgets, and boiler plates. The FESC office as well as its faculty has reached out to over 100 industry partners for collaborative proposals, providing assistance, and facilitation. Some examples of this are given in the Industrial Collaboration section of this report (p. 13).

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 KSC, Economic Development Agencies, companies from Israel to discuss potential FESC collaboration on their energy programs.

Technology Commercialization and Industrial Collaboration: The results of FESC funded research generated both additional external funded research as well as innovations leading to commercialization. FESC technology transfer program includes business plan/market research development (Phase I) and industry matched funding of early stage development (Phase II). To date FESC has funded 5 Phase II projects of which four are complete. The completed projects are the joint UCF-Harris Corp. "wave energy" project, joint UF-nRadiance LLC "fuel cell" project, joint FSU-Hunter Hunter Harp Holdings "solar concentrator project, and joint UF- Planar Energy Devices "Li-Ion battery" project. The active Phase II project is joint UF-Sestar Technologies "Polymer Solar Cells" project led by Dr. Franky So. The project progress report is given in the "Industrial Collaboration and Technology Commercialization" section of this report (p. 18).

Twenty three (23) companies have been formed over the last three years. The technology of these companies is university developed in areas that include solar fuels, concentrated solar, energy efficient optoelectronic devices, fuel cells, coating for battery/fuel cell, efficient light emitters, energy efficiency, bioenergy, and chemicals from biomass, nanoparticle thin film PV, waste to energy, and H_2 sensor.

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 and user facilities at Florida universities, FIT and the NASA Kennedy Space center. Both catalogs are posted at: http://www.flcleantech.com/our-services/ip-catalog. FESC works with the Technology Transfer directors at each University, FL CAN Market Research team, and the mentor networks to assist with technology commercialization. FL CAN team reached over 20 companies during this reporting period.

The Consortium continues to establish close connections with Florida's energy industry. In particular, FESC facilitates interactions between Florida's energy industry and the FESC faculty. This often results in the submission of proposals for research interactions. FESC is currently in communication with over 100 companies to provide technical assistance. To facilitate the faculty-industry interaction, FESC administrative office has posted FESC industry database at the FESC website: http://www.floridaenergy.ufl.edu/?page_id=11727. The site is updated regularly and new industry partners are added to the site and the FESC industry database.

Education and Outreach: 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. The progress reports on education and outreach programs are given in this report (p. 24 and 29).

Conferences:

Energy Summit: The FESC Summit will be combined with the Florida Energy Summit again this year. It is scheduled to be on October 14-15, 2013 at the Rosen Shingle Creek, Orlando, Florida. FESC office will assist the Florida Energy Office in agenda preparation, finding speakers, and poster session.

SEC Conference: The inaugural SEC Symposium, entitled the Impact of the Southeast in the World's Renewable Energy Future, was held in Atlanta GA on Feb 10-12, 2013. Since this was only for the SEC universities, the only FESC university participant was the University of Florida (UF). The UF's Provost Dr. Glover provided $60,000 funding to FESC and asked us to coordinate the attendance of UF faculty, graduate, and undergraduate students to the SEC Symposium. Posters were collected from the faculty and graduate students who were interested in participating. 8 faculty/post doc, 27 graduate students, and 25 undergraduate students (selected out of 32 undergraduate student applicants) from UF participated in the symposium. FESC office prepared a UF booth to represent the energy technologies at the University of

Florida. Robert Mueller, Graduate Student, Dept. of Chemical Engineering (Dr. Sergey Vasenkov's student) received the 1st Place in "Excellence in Poster Presentation" award. His poster title was "Combined Application of Proton and Carbon-13 Pulsed Field Gradient NMR for Studies of Gas Diffusion in Carbon Molecular Sieve Membranes". In addition, UF received an award for the highest number of undergraduate student attendance. The list of attendees and symposium photos can be seen at http://www.floridaenergy.ufl.edu/?page_id=14260. The SEC symposium presentations are listed at: http://www.secsymposium.com/presentations.php.

Sustaining Economies and Natural Resources in a Changing World: Key Role of Land Grant Universities: This conference was organized by the Florida Climate Institute and had an energy session. Dr. Sam Baldwin, Chief Science Officer at the Office of Energy Efficiency and Renewable Energy (EERE), US DOE, and Dr. Brent Shanks, Professor and Director, Iowa State University were the plenary speakers at the energy session. Dr. Jennifer Curtis, FESC Interim Director, moderated the Energy Panel. The panel members were Patrick Sheehan, Executive Director, Office of Energy, FDACS; Buck Martinez, Sr. Director of Office of Clean Energy, FPL; Gary Peter, Professor, UF/IFAS; Sam Baldwin, Chief Science Officer, EERE.

RESEARCH PROGRAM

The FESC research program included 84 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 FESC projects (11 projects) and also the ones completed during this reporting period (11 projects). The project progress reports and final reports for 22 projects are provided as an attachment to this report.

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. 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. This is being updated as we add new projects.

Table 1: Active FESC Projects and FESC Projects Completed During This Reporting Period

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 **Status: Completed. Final report submitted**
THRUST 2: Enhancing Energy Efficiency and Conservation	
	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. **Status: Completed. Final report submitted**
	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) **Status: Active**
THRUST 3: Developing Florida's Biomass Resources	
Thermo-Chemical Conversion	
	Title: Feasibility, Sustainability and Economic Analysis of Solar Assisted Biomass Conversion **PI:** Babu Joseph, **Co-PI:** Q. Zhang - USF **Budget:** $45,238 **Status: Completed. Final report submitted**

Algae	
	Title: Sustainable Algal Biofuel Production **PI:** Sarina J. Ergas Co-PI: Qiong Zhang, James R. Mihelcic, John Wolan (deceased) **Budget:** $50,000 **Universities:** USF **External Collaborators:** Mote Marine Laboratories **Status: Completed. Final report submitted**
THRUST 4: Harnessing Florida's Solar Resources	
Solar Thermal	
	Title: Development of Novel Water Splitting Catalysts for the Production of Renewable Hydrogen **PI:** Helena Hagelin-Weaver - UF **Budget:** $ 100,000 **Status: Active**
	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. **Status: Active**
Clean Drinking Water	
	Title: Fresh Water Using low Grade Heat and Alternative Energy (Formerly titled as "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 **Status: Completed. Final report submitted**
Low Cost PV Manufacturing	
	Title: Development of Low Cost CIGS Thin Film Hot Carrier Solar Cells **PIs:** Gijs Bosman, **Co-PI:** Tim Anderson - UF **Budget:** $450,000 **Status: Active**
	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 **Status: Active**
	Title: Chloride Chemical Vapor Deposition of $Cu(In,Ga)(Se,S)_2$ **PI:** Timothy J. Anderson **Student:** Christopher P. Muzzillo (Ph.D.) **External Collaborators:** Rommel Noufi (National Renewable Energy Laboratory), Bill Shafarman, University of Delaware **Status: Active**
Advanced PV Device Program	
	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 **Status: Completed. Final report submitted**
Smart Windows	
	Title: Development of a Smart Window for Green Buildings in Florida **PI:** Dr. Sarath Witanachchi **Students:** Mr. Mark Merlak, Ph.D. student **University:** USF **Status: Completed. Final report submitted**
THRUST 5: Carbon Constrained Technologies for Electric Power in Florida	
	Title: Database Infrastructure for Integrative Carbon Science Research **PI:** Sabine Grunwald. **Co-PI:** Tim Martin - UF **Budget:** $199,440 **Status: Active**
	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. **Status: Completed. Final report submitted**
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. **Status: Active**
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 **Status: Completed. Final report submitted**
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). **Status: Active**
	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. **Status: Completed. Final report submitted in Nov 2012.**
	Title: UFTR Digital Control System Upgrade for Education and Training of Engineers and Operators **PI:** Kelly Jourdan – UF (PI used to be Alireza Haghighat; he has left UF) **Budget:** $308,000 (extension with $45,000 Budget to complete the project) **External Collaborators:** Several engineers from AREVA NP Inc & Siemens Corporation **Status: Active**
FESC Phase 2 Technology Commercialization	
	Title: Development of high efficiency polymer solar cells **PI:** Franky So – UF **Industry Partner:** SestarTechnologies, LLC **Status: Active**
Other	
	Title: Development of a Highly Efficient Photocatalyst for CO2 Reduction with H2O by Hybrid Construction of Transparent, Conductive Composite (TCC) and nano-Sized MOX/INVO4/AL2O3 Particles **PI:** Norma Alcantar, John Wolan (deceased) **Universities:** Department of Chemical and Biomedical Engineering, USF **External Collaborators:** Mote Marine Laboratories **Status: Completed. Final report submitted**

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 50 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, arranging telecons, providing support letters, and finding ways to meet the cost share requirements.

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:

13-C-AJFE - Center of Excellence for Alternative Jet Fuels and Environment: Assisted in getting industry support letters. Provided FESC support letter.

BAA-13-0004 - Environmental Security Technology Certification Program (ESTCP): Communicated with the funding agency to provide information to the PI.

DE-FOA-0000793 - Vehicle technologies program: A UF led proposal was submitted in collaboration with a local energy storage company.

DE-FOA-0000798 - Advanced Technologies for Monitoring CO_2 in Geologic Storage and Utilization Operations: A USF led team submitted a proposal.

DE-FOA-0000811 - Advancements in Algal Biomass Yield (ABY): Formed team with industry partner

DE-FOA-0000812: Carbon, hydrogen, and separation efficiencies in bio-oil conversion pathways: USF team participated in a NREL led proposal effort.

DE-FOA-0000816 - Marine and Hydrokinetic (MHK) Environmental Effects Assessment and Monitoring: Introduced the PI to industry contact.

DE-FOA-0000829 - Better Buildings and Commercial Energy Efficiency Solutions: Assisted with the team formation and cost share support.

DE-FOA-0000848 - Marine and hydrokinetic system performance advancement: Introduced the industry partner to FESC faculty.

DE-FOA-0000856 - Grid Engineering for Accelerated Renewable Energy Deployment (GEARED): Introduced the teams to utility contacts and other faculty for team formation. UF faculty collaborated with FSEC/UCF faculty. Several utility partners were involved.

DE-FOA-0000864 - Novel Harsh Environment Sensing Concepts: Helped with team formation.

DE-FOA-0000865 - Solar Utility Networks: Replicable Innovations in Solar Energy (SUNRISE): Assisted with industry contact introductions, cost share, and provided a support letter.

DE-FOA-0000882 - Modern Electro/Thermochemical Advances in Light- Metal Systems (METALS): Assisted in finding industry partners.

AGDF Natural Gas Call: Worked with the funding agency to develop the call and distributed the call to the FESC faculty. Worked with the faculty and agency to answer questions.

NSF 13-545 - Scalable Nanomanufacturing (SNM): Introduced faculty to energy education partners.

NSF PD 14-7644 - Energy for Sustainability: Working on team formation.

SBIR/STTR (N13A-T007 and A13A-T006): Provided support letters to the industry partner.

FL State Bioenergy Program: Assisted with team formation, support letters and introducing industry contacts to faculty. Several teams were formed and proposals were submitted.

USAID ProParque Project, UF/IFAS: Communicated with the project manager and discussed how FESC can be helpful. Introduced UF EDGE online program for energy education opportunities and several industry contacts that they can benefit from their products. Also introduced a faculty member who can help with their solar project.

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.

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.

Progress Made During the Reporting Period

FESC Phase II Projects

There is only one active project as listed in the table below. The project progress report is given at the end of this section (p. 18).

University	Title	PI	Company
UF	Development of High Efficiency Polymer Solar Cells	Franky So/ John Reynolds	Mike Starks, CEO, Sestar Technologies, LLC.

The completed projects and their completion dates are given in the table below:

University	Title	PI	Company	Completion Date
FSU	Deployment of a Low Cost Concentrating Solar Energy Systems Using Solar Sausages	David Van Winkle	Hunter Harp Holdings, LLC	5/1/2012
UCF	UCF and Harris Corp Joint Wave Energy Projects	Zhihua Qu	Harris Corp.	11/1/2011
UF	SWNT Based Air Cathodes for FC and Metal Air Batteries	Andrew Rinzler	nRadiance LLC, portfolio company of Nanoholdings LLC	12/31/11
UF	Stress Evolution in Solid-State Li-ion Battery Materials	Kevin Jones	Planar Energy Devices Corp.	5/1/2012

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 was given in our Nov 2012 report: http://www.floridaenergy.ufl.edu/wp-content/uploads/Nov_2012-FESC-Annual-Report-Appendix-Section.pdf . 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 was provided in our Nov 2012 report. 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

Companies Contacted and/or Assisted by FESC and FL CAN Team include:

Green Liquid and Gas Technologies (Gainesville, FL) - Located at the UF Innovation Hub. Designed a Pyrolizer that converts solid plastic waste to energy using advanced thermal technology. Made the top 4 in Cade Prize competition. Introduced them to FL CAN mentoring team.

Culturing Solutions, Inc. (Tampa, FL) - Algae technology with Phyta-Platform tubular Photobioreactor. Their system has the capability to dissolve carbon dioxide from industrial flue gasses and feeds directly into growing media for use in the Phyta-Platform or Phyta-Pond Photobioreactors for enhanced cultivation of algae. Introduced the industry partner to Dr. Ed Phlips, and Dr. Pratap Pullammanappallil, UF for collaborative proposal development.

Planet Green Solutions (Fairfield, Florida) - Their thermo-chemical reactor technology, which in the presence of heat and limited oxygen, effectively breaks down any carbon based feedstock into mainly carbon and the combustible gases carbon-monoxide and hydrogen. The hydrogen synthesis gas can be used to fuel an internal combustion genset to produce electricity and it can be used to make heat. Dr. Jacob Chung collaborated with this company for proposal development.

Ceres, Energy Crop Co. (Thousand Oaks, CA)- Ceres develops & markets low-carbon, non-food grasses for advanced biofuels and biopower. They don't have a local FL office; however have an agronomy/research program with the University of Florida in Citra. In communication with company to further assist.

Citrus Energy, LLC (Boca Raton, FL) - Implements commercially viable process which transforms agricultural waste stream into locally produced, clean, affordable biofuel together with high value co-products. Introduced faculty to industry for potential collaboration.

Safrema (Lakewood Ranch, FL) - Focus is to develop small commercial hydroelectric generating stations. Need funding to build their 1st prototype. Introduced them to FAU faculty Sue Skemp and Howard Hanson for collaborative proposal effort and also FL CAN mentoring team for introduction to VC companies.

Power Support Engineering, Inc. (Lutz, FL) - In business in Florida since 1994. Added a new company, Accent Monitoring Group, LLC, also based in Florida, that started last year and is now set up as National Manufacturer's Representatives for Generex products based out of Germany. The focus of the new company is battery conditioning. Introduced them to Dr. Yoon, UF ECE faculty for collaborative research.

PWRStation (Miami, FL) - Develop standalone, portable solar PV capable of producing enough energy to feed one home. PV system can be for open yard space, tennis or basketball courts, car ports, and swimming pools to generate electricity. Introduced the consortium and explained how consortium can assist.

Okeanos Technologies, LLC (Lakewood Ranch, FL) - "Lab on a chip system" for water desalination/purification. Developing their 1st prototype. Want their manufacturing facility to be in Gainesville. Introduced them to Jamie Grooms, ICPR located at UF Innovation HUB, Dr. James Klausner, UF, and Dr. Yogi Goswami, USF faculty for collaborative research.

Nanogen Power Systems, LLC (Cocoa, Florida) - Build and sell distributed Concentrated Solar Power (CSP). Need support in the thermal storage area. Introduced the CEO to Dr. Yogi Goswami, USF.

Mud Power (Tampa, FL) - Developed modular long-term power solutions that harness energy generated in a natural process by microorganisms found in marine sediments. Customers will be able to significantly increase the length and data resolution of their deployments located near the seafloor. FLCAN TEAM has provided mentoring on customer acquisition strategies and assistance with obtaining a tech transfer license from the University of South FL. Identified an important customer – the National Buoy Center at Stennis Space Center – and is coaching the team towards a solid sales pitch deck for engagement with the Center.

Mesdi Systems (Orlando, FL). Produces ambient pressure deposition equipment. FL CAN team coached them for the Rice Business Plan Competition. Discussed a potential list of strategic customers and how to attract them.

Power Tree Corp. in partnership with Hernon Manufacturing Inc. (Sanford, FL) - An energy storage company developing a low speed flywheel energy storage system. Power Tree Corp. will be testing their system with NASA Kennedy Space Center this year. Introduced them to UF, FAU, and UCF faculty for collaborative work.

Sea-Watch Technologies (Melbourne, FL, http://www.sea-watch.net/**) -** Systems integration company providing vessel monitoring and control for the marine industry. Assistance is needed to develop a commercialization plan and accessing the Florida investor network. In addition, a beta testing/financing opportunity is needed to further develop the technology and upgrade the software. The FLCAN team is assisting with strategic partners, the commercialization plan, and capital investment strategy.

Hydromatic Technologies (Kissimmee, FL) – An energy efficient device company specializing in energy efficient heating technologies for clothes dryers and other appliances. FLCAN TEAM connected Hydromatic with the FL MEP for assistance with regards to facility layout and employee manufacturing training. Assistance is needed to help with commercialization plan rollout, access to GAP funds for beta testing, and accessing the Florida investor network.

Illuminated Electric (Melbourne, FL) – An alternative lighting company specializing in solar hybrid lighting for commercial and residential building. FLCAN TEAM has provided general business and commercialization plan assistance. Ongoing assistance is needed for marketing strategy, commercialization plan, strategic partners for development funds and beta testing.

AquaGen Inc. (Stuart, FL): Provides dynamic water treatment technology solutions for use in large-scale and sustainable applications across diverse industries. Introduced Sanjeev Jakhete, AquaGen Inc. to Dr. Eric McLamore, UF for their testing needs. The collaborative work has already begun. The FLCAN team also provided some funding to cover these costs, and will work with the company on customer development once prototype data is available.

HybridaSol (Cocoa, FL): UCF/FSEC spin off company. Faculty member was funded by FESC to develop the technology. The technology involves thermoelectric cooling integrated PV cells for a significant increase in net energy production and greatly reduced long-term cell degradation. FLCAN assisted the company in incorporating, naming and branding the company, and in registering the company for federal funding opportunities. The company was assisted with several DOE and NSF SBIR proposals, as well as an application for ARPA-E Summit's Future Energy Pitch competition.

Helicon Chemical Company LLC (Orlando, FL) - Specializes in nanoparticle coatings and additives for cleantech applications. The FLCAN team assisted the company with an NSF and DOD SBIRs, as well as market research.

NanoPhotonica (Gainesville, FL): NanoPhotonica's CEO is an experienced advanced materials ink entrepreneur who is now launching the company's second vertical market play into solar cells on flexible substrates. The FLCAN team is developing relationships with Sharp and Phillips to assist this company for strategic investment deals. In addition, the FLCAN team assigned an ex-3M/current Hisco product line manager as a mentor to assist the company in understanding the solar inks and Latin American solar markets. The team also introduced the company to two investors – Pangaea Ventures and a super angel network in Alabama.

Sigarca, Inc. (Archer, FL) – A waste to energy company. Ongoing assistance is needed for marketing strategy, commercialization plan, strategic partners for development funds and beta testing, and exploring R&D funding.

GreenPath Energy Solutions (Orlando, FL) - An energy auditing software and services firm. The company has lost sales in its auditing services and recently licensed a Pacific Northwest National Lab energy metering software – EnergyTrek from a re-seller. GreenPath intends to change their market and sales strategy from services to selling the software to commercial buildings and manufacturing facility operations managers. The FLCAN team has assisted with developing market strategy.

Advanced Turbine Technology (Fort Myers, FL) - Wind turbine channeling device for wind and water applications with patents pending. Prototype stage and inventor is looking for additional testing location and funding to develop product. Provided information regarding funding options.

Earthlinked Technologies (Lake Land, FL) - Earthlinked developed proprietary refrigerant flow controls for its EarthLinked heat pump. The controls modulate the amount of refrigerant in circulation, thus provide efficiency throughout the entire range of thermal loading of many different heat pumps. The Florida Solar Energy Center suggested that the heat pump be applied to cool PV modules. The proof of concept at FSEC was successful recovering large amounts of heat and increasing power output

Utilities – Faculty members were introduced to FPL, Duke Energy, Lakeland Energy, JEA, GRU, Southern Company, OUC, TECO contacts for collaborative proposal development.

Bing Energy International, LLC

FSU spin off company Bing Energy International, LLC received funding from the Institute for the Commercialization of Public Research. The company's fuel cell innovations will lead to power generation that is lower in cost, more efficient and cleaner for the environment, while bringing increased stability to the electric grid.

FESC Technology Commercialization Phase II Project Progress Report

Title: 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, PhD Candidates

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 μm 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.

Project Summary: Polymer bulk heterojunction solar cells based on low bandgap polymer:fullerene blends are promising for next generation low-cost photovoltaics. While these solution-processed solar cells are compatible with large-scale roll-to-roll processing, active layers used for typical laboratory-scale devices are too thin to ensure high manufacturing yields. Furthermore, due to the limited light absorption and optical interference within the thin active layer, the external quantum efficiencies (EQEs) of bulk heterojunction polymer solar cells are severely limited. In order to produce polymer solar cells with high yields, efficient solar cells with a thick active layer must be demonstrated. In this work, the performance of thick-film solar cells employing the low-bandgap polymer poly(dithienogermole-thienopyrrolodione) (PDTG-TPD) was demonstrated. Power conversion efficiencies over 8.0% were obtained for devices with an active layer thickness of 200 nm, illustrating the potential of this polymer for large-scale manufacturing. Although an average EQE > 65% was obtained for devices with active layer thicknesses > 200 nm, the cell performance could not be maintained due to a reduction in fill factor. By comparing our results for PDTG-

TPD solar cells with similar P3HT-based devices, we investigated the loss mechanisms associated with the limited device performance observed for thick-film low-bandgap polymer solar cells.

Progress Summary: Based on the demonstration of high efficiency polymer solar cells based on a low bandgap donor-acceptor copolymer with alternating dithienogermole-thienopyrrolodione (DTG-TPD) repeat units last year, we further present high efficiency inverted polymer solar cell with thicker active layers that will potentially facilitate the production yield of roll-to-roll printing process. One key factor for improving the large-scale R2R processing compatibility of polymer solar cells is the active layer thickness required to ensure high manufacturing yields in PV modules. Most high efficiency laboratory-scale devices demonstrated have an active layer with a thickness of about 100 nm which is too thin for R2R processing to ensure a pinhole-free film. Obtaining high efficiency devices with active layers thicker than 200 nm is critical for commercialization. To achieve high efficiency with an active layer thickness larger than 200nm, we fabricated the device containing a bottom transparent oxide electrode, a ZnO-PVP composite layer with UV-ozone treatment, a photo-active layer composed of PDTG-TPD and fullerene, a layer of molybdenum oxide and a top electrode—silver. In addition, the efficiency loss mechanism in the thick devices was studied in depth by the measurement of field dependent external quantum efficiency spectra and photoconductivity analysis. The work is done in collaboration with Dr. John Reynolds at Georgia Institute of Technology.

Figure 1 shows the photocurrent density–voltage (J–V) characteristics and the corresponding external quantum efficiency (EQE) spectra for inverted PDTG-TPD:$PC_{71}BM$ solar cells with 105 nm, 204 nm, and 258 nm-thick active layers. Figure 1 a shows that the short-circuit current density (Jsc) increases with increasing active layer thickness due to enhanced light absorption, with the highest Jsc of 16.1 mA cm^{-2} obtained for the device with an active layer thickness of 258 nm. The integrated current density from the EQE spectra, shown in Figure 1 b, is consistent with the measured Jsc with 5% deviation. The difference in the EQE spectra is due to optical interference effects between the incident light and light reflected from the Ag back electrode. For devices with thickness $L \geq 200$ nm, the interference effects no longer affect the photocurrent density of the device and the active layer absorbs most of the incident light below 700 nm, resulting in EQEs above 70% from 400 nm to 700 nm.

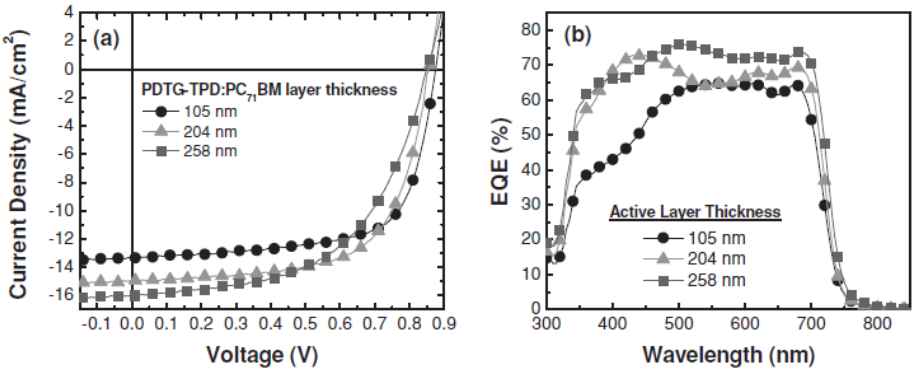

Figure 1 (a) Current density versus voltage characteristics for PDTG-TPD:PC 71 BM solar cells with 105 nm, 204 nm, and 258 nm-thick active layer. (b) Corresponding external quantum efficiency (EQE) spectra for the devices.

Table 1 summarizes the average solar cell parameters for the PDTG-TPD:$PC_{71}BM$ devices with an active

Table 1 Averaged solar cell performance for PDTG-TPD:PC 71 BM devices with various active layer thickness under initial AM 1.5G solar illumination.

Active Layer	J_{sc}	J_{sc} (EQE)	V_{oc}	FF	PCE
153 nm	13.5 +/–0.4	13.5	0.86	68.1 +/– 0.3	8.0 +/–0.2
204 nm	14.9 +/–0.3	14.7	0.86	64.5 +/–0.7	8.2 +/–0.2
258 nm	16.1 +/–0.2	16.0	0.85	54.1 +/–0.9	7.4 +/–0.1
409 nm	15.2 +/–0.1	14.9	0.82	41.6 +/–0.9	5.2 +/–0.1

layer thickness varying from 90 nm to 409 nm. The reduction in FF observed for PDTG-TPD solar cells with increasing active layer thickness is the major factor limiting the device performance. A power conversion efficiency (PCE) of 7.9% is obtained for the device with a 105 nm thick active layer, which is consistent with our previous report. The efficiency remains constant for devices with $L \leq 204$ nm, with an average PCE of 8.2% being obtained for devices with an active layer thickness of 204 nm. Above 200 nm, the FF reduction becomes significant, dropping from 69% in 105 nm film to 42% in 409 nm film.

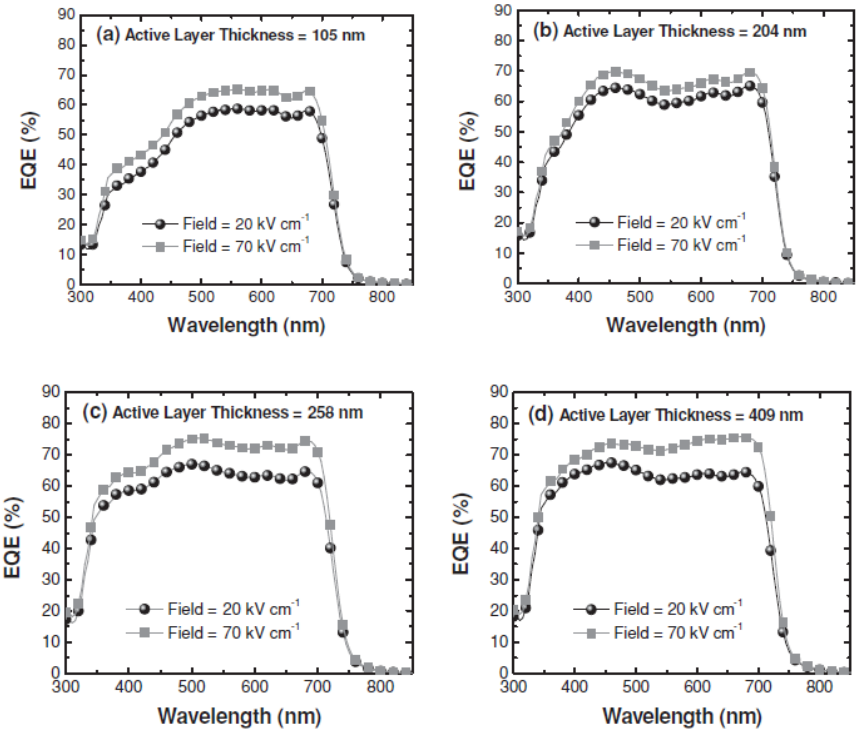

Figure 2 Field-dependent EQE spectra for PDTG-TPD:PC 71 BM solar cells with (a) 105 nm, (b) 204 nm, (c) 258 nm and (d) 409 nm-thick active layer. The EQE spectra were measured at internal electric fi eld values of 20 kV cm^{-1} and 70 kV cm^{-1}.

To determine the root cause for the reduction in FF observed in thick-film PDTG-TPD:$PC_{71}BM$ solar cells, the EQE spectra for the thin-film and thick-film devices were measured under different values of internal electric field. **Figure 2** shows the field-dependent EQE spectra for devices with 105 nm, 204 nm, 258 nm, and 409 nm-thick active layers, respectively. By measuring the EQE as a function of internal electric field (E), approximated as $E = (Voc-V)/L$, the effect of series resistance can be eliminated. For the device with an active layer thickness ≤ 204 nm, increasing the applied fi eld from 20 kV cm^{-1} to 70 kV cm^{-1} leads to a uniform enhancement in EQE across the entire spectral range. The increased applied field enhances the extraction of photogenerated charges equally across the EQE spectrum. Interestingly, for devices with $L >$ 204 nm, a stronger field dependent enhancement in EQE is observed in the spectral range from 500 to 750 nm when the applied field is increased from 20 kV cm^{-1} to 70 kV cm^{-1}. This wavelength range corresponds to the absorption spectrum for a pristine PDTG-TPD film. For devices with a thick active layer, the build-up of charges in PDTG-TPD:$PC_{71}BM$ will hinder charge collection and contribute to the FF reduction in thick solar cells.

To study the role space-charge accumulation plays in PDTGTPD: $PC_{71}BM$ solar cells with a thick active layer, we employed the SCL photocurrent model to confirm that the electrostatic space-charge limit was reached in our thick devices. We compared the results for PDTG-TPD:$PC_{71}BM$ solar cells with similar devices based on P3HT:$PC_{61}BM$, since P3HT solar cells provide a model system for studying space-charge effects. The effective photocurrent J_{ph}, normalized to the saturation photocurrent $J_{sat} = qG_{max}L$, was plotted on a double logarithmic scale against the effective voltage across the device, given by $V_{eff} = V_0 - V$. Here, V_0 is defined as the voltage where $J_{ph} = 0$ and is slightly larger than Voc. This "corrected" photocurrent analysis is a widely used tool for analyzing recombination loss processes in organic solar cells. **Figure 3a** shows the results for the PDTG-TPD:$PC_{71}BM$ solar cells with 105 nm, 258 nm and 409 nm-thick active layer. For the device with a 105 nm thick active layer, two different voltage regimes can be observed. For

V_{eff} < 0.30 V, J_{ph} steadily increases with voltage due to the competition between diffusion and drift for photo-generated carrier transport at low field. For V_{eff} > 0.30 V, the photocurrent saturates with increasing voltage. In this saturation regime, the internal field is strong enough to efficiently extract photogenerated carriers and the high field is responsible for the dissociation of *e-h* pairs. The voltage corresponding to the short circuit condition falls within the saturation regime, indicating that the high J_{sc} and FF obtained for this device is due to efficient charge collection by the internal electric field. For the device with a 105 nm active layer, space charge effects were not observed based on the data shown in Figure 3a. As the active layer thickness for PDTG-TPD cells increased above 200 nm, a square-root effective voltage dependence on J_{ph} is observed. This $J_{ph} \propto V^{1/2}$ corresponds to the onset of space-charge limited photocurrent in thick PDTG-TPD cells assuming a $J_{ph} \propto G$¾ dependence is also observed. The solid lines in Figure 3a correspond to $J_{ph} \propto V^{1/2}$. For the 409 nm-thick device, the $J_{ph} \propto V$ ½ regime extends to the short circuit condition, which correlates well with the reduction in *J*sc and FF observed in this device. These results are in contrast with those found in **Figure 3b** for P3HT:PC_{61}BM.

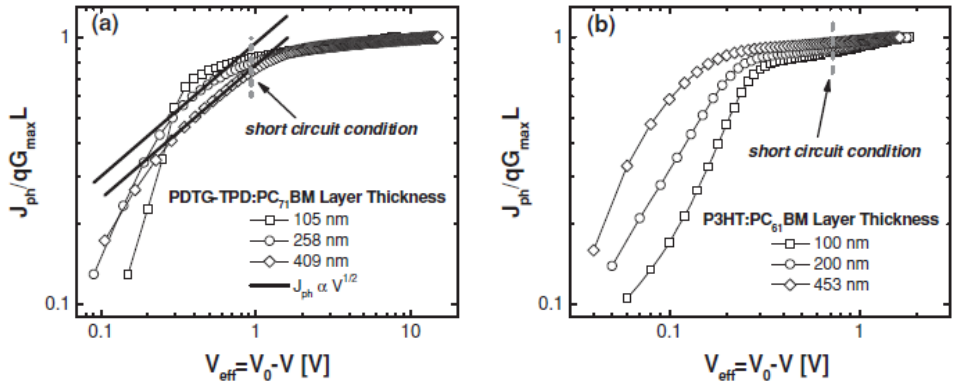

Figure 3 Effective photocurrent density (J ph) normalized by J sat = qG max L as a function of effective voltage (V_{eff}) under 100 mW cm^{-2} illumination for (a) PDTG-TPD:PC_{71}BM cells with 105 nm, 258 nm, and 409 nm-thick active layer, and (b) P3HT:PC 61 BM cells with 100 nm, 200 nm, and 453 nm-thick active layer. Dashed lines highlight the value of V_{eff} corresponding the short-circuit condition ($V_{eff} = V_0$). The solid lines correspond to $J_{ph} \propto V^{1/2}$ fits of the photocurrent in the SCL regime for PDTG-TPD solar cells.

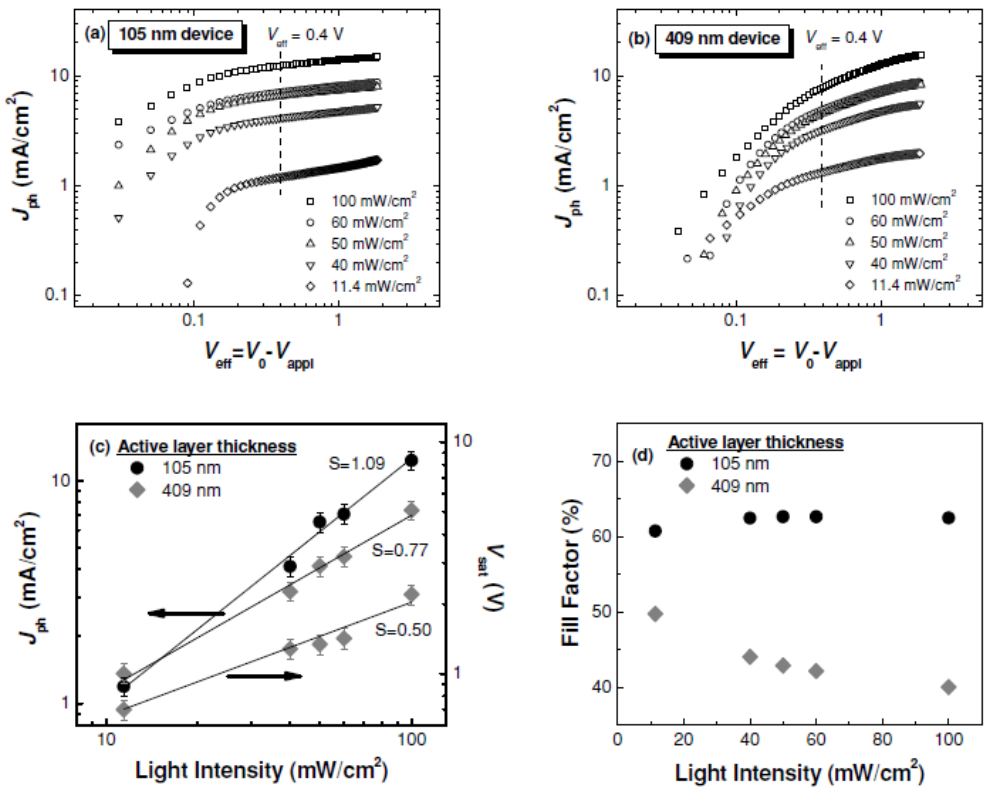

Figure 4 Light intensity dependent study for PDTG-TPD:$PC_{71}BM$ solar cells with thin and thick active layer. $J_{ph} - V_{eff}$ curves for the (a) 105 nm-thick and (b) 409 nm-thick devices under various light intensities (from 11.4 to 100 mW cm^{-2}). (c) Effective photocurrent density (*J* ph), saturation voltage (Vsat), and (d) fill factor as a function of incident light intensity for the same devices. The $J_{ph} - P_0$ curves were measured at V_{eff} = 0.4 V.

The dependence of J_{ph} and FF on incident light intensity (P_0) was plotted for the 105 nm and 409 nm-thick PDTG-TPD:$PC_{71}BM$ solar cells (see **Figure 4**). Neutral density filters were used to control the incident light intensity, which was varied from 11.4 to 100 mW cm^{-2}. The $J_{ph} - P_0$ data for the thin and thick PDTG-TPD:$PC_{71}BM$ devices, shown in Figure 4c, was extracted from the $J_{ph} - V_{eff}$ curves shown in Figures 4a and b. For the solar cell with a 105 nm-thick active layer, J_{ph} showed a linear dependence on light intensity with the slope of the linear fit tothe data equal to 1.09. In contrast, a slope of 0.77 is observed for the 409 nm-thick PDTG-TPD solar cell. The ~ 3/4 power dependence of *J* ph on the incident light intensity confirms the occurrence of SCL photocurrent in PDTG-TPD:$PC_{71}BM$ solar cells at low bias. The dependence of the saturation voltage (V_{sat}) on incident light intensity provides further evidence, in which a slope of 0.50 is extracted from the $V_{sat} - P_0$ data. To form a more clear physical picture, the light-intensity dependence of the FF was also analyzed and plotted in Figure 4d. The FF remained relatively constant with incident light intensity for the 105 nm-thick solar cell, which is expected since the device is not space-charge limited at P_0 = 100 mW cm^{-2} and the thickness is sufficiently thin to ensure efficient charge extraction. For the 409 nm-thick PDTG-TPD solar cell, a 24% enhancement in FF was observed as the incident light intensity was decreased from 100 mW cm^{-2} to 11.4 mW cm^{-2}. By lowering P_0 and, consequently, reducing the generation rate of charge carriers in the thick PDTG-TPD:PC 71 BM active layer, space-charge buildup was reduced. As a result, enhanced charge carrier collection and FF was

observed in the solar cell. Despite this enhancement, the FF of the 409 nm-thick device at low light intensity does not reach the value obtained in the 105 nm device. This result indicates that the reduced photocurrent observed for thick-film devices could not be completely recovered despite lowering the incident light intensity. There is still some degree of limited charge collection occurring in thick-film PDTG-TPD:$PC_{71}BM$ solar cells.

To conclude, the loss mechanism in thick-film PDTGTPD:$PC_{71}BM$ solar cells have been investigated. For polymer solar cells with an active layer thickness up to 200 nm, efficiencies in excess of 8.0% were obtained for devices under AM 1.5G illumination at 100 mW cm^{-2}. For L > 200 nm, the SCL photocurrent regime is reached, leading to limited charge collection efficiency in the devices due to space-charge accumulation. The onset of space-charge accumulation also coincides with reductions in FF and hence power conversion efficiency in thick devices. These results indicate that although high efficiencies can be obtained in solar cells with low-bandgap conjugated donor-acceptor polymers, the high density of photogenerated charge carriers could severely limit the performance of solar cells with a thick active layer.

Proposals Submitted

Title	Agency	PI, Co-PIs	Funding Requested	Project Time	Date Submitted
Dipole Engineering for polymer solar cells	US DOE BES	Franky So (UF) John Reynolds (Georgia Tech)	$840,000	3 years	November, 2012

EDUCATION

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).

Progress Made During the Reporting Period

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

Background

The UFTR proposes to implement the first-ever fully digital control and safety system at a nuclear reactor in the United States. This is the key piece in a full renovation of the facility, which has been in operation since 1959. This upgrade will replace the analog system with a digital control system from Siemens Energy. 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 upgrade ensures that the UFTR is on a footing to continue its research and education missions over the next decades, and will open up new revenue streams to put it on a sustainable financial path. FESC is supporting this project with a grant to help provide for critical infrastructure equipment, in this case, new reactor shutdown blade drives which will interface to the new digital system.

Progress

Blade drives are equipment that control the neutron absorber blades in the core of the reactor. By inserting and withdrawing the blades, the reactor can be shut down or the power level changed. As part of both the digital control project and the general modernization of the UFTR, the reactor blade drives will be replaced with modern components that can interface with the new control system. The first design phase of the digital system is nearly complete. The Engineering design began in April 2013 for the new blade drives, with manufacturing and install to be completed before the end of the year.

New Collaborations

Partner name	Title or short description of the collaboration	Funding, if applicable
Swiss Federal Institute of Technology, Lausanne (EPFL)	Validation of Reactor Physics-Thermalhydraulics Coupled Calculations in Water-Cooled Research Reactors with Laminar Flow Regimes	$200,000 in funding for Ph.D. student and postdoc at EPFL

Proposals Submitted

Title	Agency	PI, Co-PI and Collaborators	Funding Requested	Project Time	Date Submitted
Validation of Reactor Physics-Thermalhydraulics Coupled Calculations in Water-Cooled Research Reactors with Laminar Flow Regimes	Swiss*nuclear*	PI – K. Jordan, UF Collaborators – A. Pautz and G. Girardin, Swiss Federal Ins. of Tech., Lausanne	$10,000	3 months	Apr. 13
Plutonium Assay In Spent Fuel Using Multispectral Active Neutron Interrogation Analysis	DOE	K. Jordan, PI	$800,000	3 yrs	Jan 13
Experimental Evaluation Of Methods For Digital I&C Software Reliability Characterization	DOE	K. Jordan, PI	$400,000	2 yrs	Jan 13
Multiphysics-Based Optimization of SCWR-SMR Fuel Assemblies	DOE	D. Schubring, PI UF	$400,000	2 yrs	Jan 13
Advanced Calculational Methods in Nuclear Analyses	NRC	S. Goluoglu, PI UF	$200,000	2 yrs	Jan 13
Beyond High-k Dielectrics: Basic Science of Radiation Effects in Materials for Multi-Functional Nanoelectromechanical Switches	DTRA	J. Jones, PI UF	$1,050,000	4 yrs	Jan 13

Grants Awarded

Title	Agency	PI, Co-PIs and Collaborators	Period of Performance	Funding Awarded
Nuclear Safeguards Education at UF	ORNL	S. Goluoglu, K. Jordan, UF	1 yr	$100,000

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, 2012 FLATE achieved several milestones. Together with the National Science Foundation-funded Energy Systems Technology Technicians (EST^2) project team, FLATE has developed a new Industrial Energy Efficiency specialization for the Engineering Technology (ET) Degree and associated College Credit Certificate.

Engineering Technicians are widespread in a variety of occupational areas, including electronics, applied technologies, manufacturing, and composites fabrication, to name a few. The new Industrial Energy Efficiency specialization track and college credit certificate (CCC) for the AS/AAS degree in Engineering Technology, comes at a time when green job sectors such as energy efficiency, are flourishing. Interest in reducing operating costs through energy efficiency maximization is growing significantly, both in Florida and throughout the nation. Collaboration with industry subject matter experts has allowed us to tailor the energy efficiency specialization curriculum and match training directly to industry needs.

Industry partners have indicated a need for energy efficiency measures to help their bottom line, and as a result the new specialization/CCC is designed to help incumbent technicians in manufacturing or industrial occupations find ways to save money through efficiency in their industrial setting, or prepare students to become energy managers or auditors. Upon completion of the program, students will be armed with the knowledge and skills necessary to implement energy efficiency strategies in industrial processes and systems, and as a result impact the bottom line. It will help the student prepare to become a SEP-Superior Energy Performance Certified Systems Practitioner and a CEM Certified Energy Manager. The program will also help train workers who will assist a company in achieving the ISO 50001 standards related to energy management, as well as ISO 14001:2004 to assure a company's stakeholders that measures are being taken to improve their environmental impact.

The EST^2 team (comprising individuals from Brevard Community College, Florida State College at Jacksonville, Tallahassee Community College and Hillsborough Community College), submitted the framework to the Florida Department of Education at the beginning of 2013 and colleges will be able to implement it in the 2013-2014 academic year.

Program Title: Industrial Energy Efficiency Specialist (CCC)

Career Cluster: Manufacturing

	CCC
CIP Number	TBD
Program Type	College Credit Certificate (CCC)
Program Length	21 Credit Hours (Primary), 24 Credit Hours (Secondary)

This certificate program is part of the Engineering Technology AS/AAS degree program (1615000001/0615000001).

FLATE and FESC coordinated a second highly successful energy workshop (the last one was held in September 2011 in Gainesville), for high school and college educators, as well as industry partners, hosted by the Florida Solar Energy Center (FSEC) in Cocoa, FL on January 25, 2013. Forty attendees attended a wide variety of presentations, went on a tour of the amazing FSEC facilities and participated in a Professional Development activity focused on solar energy applications. Feedback received was overwhelmingly positive.

FLATE and FESC coordinated an Advisory Working Group Meeting in Orlando, FL on February 28, 2013 to develop a curriculum plan for the Industrial Energy Efficiency Technician (IEET) Specialization. Sixteen members from academia and industry worked on the following focus statement for the workshop, "An industrial energy efficiency technician implements energy efficiency strategies in industrial processes and systems in order to improve an organization's bottom line and reduce environmental impacts."

As a result of the meeting, a comprehensive list of IEET Resources was compiled and classes were identified as well as their associated learning outcomes.

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. The ET Forum most recently met April 4 – 5, 2013 in Clearwater at St. Petersburg College.

Activities for the 2012-2013 year are listed below.

- Presented at the Florida Association of Science Teachers Conference in October, 2012 with Mark Dick (Tallahassee Community College), "Energy Camps that are Energizing", highlighting the Teacher Energy Workshops and Energy Summer Camps for students offered over the summer by all EST 2 partners.
- Attended the Florida Energy Workforce Consortium Meeting in November 2012 and March 2013.
- Presented "Industrial Energy Efficiency Competencies for Associate Degree Programs", at the Interstate Renewable Energy Council (IREC) Clean Energy Workshop in Albany, NY, November, 2012.
- **Attended the Manufacturers Association of Florida Summit in December 2012 and surveyed 40 manufacturers about the need for energy efficiency trained technicians.** The overwhelming

majority of manufacturing members who completed the survey strongly supported the new IEET CCC since manufacturers need solutions to their high cost associated with energy consumption. A focus group meeting was held in Orlando, in February 2013 with industry, university faculty, tech center faculty and state college personnel/faculty. The focus group meeting was a scaled down, Designing a Curriculum (DACUM) that produced potential courses and course content for the proposed IEET program. The course creation validated the IEET program framework content that went to the FL Department of Education for approval at the beginning of this year, and will be implemented in the 2013-2014 academic year.

- Coordinated a second Community College Energy workshop for 40 attendees at the Florida Solar Energy Center (FSEC) in Cocoa, January 25, 2013.
- Was instrumental in the selection of Hillsborough Community College as a winner of the (Sustainability Education and Economic Development) Green Genome Award which recognizes exemplary community colleges nationwide that have taken a strategic leadership role in sustainability and green economic and workforce development.
- Attended and was part of an Energy Efficiency and Conservation Panel at 2013 Beyond Sustainability 37th Annual Conference at Hillsborough Community College, Plant Ybor City in February.
- Participated in, "An Energy Literate Citizenry from K-to-Gray: A Webcast on the Department of Energy's Energy Literacy Initiative", in March.
- FLATE hosted the Engineering Technology (ET) Forum in St. Petersburg on in April. (Energy Efficiency Specialization was presented).
- Planning is underway to host a third summer energy program for under-represented middle school students, to be held July 8 – 11 at HCC's South Shore Campus in Ruskin, FL in conjunction with the EST2 grant partners (BCC, TCC and FSCJ).

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, to 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; Palm Beach State College; School District Hillsborough County; Florida Department of Education – Division of Adult and Career Education; West Side Technical School; 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; Tampa Bay Regional Business Plan Energy Efficiency and Conservation Sub-Committee.

OUTREACH

FESC outreach program was directed by Dr. Pierce Jones, Director, Program for Resource Efficient Communities (PREC), and the program leveraged the existing network of UF extension offices to reach out to every county in Florida. 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 FESC outreach team developed educational outreach programs and materials (Fact sheets) 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.

FESC office has used all the outreach funding. The outreach team will be active when the FESC office has new funds. The outreach team's recommendation is to continue with the Sustainable Floridians^{SM} Program with the new funds. This program was piloted in 2010 and 2011. The program details are given below.

Sustainable Floridians^{SM} is a statewide educational program that was piloted in 2010 and 2011 to teach Floridians how to improve their economic, environmental and social sustainability and that of the communities in which they reside. The program was developed at the University of Florida's (UF) Department of Family, Youth and Community Sciences in collaboration with the UF/IFAS Program for Resource Efficient Communities, the UF Office of Sustainability and UF/Extension Faculty in seven counties.

The program's curriculum is both educational and action-oriented, and is directed at citizens who enroll in the class through a County Extension Office participating in the program.

Goals and Objectives:

The Sustainable Floridians^{SM} course encourages individuals and communities to become more resilient at the local community level. Beyond the objective of developing an educated citizenry, the goals include:

- Increasing participants' knowledge about sustainability issues at the global, state and local levels,
- Providing information that identifies Florida-specific actions for conserving energy and water,
- Motivating participants to implement conservation and efficiency actions that save resources and money, and
- Creating opportunities for community level leadership in sustainability education in a variety of settings from offices to community and neighborhood organizations

Participants meet with the program facilitator for six to seven weekly sessions. The classes include topics such as Why Should I Care?; Principles of Sustainability; Energy; Water; Transportation and Land Use; Food Systems; Consumerism; Community Leadership, etc. The course is very participatory and a variety of teaching methodologies are used including weekly handouts, multi-media presentations, supplemental readings and a textbook that allow participants to examine the material individually and then collectively. The course engages participants in group discussion, group and individual reflection, and personal action.

One example of a successful program is Pinellas County. Pinellas County Extension offered the program as part of the pilot initiative and continues to offer it as part of its sustainability curriculum. Pinellas County, one of 35 coastal counties in Florida, borders Tampa Bay and the Gulf of Mexico, has a population of 916,000 residents, and is considered the 6th most densely populated county in the state. Sustainability is a critical issue for a 97% "built-out" county with 25 different local governments. Although a challenge, balancing resource use with human and economic needs is critical to a successful and thriving local economy. Achieving this goal is possible with a motivated, engaged and educated citizenry. Since the start of the program, Pinellas trained 66 participants who have donated over 1,800 volunteer hours, a value of $33,588 (using $18.66 per hour as provided by Extension).

In Leon County, graduates are serving as facilitators for local EcoTeams, which are discussion circles organized within neighborhoods, faith organizations and other groups, under the sponsorship of Sustainable Tallahassee, a partnership umbrella NGO.

In addition, all participants are encouraged to track their monthly energy, water and vehicle miles travelled, and use consumption logs to develop a personal sustainability plan.

The Sustainable Floridians[SM] program has proven instrumental in filling the need for sustainability education within the community-at-large. The participatory course structure allows trainees to explore a range of educational material that will encourage sustainable practices and improve the economic, environmental and social conditions of their communities.

The County Extension offices are well positioned to provide education at the local level and possess the necessary infrastructure to support sustainability education at the community level.

The Sustainable Floridians[SM] program is now active in four counties…Leon, Osceola, Pinellas, and Sarasota. Marion County had an active program but the coordinator recently moved to take a position in Mississippi. Several other counties are contemplating beginning the program in the near future. While some counties train the participants to fulfill volunteer roles, other counties see the program as solely an educational program that they believe will have a ripple effect of educating others.

The program, up until recently, had no statewide coordination following completion of the pilot program. Now, with the assistance of UF's Office of Sustainability, UF's Program for Resource Efficient Communities through the Florida Cooperative Extension Service is working with county Extension faculty to develop curriculum review teams, an advisory committee, and all of the actions and activities needed to operate a statewide program. While in the midst of updating existing modules, along with creating new materials and determining efficiencies of scale, the program is continuing to gain statewide interest as indicated by the 16 counties represented at a recent in-service training.

Other Outreach Activities and Progress Made During the Reporting Period

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. Based on a Google Analytics report, the FESC web site was viewed by 9,690 (78.33% new visitor and 21.67% returning visitor) Google visitors during the period Oct 1, 2012 to April 15, 2013. The viewers visited 24,146 pages. Viewers were from US, Canada, India, China, Europe, Middle East, Russia, South America, Australia, and Africa as shown in the map below.

FESC e-Newsletter: FESC prepares and distributes electronic newsletters every other month to over 700 FESC industry/faculty contacts. The e-newsletter provides the current events and funding opportunities. It highlights the accomplishments of FESC faculty and Florida industry. It also covers global energy related news. The newsletters are posted at FESC web site: http://www.floridaenergy.ufl.edu/?page_id=1999.

APPENDIX A – DESCRIPTION OF FESC FUNDED RESEARCH PROJECTS

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 **Description**: The objectives of the proposed research include: 1) developing a comprehensive generation technology based portfolio optimization methodology, 2) developing carbon revenue redistribution strategies to achieve goals of emissions control policies (cap-and-trade), and 3) develop educational resources to enhance training of scientific workforce for the state of Florida. The research will directly address three major challenges: fulfillment of the growing power demand, meeting the emissions control targets, and supply of technology workforce. The potential economic impact of the proposed research on the State of Florida is expected to be very high, since an energy-secure environment is a basic necessity to support the current trend of explosive growth both in industry and human resources. **Budget:** $71,906 **External Collaborator:** Argonne National Lab
	Title: Joint Optimization of Urban Energy-Water Systems in Florida (Thrust 2: Efficiency)
	Title: Combined Cooling, Heat, Power, and Biofuel from Biomass and Solid Waste (Thrust 3: Biomass)
	Title: Design, Construction, and Operation of CSP Solar Thermal Power Plants in Florida (Thrust 4: Solar)
	Title: Development of High Throughput CIGS Manufacturing Process (Thrust 4: Solar)
	Title: Solar Photovoltaic Manufacturing Facility (Thrust 4: Solar)
	Title: Research to Improve Photovoltaic Cell Efficiency (Thrust 4: Solar)
	Title: An Integrated Sustainable Transportation System (Thrust 4: Solar)
	Title: PV Energy Conversion and System Integration (Thrust 4: Solar)
	Title: Integrated PV/Storage and PV/Storage/Lighting Systems (Thrust 4: Solar)
	Title: Reliable and Resilient Electrical Energy Transmission and Delivery Systems (Thrust 7: Storage & Delivery)
	Title: Secure Energy Systems – Vision and Architecture for Analysis and Design (Thrust 7: Storage & Delivery)
THRUST 2: Enhancing Energy Efficiency and Conservation	
	Title: Innovative Proton Conducting Membranes for Fuel Cell Applications **PI:** Ongi Englander, **Co-PIs:** Anant Paravastu, Subramanian Ramakrishnian - FSU **Description:** This project was initiated in January 2009 as an interdisciplinary effort among Englander (Mechanical Engineering), Paravastu (Chemical and Biomedical Engineering) and Ramakrishnan (Chemical and Biomedical Engineering). The work was divided into two main tasks: (1) the fabrication and characterization of silica and latex-supported membranes, and (2) the incorporation of protein nanomaterials inside the silica membranes. Three female students have participated and contributed to the project (see below). Two of the students (Holley and Kissoon) have received/will receive MS degrees in Materials Science. Two of the students (Kissoon and Witherspoon) belong to underrepresented groups. **Budget:** $30,000 ***This project has been completed***
	Title: Sustainably Integrated Advanced Building Subsystems (OGZEB) **PI:** A. "Yulu" Krothapalli, **Co-PI:** Justin Kramer - FSU **Description:** This project focused on the development of building subsystems that minimize the use of

	natural resources and carbon-based energy in Florida while also using materials that are renewable and sustainable. A key component of this project was the Off-Grid Zero Emissions Building, which allowed for the testing of these subsystems. This team forms the engineering team participating in the Team Florida's Solar Decathlon Competition. Lessons learned from the Off-Grid Zero Emission Building are incorporated into Team Florida's design. This project is complete. **Budget:** $503,168 ***This project has been completed***
	Title: Insight into Membrane Degradation Mechanisms Through Verification of Chemical and Mechanical Degradation Test Capabilities **PI:** Darlene Slattery, **Co-PIs**: Len Bonville, Marianne Rodgers - UCF/FSEC **Description:** The objectives of the program were to gain insight into fuel cell membrane degradation mechanisms including both chemical and mechanical degradations. In order to achieve this objective, the Membrane Electrode Assembly Durability Test System, MEADS, was verified, after which chemical degradation tests were conducted. By performing post mechanical testing and analyzing the data, the impact of accelerated degradation tests on the cell performance decay, chemical decomposition and mechanical weakening of the membranes were evaluated. This project is complete. **Budget:** $351,518 ***This project has been completed***
	Title: Energy Efficient Building Technologies and Zero Energy Homes **PI:** R. Vieira, **Co-PIs:** P. Fairey, J. Sonne - UCF/FSEC **Description:** The project consists of two elements: 1) the construction of two flexible research homes at FSEC to conduct research on advanced building energy efficiency technologies under controlled conditions; and 2) a staged, field retrofit study in a small number of unoccupied homes to measure and document the effectiveness of a series of retrofit measures that can be deployed using current technology. The project will also conduct an annual meeting where other FESC participants, other university members and utility, industry, the U.S. Department of Energy and other stake holders who will be briefed on plans and progress. Inputs from meeting participants will be sought. **Budget:** $1,224,000
	Title: Joint Optimization of Urban Energy-Water Systems in Florida **PI:** James P. Heaney - UF **Description:** Urban water infrastructure systems for providing water supply, collecting and treating wastewater, collecting and managing stormwater, and reusing wastewater and stormwater require major energy inputs. End users of the water require even more energy to heat this water for showers and baths, clothes washing, cooking and other uses. Increasingly, cities will rely on alternative water supplies such as desalination that require much more energy per gallon of water produced. Conservation is the ideal way to save energy and water by managing the demand for these precious commodities. Major strides have been made in reducing indoor water use from about 75 gallons per person per day to as low as 40 gallons per person per day. However, these gains are being offset by concurrent increases in outdoor water use for irrigation that range from 30 to 300 gallons per person per day depending on irrigation practices and the size of the landscape. From a water use perspective, perhaps the greatest challenge will be the expected growing competition for water if certain energy options are implemented in order to reduce our current dependence on foreign oil. Several recent national studies warn of this impending energy-water crisis. This project will build on our extensive experience in evaluating urban water conservation options to include the implications for energy use and to develop integrated energy-water management systems that are compatible. **Budget: $72,000** Back to Thrust 1: Overarching
	Title: Planning Grant: High Performance and Low Cost Fuel Cells for Future Vehicles

	PI: Jim Zheng, **Co-PIs:** Richard Liang, Chuck Zhang, Ben Wang - FSU **Description:** The objective of this project is to provide an innovative approach to revolution of current energy storage and conversion technology and greatly leverage FSU position in the strategic important area for sustainable energy. The project was performed by Drs. Jim Zheng and Richard Liang at the Department of Electrical and Computer Engineering and Department of Industrial Engineering, respectively. First to demonstrate preliminary results in high performance of energy storage and conversion materials and devices in order to seek outside funding consistent with the vision of IESES. The deliverables were conference proceedings and journal papers and proposal submissions for additional funding. This project is complete. **Budget:** $15,000 **Research Integration (collaboration):** NCSU and NHMFL on advantage batteries; Industrial Engineering on fuel cells; Maxwell Technologies, Inc. and Ionova Technologies, Inc. on supercapacitors; CAPS on microgrids; MARTECH on thermoelectric; Shanghai Institute of Technical Physics on photovoltaic; N. Dai, F.Y. Huang, S.L. Wang, X.N. Li, J.P. Zheng (co-PI), and D. Wei, "An International Collaboration Group on Solar Cell Technologies Development", Sponsor: Chinese Academy of Sciences, Budget: $877,193 (￥6,000,000 RMB), Project Dates: 4/09-4/14. ***This project has been completed***
	Title: NIRT: C-MEMS/CNEMS for Miniature Biofuel Cells **PI:** Marc Madou, Co-PIs : Chunlei Wang, Sylvia Daunert and Leonidas Bachas - FIU **Description:** In recent years, the quest for alternative sources that can autonomously power bioMEMS devices, especially those geared for in vivo applications, such as monitoring and drug delivery, has been the focus of research by scientists and engineers as new power sources will prove critical for the advancement of the field. Current batteries are still less than optimal and often present drawbacks related to safety, reliability and scalability. An ideal power source for implantable devices should take advantage of natural compounds present in the body of an individual and use them as fuel to produce power in a continuous and reproducible manner, as long as the patient's physiological functions remain steady. Biofuel cells, which are capable of converting biochemical energy into electrical energy, have been deemed as a potential solution to the drawbacks presented by conventional batteries, but the power density and operational lifetime requirements for implanted devices have not been met yet. To that end, we are integrating genetically engineered catalytic proteins and carbon-based 3 dimensional (3D) MEMS/NEMS structures to create new biofuel cells. The biofuel cell electrode surfaces, especially fractal electrode array, presents significantly increased surface area as compared to traditional architecture, increasing the biocatalyst loading capacity considerably for high power throughput. The genetically engineered enzymes inherently increase enzyme stability, consequently increasing biofeul cell lifetime. The scaled fractal electrode surface plays a role in wiring the enzymes to the biofuel cell anode, which increases the electron transfer efficiency from the enzyme to the electrode for an increase in the overall performance of the biofuel cells. Furthermore, C-MEMS/C-NEMS architectures will enable the reproducible fabrication of low cost carbon-based electrode structures. **Budget:** $171,432 (PI portion) (total amount: $1,000,000) - *Not Funded by FESC.*
	Title: Fabrication of Nano Fractal Electrodes for On-Chip Supercapacitors **PI:** Chunlei Wang - FIU **Description:** Nature has always strived for the highest efficiency in all organisms. Just as nature has benefited from fractal structures in almost all of its organisms, biomimetic fractal designs in electrochemical devices such as power conversion & storage devices and sensors can also lead to benefits in scaling. Our proposed concept is geared to take advantage of the scaling relationship between interface area and overall volume. Fractal electrode design is believed as a promising solution to optimize surface area while minimizing the internal resistance. We will fabricate and characterize carbon-based

	microelectrodes pyrolyzed from photolithographically patterned photoresist, which exhibits nano fractal geometry by design. In contrast with the current research trend of, first fabricating carbon nanostructures (CNTs, CNFs, etc), and then lithographically defining an electrode at the convenient location on the substrate, our novel methods will integrate the fabrication of the micro and the nano- structures using simple process thus bridging the gap that separates these two scales. Since the fabrication methods are all based on IC manufacturing methods, it will be easy to integrate into microchips. **Budget:** $150,000 - *Not Funded by FESC.*
	Title: Energy Efficient Technologies and The Zero Energy Home Learning Center **PI:** Stanley Russell, **Co-PIs:** Yogi Goswami **Graduate Assistant**: Mario Rodriguez - USF **Description:** The project is to create and evaluate an affordable residential scale Zero Energy building that will function as an exhibition of energy efficiency and Zero Energy Home [ZEH] technology on or near the University of South Florida campus. The project will feature the most cost-effective combination of renewable solar energy with high levels of building energy efficiency. The building will incorporate a carefully chosen package of the latest energy-.efficiency technologies and renewable energy systems to achieve the most successful and reliable results. The building will utilize Photovoltaic solar electricity and solar domestic hot water heating systems using the grid as an energy storage system, producing more energy than needed during the day and relying on the grid at night. Plug-in hybrid automobile technology offers a promising means of providing distributed energy storage for such homes but has not been sufficiently tested. Using a systems approach to couple zero energy home technology with PHEVs we will explore opportunities to develop marketable products that meet Florida's energy and environmental goals. **Budget:** $344,600 **External Collaborators:** FSU College of Engineering- Justin Kramer, Brenton Greska; UF- Department of Interior Design- Maruja Torres, Nam-Kyu Park; UF Rinker School of Building Construction- Robert Ries; UCF Florida Solar Energy Center- 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 **Description**: Recent environmental, social, and economic challenges are fostering a wave of interest in maximizing energy efficiency and conservation (EE+C) in existing U.S. homes. Long standing programs, ratings, and metrics are being reapplied into new stimulus initiatives such as the *Recovery through Retrofit*[1] program. Simultaneously, electric and gas utilities are expanding their demand side management (DSM) programs from weatherization and conventional technology replacement incentives to include conservation behavior campaigns with "recommendation algorithms" designed to assist in homeowner energy retrofit decision making. Furthermore, loan programs are emerging to address the financial barriers that commonly limit initiation of the necessary retrofits. Collectively, these approaches most often project future home energy performance based on engineering models of the physical characteristics of homes (i.e., "asset ratings"). Yet to date, the marketplace is inadequately integrating historical household energy consumption patterns (i.e., "operational ratings") into the decision tree to optimize retrofit program efficacy and consumer benefits. Moving toward the unification of asset and operational ratings is crucial for successful program management, proper monitoring/measurement/verification (MMV), loan risk assessment, and for the persistence of reduced home energy use over time. However, unification will not be easy. This research project combines qualitative and quantitative research methods in social science and building science using Florida case studies to evaluate the opportunities and constraints of asset and operational rating unification and the steps

	necessary to get there. Relationships between our project and the collaborative, transparent, and participatory nature of "open government" initiatives are also being explored. **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)
	Title: Meteorological Factors Affecting Solar Energy Efficiency **PI:** Paul Ruscher **Co-PIs:** (formerly Yaw Owusu, Hans Chapman - FSU **Description:** There are numerous meteorological factors that limit the efficiency of solar energy systems in the tropics. Depletion of available solar energy at the surface by increased water vapor, cloudiness, temperature of the solar panel system, pollution, are sometimes overlooked, because engineering specifications for design are often based upon midlatitude continental air masses. The typical tropical atmospheric reduction factors were reviewed using a state of- the-art solar energy model for this project. In addition, meteorological variability can be quite extreme in the tropics and many engineering studies on feasibility of renewable energy sources in general are often based upon "typical" year criteria, rather than longer term climatologies. It is suggested that climatological data be utilized to more accurately portray the variability of output to be expected at a typical installation. Many of these variables are already widely available from a combination of surface and upper air meteorological stations, as well as remote sensing data from satellites. We demonstrated the sources for these data as well as strategies for teaching about solar energy efficiency using routine observations from school-based weather stations. This project is complete. **Budget:** $15,000 ***This project has been completed***
THRUST 3: Developing Florida's Biomass Resources	
Algae	
	Title: Establishment of the Center for Marine Bioenergy Research: Systems Approach to BioEnergy Research (SABER) **PI:** J. Kostka (he has left FSU), **Co-PIs**: William Cooper, Ivonne Audirac, Amy Chan-Hilton,Ellen Granger – FSU **Description:** IESES' Systems Approach to Bio-Energy Research (SABER) is particularly focused on coupling algal cultivation to wastewater nutrient remediation. SABER has partnered with the City of Tallahassee's T. P. Smith Waste Water Treatment Plant in order to study the growth of local fresh water algae in waste water for use as biofuel. The two main objectives of this project are to: 1) perform both laboratory and field experiments to test for species-specific growth potentials, as well as for the effects of different environmental parameters, including light, carbon dioxide, and nutrient availability on microalgal growth rates and lipid production, and 2) determine the extent to which microbes (i.e. bacteria), which are exceptionally abundant in waste water, act as either competitors (for nutrients, carbon) or symbiotically with algae. To do this we are examining the bacterial community present in the waste water and detecting community shifts that occur during algae cultivation. We are also examining the nutrient uptake dynamics between bacteria and algae by monitoring the usage and production of nitrogen, phosphorous, and carbon-containing compounds. Finally, a number of advanced analytical chemistry techniques are being used to characterize wastewater before and after algae cultivation. With a better understanding of the microbial and biogeochemical processes occurring in waste water during algae cultivation, engineering approaches may be proposed in order to further optimize algal growth in waste water. **Budget:** $494,135 **External Collaborators:** City of Tallahassee ***This project has been completed***
	Title: Constructual Optimization of Solar Photo-Bioreactors for Algae Growth

	PI: Juan Ordonez - FSU **Description**: This was a planning grant (15K, only). The work was targeted towards placing us in a more competitive position in future submissions in the area of bio-fuels. By the end of this one-year effort we now have a complete design of a small-scale photo-bioreactor for algae growth, obtained additional funds that will allow us to build a large-scale photo-bioreactor and conduct the necessary research for its optimal design and operation. This project is complete. **Budget:** $15,000 **External Collaborators:** Federal University of Parana, Brazil ***This project has been completed***
	Title: Optimization of Algae Species for Biofuels Production Using Genetic Altration **PI:** Ed Phlips- UF **Description:** This study will begin in June, 2011, and will focus on genetically altering selected species of algae to optimize their performance in biomass production systems aimed at biofuels. Two approaches to genetic alteration will be explored: mutagenesis and transformation. **Budget:** $15,000
	Title: Sustainable Algal Biofuel Production **PI:** Sarina J. Ergas Co-PI: Qiong Zhang, James R. Mihelcic, John Wolan (deceased) **Description:** This project is designed to develop PI expertise and collaborations and train graduate students in a new field of research that is critical in establishing Florida as center of algal biofuels production. Future research directions include: 1) integration of algal biofuel production with domestic, agricultural and industrial wastewater, 2) sustainable aquaculture system development, 3) production of jet fuel from algae cake, 4) application of algal biofuels technology in developing countries, 5) development of integrated LCA-economic assessment tools to assist in algal biofuel system decision making. **Budget:** $50,000 **Universities:** USF **External Collaborators:** Mote Marine Laboratories
High Energy Crops	
	Title: Energy Intensive Crop Development **PI:** Gary Peter , Matias Kirst, Don Rockwood - UF **Description:** To build a commercially viable, industrial scale system to produce transportation fuels and electricity from biomass requires both efficient conversion technologies and environmentally sustainable, cost effective supplies of biomass. In the US, Florida ranks first in its annual growth of plant biomass, because of its large cultivable land area and its subtropical climate, even though substantial land areas that can be planted are not currently in agricultural or forest production. The development of high yielding production systems for dedicated energy crops is considered essential for a sustainable, biomass to energy industry to be established, because the long-term availability of sufficient amounts of reasonably priced biomass is one of the most important factors in the site selection for new biofuel and bioenergy facilities. Dedicated energy crops are ones that 1) have high yields with minimum energy inputs in terms of agronomic practices, water and nutrient applications, 2) can be harvested, transported and processed efficiently into fuel or power, and 3) can be grown sustainably for generations without adverse environmental affects, or significantly impacting the food supply. We will evaluate likely energy crop species, *Eucalyptus* and southern pine to provide important yield and best management practices for growing these species for bioenergy conversion. We will also provide important chemical composition information that will impact the conversion efficiency of this biomass to ethanol, and identify and characterize important genes that regulate wood chemical composition **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 **Description:** Florida ranks first in the USA in annual growth of plant biomass because of a large cultivatable land area, high rainfall, and long growing season. In order to capitalize on these advantages, the agricultural production sector and biomass conversion industries require information regarding which crops are adapted to particular Florida regions and local environments, how much biomass can be produced during what times of the year, which crops produce the most biomass per unit of water used, and which crops have the desired yield and composition for particular bioenergy applications. Research conducted to date has quantified the seasonal biomass supply provided by the most likely crops for use in Florida, identified crops and management practices that result in most efficient water use, and described the chemical composition of these plants to allow estimates of potential energy production per unit of biomass. Florida growers and industry representatives have gained access to this information through on-line resources, presentations by several of the project investigators at the Florida Farm to Fuel Conference, and by attending the Bioenergy Crop Field Day at the University of Florida Plant Science Research and Education Unit. Seven graduate students are being trained through this project and undergraduate students are gaining invaluable research experience via internships mentored by project investigators. Faculty involved in the FESC project have formed collaborations regarding agronomic and breeding projects with Speedling, Inc., SERF, and BP. Both SERF and BP plan to construct ethanol facilities in Florida that would create an estimated 400 temporary construction jobs and 140 permanent jobs each. **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 **Description:** With the ever-increasing price of petroleum and its finite supply, it is of high priority to develop domestic sources of transportation fuel, as well as other chemicals. Ethanol is an attractive alternate fuel that is being produced from corn starch. It is necessary to target other feedstocks for biofuel production and develop processes that have a minimal environmental impact. There is considerable ongoing research on developing processes and catalysts for conversion of biomass to biofuels like ethanol (called cellulosic ethanol process). But this project addresses other feedstocks with the following objectives: 1) development of biocatalysts for the conversion of waste biodegradable poly lactic acid based plastics to ethanol and 2) development of processes that processes for the production of additional fuels like biogas, bio-oil and biochar from the waste and byproducts of a cellulosic ethanol plant for the cleanup and reuse of these waste streams **Budget:** $192,000 **External Collaborators:** University of Central Florida
	Title: Engineering Biocatalysts for Hemicelluloses Hydrolysis and Fermentation **PI:** James F. Preston - UF **Description:** Our goal is to develop biocatalysts for the cost-effective production of fuel alcohols and chemical feedstocks from underutilized sources of renewable biomass and evolving energy crops. To reach this goal protocols for efficient saccharification of hemicellulose fractions from these resources will be developed. Objectives are to: 1. Develop improved enzyme-mediated saccharification protocols of hemicelluloses with existing bacterial biocatalysts for production of biofuels and chemical feedstocks. 2. Develop Gram positive biocatalysts for direct conversion of hemicelluloses to biobased products. 3. Develop systems with bacterial biocatalysts for efficient bioconversion of the hemicellulose fractions

	of perennial energy crops (poplar, eucalyptus, switchgrass, energy cane) to targeted products. **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.
	Title: Thermophilic Biocatalysts for the Conversion of Cellulosic Substrates to Fuels and Chemicals **PI:** K.T. Shanmugam - UF **Description:** Biomass is an attractive source of sugars for a state like Florida that produces very limited amount of corn for fermentation to produce ethanol as transportation fuel or other products such as lactic acid that can be converted to bioplastics. Florida currently generates about 8.7 million tons of dry cellulosic biomass per year (US-US DOE) that can be converted to about 0.7 billion gallons of ethanol. With specific energy crops and short rotation trees cultivated for energy production using the abundant sunshine and water resources, the ethanol produced from biomass can be significantly increased to meet the demand for transportation fuel in the State of Florida. Before biomass-based fuels and chemicals become an economic reality, several key steps in the depolymerization of biomass to constituent sugars need to be addressed. One is depolymerization of cellulose to glucose by fungal cellulases before fermentation to ethanol by microbes. The current estimated cost of fungal cellulases is $0.32 per gallon ethanol produced and this cost is targeted for reduction to $0.10 or less by year 2012 (US DOE). We have demonstrated that by increasing the temperature of Simultaneous Saccharification and Fermentation (SSF) of cellulose from 30-35 ºC to 50-55 ºC, the amount (and associated cost) of cellulases can be reduced by the required 3-fold with the current commercial enzyme preparations. A microbial biocatalyst that produces ethanol or other chemicals as the main fermentation product and can also function at this higher temperature and pH 5.0 in conjunction with the fungal cellulases in the SSF process is a critical component of this process. We have identified a thermophilic facultative anaerobe, *Bacillus coagulans*, with versatile metabolic capability as the microbial platform for the SSF of biomass to products and engineering this L(+)-lactic acid producing bacterium to produce ethanol. *The primary objective of this proposed study is to construct a B. coagulans derivative that produces ethanol as primary product of fermentation and to enhance the ethanol productivity of the engineered derivative.* **Budget:** $192,000 ***This project has been completed***
Bio gasification	
	Title: Combined Cooling, Heat, Power, and Biofuel from Biomass and Solid Waste **PI:** William Lear, **Co-PI:** J.N. Chung - UF **Description:** The goal of this project is to provide the underlying research and demonstration of a novel technology which would enable the economic utilization of dispersed biomass and solid waste resources to produce electric power, cooling, heat, and transportation fuels. This integrated gasification and power generation system combines University of Florida advances in high-temperature gasification, hydrogen generation and separation, and advanced gas turbine systems. Their integration is expected to result in significant improvements in the cost, emissions, feedstock flexibility, and water requirements, all in a relatively compact, modular plant system. This in turn will enable much greater utilization of renewable energy supplies, helping the development of a sustainable energy supply infrastructure. **Budget:** $576,000 **External Collaborators:** Siemens Power Generation, Florida Turbine Technologies, Energy Concepts Co., Nu-Power Technologies LLC, PlanetGreenSolutions Inc., LPP Combustion, LLC. Back to Thrust 1: Overarching
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 **Description:** The objective of this project is to develop technology for the economical thermo-chemical conversion of lingocellulosic biomass (non-food grade biomass such as agricultural waste, bagasse from sugar mills, citrus peels, switch grass, municipal green waste, etc.) to clean burning liquid fuels. Five of the major advantages of this process over a biochemical route to production of ethanol are: (i) it US DOEs not utilize food-grade feed stocks and therefore complements and US DOEs not compete with the agricultural food production in the state, (ii) the fuel produced is similar to those derived from petroleum unlike ethanol derived fuels which have at least a 25% lower energy content, (iii) the conversion is accomplished in using fast chemical reactions unlike the slow biological reactions for fermenting alcohol, (iv) the process US DOEs not require large amounts of water and associated energy costs of separating the water from the fuel as in bioethanol processes, (v) it can utilize a wide variety of biomass sources unlike the biochemical route which cannot work with high lignin containing biomass. **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 Description: The main deterrent for commercialization of biomass conversion processes is the cost of conversion; particularly the need to sacrifice as much as 30% of the energy content in the biomass for the thermo chemical conversion step. We want to research and develop the concept to use solar thermal energy from concentrating units to provide energy for the biomass gasification step. We also propose to evaluate the sustainability of such a process. Overall Objective: The overall objective is to conduct a theoretical analysis of solar assisted thermo chemical conversion of biomass from the point of view of energy efficiency, economic feasibility, environmental impact, and long term sustainability of renewable energy production. **Budget:** $45,238
	Title: Integrated Florida Bio-Energy Industry **PI:** Ali T-Raissi **Co-PIs:** N.Z. Muradov, D.L. Block - UCF/FSEC **Description:** The aim of this project continues to be production of liquid hydrocarbon fuels derived from lignocellulosic and aquatic biomass employing a two-step thermocatalytic process. In the first step, pre-treated biomass is gasified with oxygen (or air) and steam yielding synthesis gas (syngas) containing hydrogen and carbon monoxide. In the second step, syngas generated by the gasifier enters a Fischer Tropsch (FT) synthesis unit where it reacts to form a range of liquid hydrocarbon fuels – including diesel. **Budget:** $648,000
	Title: Biofuels Through Thermochemical Processes: Approach to Produce Bio-Jet Fuel **PI**: Anjaneyulu Krothapalli - FSU **Description:** The objective of this project was to develop technologies to produce biojet and biodiesel fuels from sustainable sources such as bio-oils and hydrogen produced from biomass generated synthetic gas. Novel processing concepts, reactor design and catalyst systems are employed in this integrated approach to convert any cellulosic biomass and any nonedible bio-oils into bio-jet fuel (Figure 1). Feedstock flexibility offers significant cost and logistic advantages to this approach. Unlike other processes which use only the oil derived from a plant, the entire plant can be used as feedstock source and the proposed approach can also convert the more challenging lignocellulosic component. This project is complete. **Budget:** $229,572 ***This project has been completed***
THRUST 4: Harnessing Florida's Solar Resources	
Solar Testing Facility	
	Title: Solar Systems Testing Facility

	PI: James Roland, David Block - UCF/FSEC **Description:** Over the past four years, the Florida Solar Energy Center (FSEC) has received a significan increase in demand for solar and PV systems testing and certification. This occurrence has resulted i requiring the Center to correspondingly amplify its capabilities to respond to the increased demand. Thus, th objective of this task was to construct a solar and PV systems testing facility by adding walls, windows, door and A/C to an existing Florida Solar Energy Center roof only facility. The enclosing of this existing spac was done for the purpose of increasing laboratory space and to allow for laboratory testing of solar wate heating systems and PV modules and inverters. The action was taken following a study which determined thi project was the most cost effective means of adding valuable indoor laboratory space. **Budget:** $600,609 ***This project has been completed***
Solar Thermal	
	Title: Concentrating Solar Power Program **PI:** Charles Cromer, R. Reedy - UCF/FSEC **Description:** The objective of this effort is to produce a detailed Florida map of the solar direct beam and global resource available for use in Florida whereby a potential user of solar energy can enter their location latitude and longitude and receive a table of solar energy monthly averages for that specific site as derived from the past eleven years of data. The concept is to use NOAA satellite photos and utilize the brightness of the cloud cover as a clearness factor predictor of the solar energy that gets through to the ground below. **Budget:** $52,000 **External Collaborators:** FPL ***This project has been completed***
	Title: Development of Novel Water Splitting Catalysts for the Production of Renewable Hydrogen **PI:** Helena Hagelin-Weaver - UF **Description:** This project focuses on the development of iron-based catalysts for the thermochemical splitting of water into hydrogen and oxygen. The thermochemical process of splitting water is particularly well-suited for the utilization of solar energy to provide the heat for the reaction and is a way to produce a renewable hydrogen fuel. As hydrogen is difficult to transport and store, producing hydrogen on site for power plants using proton exchange membrane (PEM) fuel cells or internal combustion engines to generate electricity or for the production of chemicals, such as liquid hydrocarbon fuels, is a very attractive approach. The project uses a two-step process in which water is passed over a reduced iron oxide to generate hydrogen while the oxygen is taken up by the oxygen-deficient iron oxide (Step 1: FeOx-1 + H2O FeOx + H2). In the second step the resulting iron oxide is heated to desorb oxygen and regenerate the oxygen-deficient iron oxide to close the catalytic cycle (Step 2: FeOx FeOx-1 + ½O2). The main objectives of the project are to develop mixed metal oxide catalysts that 1) will release oxygen at temperatures lower than 1500°C (Step 2), while still maintaining water-splitting activity (Step 1) and 2) are stable up to the temperature necessary for the oxygen desorption step. **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) **Description:** The Florida Solar Energy Center (FSEC) serves the State of Florida by providing independent, third-party testing and certification of solar equipment for the main purposes of providing product value in the marketplace, especially for products that are not widely "proven" with consumers such as solar water heating systems and solar electrical (photovoltaic) systems. Even more important, third-party certification provides protection to reputable manufacturers, ensuring that lower quality products, often from foreign markets, do not compete head-to-head with Florida and U.S. products unless they meet the same standards.

	Budget: $809,295 **External Collaborators:** Solar thermal manufacturers
	Title: Solar Fuels for Thermochemical Cycles at Low Pressures **PI:** Jörg Petrasch - UF **Description:** The project focuses on the production of solar fuels from solar thermochemical cycles employing metal/metal oxide redox pairs. These thermochemical cycles consist of a high temperature endothermic solar driven reduction step and a low temperature, slightly exothermic water or CO2 splitting step. The high temperature step typically proceeds at temperatures above 2000 K. Hence, it poses a range of material and design challenges. According to Le Chatelier's principle, the temperature for the solar dissociation reaction decreases as the pressure inside the reactor is reduced. The central hypothesis of the project is that operating the high temperature step of metal/metal oxide solar thermochemical cycles at reduced pressures will lead to significantly relaxed temperature requirements, while the work necessary to produce the pressure difference will not significantly reduce the overall efficiency of the process. The main goal of the project is to demonstrate the feasibility of carrying out high temperature thermal reduction of metal oxides in rarefied conditions using high intensity solar radiation from UF's solar simulator. **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 **Description:** While there are many different approaches to hydrogen generation, the most attractive means is to split water molecules using solar energy. The current approach is to develop highly reactive metal oxide materials to produce intermediary reactions that result in the splitting of water to produce hydrogen at moderate temperatures (<1000 K). It is envisioned that the metal oxide reactors will ultimately be mounted within a solar concentrating reactor, and irradiated via heliostats. This Task is structured toward the overall goals of solar-driven, thermochemical hydrogen production, with associated efforts toward the enabling surface science, catalysis, particle science, material synthesis, nano-structures, multiscale-multiphase physics modeling, and process simulation that will enable the realization of solar hydrogen-based fuels to power the transportation economy. Successful efforts as targeted in this project are a critical step toward increased renewable-resource based fuels and energy, reduction of GHG emissions, and establishment of a new power industry in Florida. **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 Florida utilities are mandated to achieve 20% renewable energy contribution to their generation mix by 2020. While technologically feasible with solar energy, the capital costs are high – presently, capital costs range from $6,000-$7,000/kW for PV and $3,500-$4,000/kW for concentrating solar thermal power. This project targets the development of solar thermal power technology for bulk power and distributed generation, which will diversify energy resources in Florida and reduce greenhouse emissions by utilizing renewable sources. Also, there will be economic impacts with the establishment of new power industry in Florida, which will help the electrical utilities of the state to meet the renewable portfolio standards. The project has three main tasks; the first one is to develop design methodologies and standards for the proven solar thermal power technologies in combination with bio or fossil fuels based on Florida conditions and resources. Secondly, the project aims to set up demonstration and test facilities for these technologies for optimization for Florida conditions, and the final task is to develop and commercialize innovative technologies based on new thermodynamic cycles. **Budget:** $882,000

	External Collaborators: Sopogy Inc. and Gulf Coast Green Energy. Back to Thrust 1: Overarching
	Title: Multi-Generation Capable Solar Thermal Technologies **PI:** A. Krothapalli, **Co-PI:** Brenton Greska - FSU **Description:** The objective of the research was to develop and demonstrate small-scale solar thermal technologies that can be used separately, in conjunction with one another, or with existing waste heat producers, thus improving the overall system efficiency. This project is complete. **Budget:** $544,226 ***This project has been completed***
Clean Drinking Water	
	Title: Low Cost Solar Driven Desalination **PI:** James Klausner - UF **Student:** Fadi Alnaimat/ Ph.D **Description**: This work concerns the development of a cost effective, low power consumption, and low maintenance desalination process that is powered by solar energy. The solar diffusion driven desalination (DDD) process is most suitable for decentralized applications. While theoretical models have been developed to analyze the evaporation and condensation processes of the solar DDD under transient operating conditions (Alnaimat et al., 2011), experimental investigations have been conducted to validate the theoretical models. In this reporting period, the overall distillation performance of the solar DDD has been investigated under different design and operating conditions. The best operating modes have been proposed to improve the water production and reduce the specific energy consumption. **Budget:** $252,000 **University:** UF
	Title: Fresh Water Using low Grade Heat and Alternative Energy (Formerly titled as "Clean Drinking Water using Advanced Solar Energy Technologies") **PI:** Lee Stefanakos **Co-PI's:** Yogi Goswami, Matthias Batzill, Maya Trotz, Sesha Srinivasan - USF **Description:** Availability of fresh water is one of the biggest problems facing the world and Florida is one of the most vulnerable to fresh water shortages. Moreover, Florida ground water is contaminated in many locations from leaky underground tanks, agricultural pesticides, and other chemicals. Although it is possible to desalinate abundant seawater, conventional systems are too energy intensive. Solar energy can provide the needed energy, and innovative new solar vacuum (USF) and humidification/dehumidification (UF) desalination systems can provide adequate fresh water for the state's needs. Systems are being developed for both bulk water desalination and small community needs/disaster response. We will also develop photocatalytic disinfection to remove contaminants and integrate these technologies with solar PV for complete water supply systems. Photocatalysis is a promising water treatment technology capable of utilizing solar light. However, the construction of an effective photocatalytic disinfection system for water purification is currently limited by the lack of reliable models to aid in the design and testing of these systems. Simplified models have been proposed, but most are inadequate because they rely on traditional disinfection theories which are not applicable to photocatalysis. Therefore, the major goal of this research is to develop a model for photocatalytic disinfection based on fundamental processes which may then be used to design water treatment systems in the state of Florida. **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

	Description: An important FSEC function is consumer protection from poorly designed and manufactured PV modules and systems. FSEC's test capabilities were established over 10 years ago and were adequate at the time to test PV modules for certification. However, PV costs have fallen and competing electric utility rates have risen. In the last two years, these curves have crossed under some economic scenarios and incentive programs, and the demand for PV module testing and system certification has jumped. Thus, this task will provide for enhanced and expanded PV testing and certification capabilities. The task will also be done in close coordination with FSEC's work with the U.S. Department of Energy's PV program. **Budget:** $196,018
	Title: Development of High Throughput CIGS Manufacturing Process **PI:** Neelkanth Dhere - UCF/FSEC **Description:** A reduction in the cost of CIGS and other thin film PV modules is required for broad PV applications. The objective is to develop a high-rate deposition process for synthesis of CIGS absorbers and other layers by employing in-line and batch deposition techniques. The goal is finally to attract a PV manufacturing company to Florida by developing a high-rate manufacturing process for $CuIn_xGa_{1-x}Se_2$ (CIGS) solar cells. **Budget:** $141,620 Back to Thrust 1: Overarching
	Title: Florida Opportunities for PV Manufacturing and Applications **PIs:** D. Block, J Fenton, P. Fairey, W. Schoenfelds, R. Reedy - UCF/FSEC **Description:** The overall goal of this project is to assist in the development of a photovoltaic (PV) manufacturing industry in Florida. The project objective is to conduct a review of the state, national and international PV manufacturing data for the purposes of establishing industry practices and an industry data base. The data base will then be available to assist Florida in establishing PV manufacturing firm(s). **Budget:** $81,120
	Title: Development of Low Cost CIGS Thin Film Hot Carrier Solar Cells **PIs:** Gijs Bosman, **Co-PI:** Tim Anderson - UF **Description:** Our study is focused on hot carrier solar cells for cell conversion efficiency improvement in a low cost, high throughput CIGS system. The rapid thermalization loss of hot photoexited carriers interacting with the lattice can potentially be reduced through phonon engineering in the absorber layer; the subsequent extraction of the hot carriers may be realized through device engineering of energy selective contacts. **Budget:** $450,000
	Title: Chloride Chemical Vapor Deposition of $Cu(In,Ga)(Se,S)_2$ **PI:** Timothy J. Anderson **Student:** Christopher P. Muzzillo (Ph.D.) **Description:** The intent of the work is to demonstrate chloride chemical vapor deposition (CVD) of chalcopyrite thin films with material quality suitable for use as photovoltaic absorbers. To this end, CuInSe2 films have been grown and characterized. **External Collaborators:** Rommel Noufi (National Renewable Energy Laboratory), Bill Shafarman, University of Delaware
	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 **Description:** The primary goal of this project is to enable the establishment and success of local solar photovoltaic manufacturing companies to produce clean energy products for use within the state and beyond and to generate jobs and the skilled workforce needed for them. Thin film technologies have shown record efficiencies of 20%, and present tremendous opportunities for new Florida start-up companies. USF, UCF, and UF are collaborating to develop a pilot line facility for thin film solar technologies, which will

	serve as a test bed for making ongoing improvements in productivity and performance of solar modules, develop advanced manufacturing protocols, and help train a skilled workforce to ensure the success of new companies. **Budget:** $1.6M **External Collaborators:** Mustang Solar, a Division of Mustang Vacuum Systems Back to Thrust 1: Overarching
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 **Description:** Photovoltaic/thermoelectric (PV/TE) cell integration is a promising technology to improved performance and increase the cell life of PV cells. The TE element can be used to cool and heat the PV element, which increases the PV efficiency for applications in real-world conditions. Conversely, the TE materials can be optimized to convert heat dissipated by the PV element into useful electric energy, particularly in locations where the PV cell experiences large temperature gradients, i.e. use the thermoelectric module for cooling, heating and energy generation depending on the ambient weather conditions. Thus, the goal of this research effort is to research and develop nanoscale design of efficient thermoelectric material through a fundamental understanding of the materials properties and to design and build a photovoltaic thermoelectric (PV/TE) hybrid system. **Budget:** $167,820 Back to Thrust 1: Overarching
	Title: PV Devices Research and Development Laboratory **PI:** Robert Reedy **Co-PI's:** Nicoleta Sorloaica-Hickman, Neelkanth Dhere - UCF/FSEC **Description:** The primary challenge facing the PV industry is to dramatically reduce the cost/watt of delivered solar electricity by approximately a factor of 2 to 3, to increase the manufacturing volume by a factor of 10 and to improve the cell efficiencies by a factor of 2 to 3. This task will conduct R&D on basic science of PV cells and develop a world class PV cell laboratory for future cell research. The R&D will focus on developing new and improved PV cells such as organic PV, nano-architectures, multiple excitation generation, plasmonics, and tandem/multi-junction cells. **Budget:** $450,250
	Title: Beyond Photovoltaics: Nanoscale Rectenna for Conversion of Solar and Thermal Energy to Electricity **PI:** Shekhar Bhansali, **Co-PIs:** Elias Stefanakos, Yogi Goswami, Subramanian Krishnan - USF **Description:** The main objective of the proposal is to commercialize and scale up a new technology, rectenna to convert waste heat energy to electricity. Although the prediction of highly efficient (~85%) solar rectennas was published almost 30 years ago, serious technological challenges have prevented such devices from becoming a reality. Since the ultimate goal of a direct optical frequency rectenna photovoltaic power converter is still likely a decade away, we plan to convert optical solar radiation to thermal radiation (~30 THz regime) using an innovative blackbody source. Leveraging the research efforts of the world-class team members, we plan to further develop the rectenna technology that is within reach of efficient radiation conversion at 30 THz. A fully integrated, blackbody converter and 30 THz rectenna system will be capable of converting at least 50% of solar and thermal energy into usable electrical power, clearly demonstrating a truly transformational new technology in the renewable energy technology sector. **Budget:** $598,500 **External Collaborators:** Bhabha Atomic Research Center, India
Smart Windows	
	Title: Development of a Smart Window for Green Buildings in Florida

	PI: Dr. Sarath Witanachchi **Students:** Mr. Mark Merlak, Ph.D. student **Description:** This project is aimed at developing a smart window concept that has the potential to convert part of the solar radiation falling on windows during daytime to electricity, and to use this harnessed energy to power a phosphor-based, highly efficient white-light LED source to illuminate the building at night. This project pursues two different technologies: (1) use of quantum dot based solar cells to harvest solar energy, and (2) develop an electroluminescent light source based on nanophosphors to provide illumination for buildings. The project brings together two unique nanoparticle growth techniques developed at the Laboratory for Advanced Material Science and Technology (LAMSAT) at USF to fabricate a prototype device that would demonstrate the possibility of significant energy savings. **University:** USF
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) Description: The objective of this project is to develop a system-driven Plug'N'Gen solar power system demonstrating architecture of decentralized, low-cost, mass-produced, PV panel-mounted micro-inverters. This system will be able to compete with today's centralized multi-kW PV inverters that require cost prohibitive professional installation. The project tasks are: 1) novel inverter topology and control concepts; 2) advanced digital control algorithms; 3) SmartTie interface with the utility grid; and 4) low cost and ultra-compact PV inverter in package. **Budget: $1,267,000** Back to Thrust 1: Overarching
	Title: Non-Contact Energy Delivery for PV System and Wireless Charging Applications **PI:** Jenshan Lin - UF **Description**: Innovative non-contact energy delivery method will be used in photovoltaic energy generation system to accelerate the system deployment. Instead of delivering electric power using cables penetrating through building structures, magnetic field coupling allows power to be transferred wirelessly through building walls and roofs. In the meantime, the DC electric energy from photovoltaic cells is converted to AC energy. This enables the photovoltaic system to be quickly set up or relocated, and the collected solar energy from outdoor system can be conveniently delivered to indoor appliances. Techniques to achieve high efficiency at high power delivery through different building structures will be studied for this plug-and-play architecture. In addition, the technique and the system can also be used for non-contact charging of electric vehicles. The transmitter/charger can be placed as a mat on garage floor or parking space. The receiver inside vehicle will pick up the energy delivery through magnetic coupling. This eliminates the need of connecting charging wires to vehicles and exposed metal contacts, which is a safer method of charging electric vehicles **Budget: $**252,000
	Title: An Integrated Sustainable Transportation System **PI:** David Norton, Keith Duncan – UF (Formerly Eric Wachsman (PI) and Shirley Meng (Co-PI);left UF) **Description:** The proposed vehicle, operating on biofuel while in transit and charged by the sun while parked, is the ultimate sustainable transportation system operating completely on renewable American energy resources. Moreover, the use of solid oxide fuel cells (SOFCs) rather than an IC engine in this hybrid vehicle results in a dramatic improvement in efficiency and reduction in emissions. SOFCs are the most efficient technology for converting energy from hydrocarbon fuels to electricity on a "well to wheels" basis. In contrast, the more conventional fuel cells require hydrocarbon fuels to first be converted to H_2, with resultant efficiency losses, followed by losses due to H_2 transport and storage. Therefore, on a system-basis SOFCs hold the potential for producing the least CO_2/kWh from conventional fuels, and if designed

	to operate on biofuel would in effect be carbon neutral and operating on a renewable resource. *If developed this vehicle would be a transformational change in transportation technology.* **Budget:** $594,000 **External Collaborators:** Solid-State Energy Technology, Inc., Lynntech, Inc., Planar Energy Devices, Inc., CFX Battery, Inc. Back to Thrust 1: Overarching ***This project has been completed***
	Title: PV Power Generation Using Plug-in Hybrid Vehicles as Energy Storage **PI:** J. Shen, **Co-PI:** I. Batarseh - UCF **Description:** The objective of this project is to develop and demonstrate an alternative PV power generation architecture that uses plug-in hybrid vehicle as the energy storage and transfer element with a total system cost target of $3.50/W. The tasks include developing efficient, reliable, and inexpensive maximum power tracking DC/DC battery chargers and 3-phase converters. A 10kW demonstration solar carport charging station will be built on UCF campus. A plug-in hybrid vehicle with a 25kWh battery bank (battery-only driving range of 50-100 miles) and onboard bidirectional AC charging system will be demonstrated **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 **Description:** The goal is to increase the efficiency and reduce the cost of solar power through the integration of PV, Li-battery, and LED lighting technologies. Since all components are in the form of thin films, the PV/battery/LED system can be integrated as a single module. Since half of the materials cost of each device is the substrate, integrated module will also reduce materials costs and processing steps. Importantly, their integration further eliminates the need for inverters since they are all low-voltage devices. Such an integrated device can be used to store energy during the day and power the LED panel for lighting in the evening. In addition, we will explore the possibility of fabricating a semi-transparent module. The success of this Task will lead to a novel solar-power lighting panel that can be used as a sky light during the day and a lighting panel during the night without using grid-power. We not only will develop the technologies, but also integrate devices and perform technology-economic evaluation, including life-cycle costs. **Budget:** $576,000 Back to Thrust 1: Overarching
THRUST 5: Ensuring Nuclear Energy & Carbon Constrained Technologies for Electric Power in Florida	
	Title: Reducing Residential Carbon Emission in Florida: Optional Scenarios Based on Energy Consumption, Transportation, and Land Use **PI:** Tingting Zhao**, Co-PI:** Mark Horner - FSU **Description:** In 2007 the Governor of Florida established targets for greenhouse gas (GHG) emissions, which mandate that the State of Florida aims to reduce emissions to 2000 levels by 2017 and to 1990 levels by 2025. To fulfill these goals, not only is the development of renewable sources of energy and fuel needed, but it is also necessary to achieve more sustainable energy and fuel consumption patterns. This project is dedicated to the latter objective, i.e., exploring the effectiveness of optional scenarios for households' consumption of energy and transportation fuels with respect to carbon dioxide mitigation. Human land use is another major concentration of this research, as changes in the built environment and vegetation cover may create sources or sinks of carbon dioxide and hence affect the intensity and origins of carbon emissions. The proposal of this project consisted of three major steps: 1) calculating the Florida baseline carbon dioxide emissions from residential energy and fuel consumption as well as human land uses; 2) developing models of household behavior regarding various energy/fuel conservation and incentive options based on a

	residential survey; and 3) forecasting energy/fuel demand and CO_2 emission levels in 2017 and 2025 throughout the state of Florida based on the scenarios created in step two. This project was planned to be completed within two years. The PIs concentrated mainly on 1) journal publications on carbon inventory analysis at the state level; 2) finalizing the household energy consumption survey (including sampling design), which is composed of over 30 questions dedicated to household energy practice and responses to energy-saving incentives; and 3) preparation for the external grant application to the NSF Geography and Spatial Sciences (GSS) program. Data collection from the survey is complete and data analysis is underway. **Budget:** $60,844 ***This project has been completed***
	Title: Planning Grant: Enhanced Thermal Performance and Microstructure Simulation of Nuclear Fuels **PI:** Justin Schwartz - FSU **Description:**The objective of this proposal was to perform preliminary investigations to determine the viability of improved oxide nuclear fuels through high thermal conductivity coatings such as "BeO." To meet Florida's sustainable energy demands, they pursued the option of enhanced oxide nuclear fuel performance by considering the potential for improved thermal behavior through high thermal conductivity oxide coatings. This work will included a literature search of past investigations of the impact of enhanced thermal conductivity on nuclear fuel and reactor performance, the temperature and irradiation dependence of the thermal conductivity of BeO and other high thermal conductivity oxides, the chemical and thermal compatibility of BeO and nuclear fuels (UO2, PuO2, ThO2 and MOX), and initial studies into BeO coatings on HfO2 particles, where HfO2 serves as a benign surrogate for nuclear fuel oxides. This project is complete. **Budget:** $15,000 ***This project has been completed***
	Title: Biocatalytic Lignin Modification for Carbon Sequestration **PI:** Jon Stewart - UF **Description:** After cellulose, lignin is the second most abundant forma of carbon in plants. Lignin's complex structure makes it difficult to use this material in value-added products, and ahte vast majority of lignin is currently burned to provide energy for factory operations. While burning plant derived lignin US DOEs not add to global greenhouse gas levels, having options to remove lignin from the global carbon cycle would lead to diminished atmospheric CO2 levels. This could be accomplished by chemically altering lignin's structure to facilitate long-term terrestrial sequestration or using it in value-added products that would not be discarded immediately. We will use Nature's catalysts (enzymes) to tailor the chemical structure of lignin for both deep-well injection (by using lignin derivatives as drilling "muds") and for materials that can be used in building, packaging, and other manufactured products.) **Budget:** $200,000
	Title: Database Infrastructure for Integrative Carbon Science Research **PI:** Sabine Grunwald. **Co-PI:** Tim Martin - UF **Description:** Rising CO_2 concentrations in the atmosphere and effects on global climate change have been well documented, and future impacts are uncertain but potentially devastating. Florida's natural and agro-forest ecosystems have much potential to sequester carbon in biomass and soils due to unique climatic and landscape conditions. However, research gaps exist to accurately assess carbon pools and fluxes at coarse scales, ranging from county to the region and larger. The overarching objective of this project is to address these obstacles by creating a terrestrial carbon

	information system (called "TerraC") for the carbon science community, focused on ecosystems in Florida. The information system will be administered through the UF Carbon Resources Science Center (http://carboncenter.ifas.ufl.edu), a multi-disciplinary Center dedicated to research in support of enhanced agricultural and natural resource carbon management. **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 **Description:** Rising concerns over increasing levels of greenhouse gases, especially carbon dioxide, have led to suggestions to capture carbon dioxide at fixed sources, such as fossil fuel power plants, and sequester the carbon for millennia by injecting it underground. Florida overlies many thousands of feet of carbonate rocks which may be suitable for geologic sequestration of carbon dioxide. This project will investigate the potential for geologic sequestration of carbon dioxide in Florida, the physical and chemical changes that may occur as a result of injection, assess the potential for escape of injected carbon dioxide, determine the risk, if any, to aquifer systems used for water supplies, develop methodologies for Florida utilities to predict the performance and risks of proposed sequestration projects, and educate a cohort of geologic sequestration professionals to create a carbon sequestration industry in Florida. **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: Marine Energy Resources	
	Title: Southeast National Marine Renewable Energy Center **PI:** Susan H. Skemp**, Co-PIs:** Howard P. Hanson, James VanZwieten - FAU **Description**: The research and development program being conducted by the Southeast National Marine Renewable Energy Center (SNMREC) is structured to be the catalyst that will enable the ocean energy industry in Florida toward determining solutions to answer the state's energy challenge. This project focuses on determining the potential of harnessing the ocean current resource and ocean thermal energy conversion (OTEC). The regulatory process both at State and Federal levels continues to evolve as the roles and interdependencies of the individual agencies are more clearly articulated. In addition, knowledge to make these decisions is being defined and targeted on a micro level necessary to assess individual devices. SNMREC's mission is to bridge the gap between concept and commercial deployment of ocean energy technologies by providing at-sea testing facilities for both ocean current and thermal energy research and for technology development. Research cuts across environmental, ecological, resource and technology. **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.
	Title: Buoy Array for Ocean Wave Power Generation **PI:** Z. Qu, **Co-PI**: K. Lin - UCF **Description:** The objective of this project is to develop a novel design that can extract ocean wave energy for commercial consumption. The design detailed herein is unique in that it is a wave point energy

	harvester that is small in size and contains all of the mechanical components directly within the buoy. The project focuses mainly on the mechanical system within the buoy as well as methods to control the electrical load on the system. Different mechanical systems have been developed and tested on a motion platform to simulate a vertical wave motion—these systems have been analyzed and compared in order to provide an ever-increasingly effective design. The Harris Corp. have acted as new collaborators with the project since October 1st 2010, funding four UCF senior design teams in the development of a buoy for wave power generation. **Budget:** $150,000 ***This project has been completed***
THRUST 7: Securing our Energy Storage and Delivery Infrastructure	
	Title: The Future Florida Grid: Ensuring a Reliable and Resilient Electrical Energy Transmission and Delivery System in a Changing Environment **PI:** Steinar Dale, **Co-PIs:** T. Baldwin, O. Faruque, J. Langston, P. McLaren, R. Meeker, K. Schoder, M. Steurer - FSU **Description:** The project research goal is to address the challenges of the reliable movement of electrical energy throughout the state as the power system is transformed to include far more renewable and alternative sources, increased use of distributed energy resources (including storage and electric vehicles), emergence of microgrids, possible expansion of new very-large centralized baseload (nuclear), and incorporation of new power conversion, transmission, measurement, communication and control technologies (smart grid). This project has also supported ongoing participation and contributions in national, state, and local power and energy stakeholder groups, including the Gridwise Alliance, the North American Synchrophasor Initiative (NASPI), the American Society of Mechanical Engineers' (ASME) National Energy Committee, the Institute of Electrical and Electronics Engineers (IEEE) Power Engineering Society (PES), Florida's Great Northwest Alternative Energy Advisory Council, and the Tallahassee-Leon Economic Development Council (EDC) Energy and Environment Roundtable. **Budget:** $431,982 Back to Thrust 1: Overarching ***This project has been completed***
	Title: Microgrids for a Sustainable Energy Future **PI:** Chris S. Edrington, **Co-PIs:** Helen Li, Juan Ordonez, Jim Zheng, Mischa Steurer - FSU **Description:** The primary aim of the project was to address research and development in the area of microgrids. Specifically the focus was in the area of PV and Plug in Hybrid Electric Vehicles integration, microgrid modeling and control, grid-tying inverters/converters, energy storage, tri-generation, and standards development for smart grids. **Budget:** $719,333 ***This project has been completed***
	Title: Real-Time Power Quality Study For Sustainable Energy Systems **PI:** U. Meyer-Baese, **Co-PIs:** Helen LI, Simon Foo, Anke Meyer-Baese, Juan Ordonez - FSU **Description:** The main objective of this project is the collection of preliminary data for IESES proposals that can be used to seek local, national and international sources of external funding from private and government sponsors. The overall project has been split up in several independent subprojects to allow a timely completion of the tasks. All tasks have been completed successfully. **Budget:** $15,000 ***This project has been completed***
	Title: Planning Grant: Advancing Knowledge of Network Theory for Analysis and Design of Smart Power Grids **PI:** Svetlana V. Poroseva. **Co-PIs:** Yousuff Hussaini, Per Arne Rikvold - FSU

	Description: With power grids evolving towards increasing size, complexity, and integration, it has become more difficult to describe and predict their behavior, even under normal operational conditions. With technological development, climate change, and activities in the political arena, adverse circumstances (natural disasters, intelligent adversary, software design errors, human errors, etc.) have become more probable and costly events. The Project seeks to provide industry and government with advanced analytical and computational tools necessary for the automated evaluation of the structural resilience and reliability of power grids. The potential applications of the Project's results go beyond power grids. Any infrastructure essential to our society and economy (e.g., computer, communication, transportation) can benefit from the Project's results. This project is complete. **Budget:** $15,000 ***This project has been completed***
	Title: Investigating the Effect of Appliance Interface Design on Energy-use Behavior **PI:** Paul Ward**, Co-PIs:** Ian Douglas, David Eccles - FSU **Description:** The primary objective of this research project was to identify the behavioral factors that contribute to energy in/efficiency in the home. In particular, this project was designed to (a) examine current state-of the science on behavioral factors that affect energy efficiency, (b) report on the efficiency of typical energy consuming technology used in the home as well as existing programs designed to improve efficiency, and (b) investigate the types of human-technology interactions and other behavioral factors that lead to in/efficient energy use. To achieve these objectives this project proposed to use laboratory-based experimental and field-based methods to (i) identify interface-design factors that constrain individuals to behave in locally optimal but globally sub-optimal ways, and (ii) survey how cognitive, technological, and motivational behavioral issues affect use in the home environment. **Budget:** $247,720 ***This project has been completed***
	Title: Energy Delivery Infrastructures **PI:** Lee Stefanakos **Co-PIs:** Zhixin Miao - USF (Formerly Alex Domijan (PI) and Arif Islam (Co-PI). Left USF). **Description:** The proposed project is to simulate the effects of a renewable energy generation system in a microgrid context to the distribution grid system. The proposed project is to simulate the combination of renewable distributed generation and a battery system to assess the effects during critical conditions such as power system peak. A research opportunity is to investigate how existing tools can be applied to properly representing dynamic and transient behaviors of microgrids. Therefore, in this project we propose using simulation tools to model a microgrid and investigate how well we can reproduce its measured behavior in the field **Budget:** $485,184
	Title: Micro Battery Defense Development **PI:** Chunlei Wang - FIU **Description:** The microbattery market for new miniature portable electronic devices such as cardiac pacemakers, hearing aids, smart cards, personal gas monitors, micro electromechanical system (MEMS) devices, embedded monitors, and remote sensors with RF capability is increasing rapidly. Thin-film lithium batteries are among the most advanced battery systems that can scale down to the dimensions that match the MEMS devices. However, these two-dimensional (2D) batteries are necessarily thin in order to maintain effective transport of Li ions. In order to power MEMS devices with limited device area (areal "footprints"), batteries must somehow make good use of their thickness. Three-dimensional (3D) configurations offer a means to keep transport distances short and yet provide enough material such that the batteries can power MEMS devices for extended periods of time. In this project, we focus on developing functional 3D microbatteries based on our carbon microelectromechanical systems (C-MEMS) technique.

	These microbatteries could offer order of magnitude increases in electrode surface area and charging capability than thin film batteries at the same size scale. **Budget:** , $192,418.30 – *Not Funded by FESC*
	Title: Electrostatic Spray Deposition of Nanostructured Porous Metal Oxide Composite **PI:** Chunlei Wang - FIU **Description:** Recently, conversion reactions of interstitial-free 3d metal oxide structures (such as CoO, CuO, and NiO) with structures unsuitable for intercalation chemistry have nevertheless been shown to exhibit large, rechargeable capacities in cells with lithium. The specific capacities of these materials, which are potential candidates for the negative electrode, can be as high as 1,000 mAhg-1 (about three times of commonly used graphitic carbons). However, practical implementation using these metal oxides is hampered by the large capacity loss of the first cycle and poor material cyclability. These problems are partially attributed to the significant volume changes that occur during lithium uptake and removal (molar volume change of ~100%), which causes mechanical failure and the loss of electrical contact at the anode. They are also due to aggregation of metal nanoparticles that appears during the process of discharging the metal oxide anodes. In order to overcome these two challenges and develop excellent rate capabilities and high power densities of Li-ion batteries, metal oxide composite electrodes with hierarchical mixed conducting network structures will be synthesized. We propose the preparation and testing of multi-component metal oxide anode films with a variety of morphologies using a simple and versatile method based on the electrostatic spray deposition (ESD) technique. The ESD technique enables us to reproducibly fabricate thin film ceramic materials with simple, low-cost and controllable designed morphologies. ESD-derived ceramic thin films we obtained including 3-D reticular, spongy-like, hollow sphere, dense, etc morphologies. The structures of these films can be easily tailored by changing the precursor solution component(s) and adjusting the substrate temperature. In this project, we plan to fabricate porous metal oxide materials, MxOy (M=Fe, Co). Material characterization methods (such as: SEM, TEM, AFM, BET, etc) will be used to study the correlation between ESD parameters and surface morphologies. **Budget:** $88,378.711 - *Not Funded by FESC*
	Title: Fabrication and Investigation of Porous Tin Oxide Anodes for Li-Ion Micro Batteries **PI:** Chunlei Wang - FIU **Description:** The requirement of higher energy capacity microbatteries demands the exploitation of new substitute materials with higher energy capacity than traditional graphite. SnO2 has been considered as one of the most promising substitutes for the carbon anode in Li-ion batteries due to its high Li+ storage capacity. However, the practical application of SnO2 as anode is restricted by poor cyclability and rate capability due to large volume change during cycling, which can cause disintegration and electrical disconnection from current collector. In this project, we propose the preparation and testing of tin oxide anode films with a variety of porous morphologies using Electrostatic Spray Deposition (ESD) technique. Our research focus will be developing an ESD processing to fabricate tin oxide electrode with different pore sizes ranging from macropores to mesopores and down to micropores; constructing hierarchical porous tin oxide electrode by controlling process parameters and introducing a surfactant or polymer additives, and material characterization and electrochemical analysis in order to investigate the correlation between morphology and electrochemical performance and understand the underlying mechanism. The proposed research will significantly enhance our understanding of fundamental issues regarding intrinsic properties of porous SnO2 films as anode for Li-ion batteries. **Budget:** $100,000 - *Not Funded by FESC*
	Title: Very High Energy-Density Ultracapacitors **PI:** E. Bakhoum, UWF **Description:** A new type of ultracapacitor that offers a capacitance density on the order of 500 Farads per cubic centimeter or higher has been created. The principle behind the new ultracapacitor structure is the

	insertion of a 100 nm-thick layer of barium strontium titanate as an interface between the activated carbon electrode and the electrolyte. The new ultracapacitors are highly needed in hybrid vehicle applications; as any significant increase in the energy storage capability of the ultracapacitors leads to substantial improvement in the fuel efficiency of hybrid vehicles. Two manuscripts about this new development were published in 2009. Additional research is ongoing. - *Not Funded by FESC*
	Title: Secure Energy Systems **PI**: Pramod Khargonekar - UF **Description**: The goal of this project is to investigate the concept of secure energy systems and formulate a concrete vision of a broad-based, comprehensive research program. An additional project goal is to develop architecture for modeling, analysis, and design of secure energy systems. An energy system consists of a collection of interconnected subsystems representing energy generation devices, energy consumption devices, transmission, distribution, and storage devices, and communications and computing devices. Such systems are dynamic and its operation is influenced by external perturbations. Definition of the system and it environment depends on the problem of interest. This project is motivated by strong interest among key decision makers in understanding and assuring security of energy systems in the face of various natural and man-made threats. Increasing penetration of renewable energy sources and capabilities offered by smart grid have the potential to enhance or degrade security of energy systems. Thus, these new developments present additional motivation for understanding of secure energy systems. Whereas there is an intuitive understanding of security and assurance, much work remains to be done in formulating precise definitions that cover problems of interest and devising an overall architecture that may facilitate a system level analysis and design of such secure energy systems. Taking into account rapid changes in the energy issues in a wide variety of private and public sectors, this project is a proactive effort to develop a vision and architecture for analysis and design of secure energy systems. It is expected that the results of this project will lead to future development and integration of specific analysis and design algorithms and software that will assist system designers in assessing and ensuring an appropriate level of system security. **Budget**: $220,000 Back to Thrust 1: Overarching
	Title: Optimization, Robustness and Equilibrium Modeling for the Florida Smart Grid **PI:** Panos Pardalos - UF Description: This project began in January 2011. It aims to develop algorithms for optimal design and functioning of Florida's next generation of power transmission and distribution systems that will incorporate the new realities of the grid. The goal is to create innovative real time capabilities for 1) optimal location of renewable energy source; 2) detection and prevention of instabilities and outages; and 3) operating models including generalized Nash equilibrium problems in the electricity market. **Budget**: $30,000
Policy	
	Title*:* Economic Impacts of Renewable Energy and Energy Efficiency Policies **PI:** Theodore Kury – UF (PI use to be Mark Jamison) **Description**: To serve its mission and contribute to FESC's fulfillment of its mission, PURC is conducting the three projects described below. These projects will be completed in two years and will deliver policy relevant reports and academic quality papers. The projects are: 1) Economic and Job Impacts of State Renewable Energy and Energy Efficiency Policies This project will provide empirical estimates of state renewable energy and energy efficiency policies on economic development and jobs. 2) Electric Grid Impacts of State Renewable Energy and Energy Efficiency Policies This project will provide an estimate of the impacts of renewable energy policies on the electric grid. It will fill a gap in the literature for Florida, which as to date focused on the impacts on electricity generation.

	3) Effects of Energy Commodity Profit Margins on Effectiveness of Energy Efficiency Programs This project will test an assumption that is built into many state energy policies and that is held by many policy makers at the national level, namely that utilities would improve consumer energy efficiency practices if utility prices were decoupled from utility profits. **Budget:** $150,000
	Title: Environmental Impacts of Energy Production Systems: Analysis, Evaluation, Training, and Outreach **PI:** Amy B. Chan-Hilton, **Co-PIs:** Gang Chen, Wenrui Huang, Michael Watts, Ming Ye, Paul Lee - FSU **Description:** The goal of this project is to develop tools and conduct research to objectively assess environmental and water resources needs and constraints while developing prudent energy strategies and policies. The focus of this research will be on fuel cycle and energy production systems. The objectives of this project were to analyze the environmental and water resources demands and potential impacts, specific to Florida's unique geographical challenges, of fuel cycle systems and develop an objective environmental impact screening and evaluation tool or decision support system for energy planning and policy making by Florida's industry, utilities, and government. As Florida develops its long-term energy strategy, multiple efforts are ongoing to develop and apply a wide range of energy technologies that are sustainable and carbon-neutral. But pragmatic issues related to environmental impact and sustainability need to be addressed before these technologies may be implemented. This project directly addressed the FESC's Thrust 6 on "Energy systems and their environmental and economic impacts." This project also directly addresses IESES's Objective 4 on unique geographical challenges and Objective 5 on sustainable energy engineering, science and the sustainable energy economy. **Budget:** $118,470 **External Collaborators:** Florida Department of Environmental Protection ***This project has been completed***
	Title: Promoting Energy and Land Use Through Land Use, Transportation and Green Infrastructure Polices **PI:** Tim Chapin, **Co-PIs**: Ivonne Audirac, Chris Coutts, Greg Thompson, Mark Horner - FSU **Description:** In response to the many issues related to energy provision, energy sustainability, and GHGs, in 2007 Governor Crist created an Action Team on Energy and Climate Change. This group was tasked with investigating and recommending strategies for reducing GHG emissions, creating more sustainable energy systems in Florida, and for establishing Florida as an international leader in innovative energy provision. Related to this, the 2008 session saw the Florida Legislature pass HB 697 which, among many things, requires every local government in the state to address energy systems and GHG emissions explicitly within their comprehensive plans. Currently, the linkages between energy planning, environmental and economic sustainability, land use and transportation planning, and GHG reductions have never been stronger in Florida. This project is aimed at continuing the momentum in Florida for developing broad-based solutions to these problems by helping to develop a knowledge base for informing state policy in the areas of energy, sustainability, and land use and transportation planning. **Budget:** $168,185 ***This project has been completed***
	Title: Political and Economic Institutions Regarding Siting of Energy Facilities **PI**: R. Mark Isaac, **Co-PIs:** Douglas Norton, Svetlana Pevnitskaya - FSU **Description:** The "Hold-Out" project evaluates the "hold-out" concept, which is discussed repeatedly in the context of public policies regarding land acquisition and facilities siting, but a clear definition is elusive. To economists, the most likely definition is that a profitable amalgamation of land parcels by one buyer from competing sellers US DOEs not occur because of the failure of the private bargaining process. However, sometimes the term seems to be used more for delay instead of failure in bargaining, or even the

	very different concept of creation of any bilateral bargaining situation of the buyer and the "last" or "holding-out" seller, which may be inconvenient to the buyer but is immaterial in terms of economic efficiency unless efficient trades actually fail. The experimental design is complete, the programming is complete, Institutional Review Board approval has been obtained, and we have conducted two complete experimental treatments. This research was presented at one of the Presidential Sessions at the 2009 Meetings of the Southern Economics Association in November in San Antonio. **Budget:** $79,621 ***This project has been completed***
	Title: Experimental Investigation of Economic Incentives of Policies, Institutions and R&D in Environmental Conservation **PI:** Svetlana Pevnitskaya, **Co-PI:** Dmitry Ryvkin - FSU **Description:** Policies and institutions aiming at reducing pollution and battling climate change often do not reach desirable results because actual decisions of governments and economic agents deviate from those predicted by theory. We employed methods of experimental economics to find and explore such deviations and their causes, and used the findings to modify theory and design better policies and institutions. In this project, we constructed a theoretical model of decisions in a dynamic environment with costs of pollution and climate change, while testing the theory in laboratory experiments with human subjects. We studied actual behavior and explore responses to changes in the environment, production technologies, investment in clean technology and institutions. This project is complete. **Budget:** $43,217 ***This project has been completed***
	Other
	Title: Fusion Energy Spheromak Turbulent Plasma Experiment-STPX **PI:** Charles A. Weatherford, **Co-PIs:** Kyron Williams, Ephrem Mezolin - FAMU **Description:** The Florida A&M University's Center for Plasma Science and Technology (CePaST) has nearly completed the construction of a spheromak fusion reactor. A spheromak is one of a general class of experiments used to investigate key plasma physics principles relevant for the development of magnetically confined, controlled thermonuclear fusion as a source of electrical power. This project involves collaboration between Florida A&M University CePaST, West Virginia University, and Auburn University. The spheromak turbulent plasma physics experiment (STPX) is being constructed at FAMU in a facility especially built for the STPX experiment. Fusion research is a key element in the nation's long term energy supply strategy, The spheromak concept may be a possible alternative to the tokamak concept (deployed at ITER) which affords access to fundamental fusion science issues supportive of fusion while allowing us to maintain and nurture an American fusion scientific workforce. This project will determine, using a fast duty cycle between theory, experiment, and simulation, the essential elements required for full kinetic modeling of an entire spheromak plasma using ab initio MHD with direct modifications from new turbulence physics. The project will focus on the management of fluctuations and transport in a spheromak plasma using new turbulence physics models and comprehensive helicity control. We will employ high time- and spatial-resolution measurements of electron temperatures, ion temperatures, and magnetic field fluctuations to investigate, understand, and eventually control reconnection driven heating as a means of increasing the plasma temperature of spheromak plasmas. We will use divertor diagnostics of radiation and particle transport along with edge biasing for electric field control to explore the effects of driven flows on confinement and heating in spheromak plasmas with microparticles and will investigate the effects of MW pulses coupled to protons on the plasma current and confinement. **Budget:** $950,000 – *Not Funded by FESC* **Universities and External Collaborators:** Dr. Earl Scime, West Virginia University

	Dr. Ed Thomas, Auburn University Dr. Simon Woodruff, Woodruff Scientific, Inc
	Title: Marketing Strategies to Incentives Entrepreneurship and Innovation in the Development of Sustainable Energy **PI:** Joe Cronin - FSU **Description:** The objective of this project was to investigate the role of market pull strategies in advancing sustainability goals. Specifically, the intent is to identify what "drives" consumers' attitudes and behaviors relative to sustainable products. This includes consumers' personal attitudes, opinions, and beliefs, their perceptions of their own and organizations' abilities to affect or change the environment in which they live, and their personal characteristics (e.g., demographics). In addition, in collaboration with the College of Communications, the strengths and weaknesses of the various communication modalities that can be used to deliver sustainability knowledge to consumers (e.g., advertisements, testimonials, expert word-of-mouth communications, public relations, publicity, etc) were assessed. Specifically, the research attempts to identify the optimal market pull modality; that is, the means by which to deliver to consumers the knowledge that drives the purchase of sustainable goods and services. The overall objective of the research is to provide much needed market pull information for organizations embarking on "green" marketing strategies; that is, firms in the process of developing or expanding their mix of environmentally friendly goods and services. **Budget:** $191,555 ***This project has been completed***
	Title: Energy Sustainable Florida Communities **PI:** Richard Feiock, **Co-PIs:** Ivonne Audirac, Keith Ihlanfeldt - FSU **Description:** The objective of NESC is to stimulate innovation and energy investments that will accelerate energy savings by local governments by sharing best practices and organizing and managing large scale collaboration and bulk buying projects. Florida State University has been working with U.S. US DOE contributing surveys, research and outreach assistance to assist in efforts to promote investment, collaboration, and bulk purchasing by local governments that will achieve significant cost savings. This includes organizing NESC conference calls co-hosted by hosted by FSU and US DOE, conducting several surveys, and hosting a meeting of Florida local government EECBG sub-awardees. These initial research efforts and conference calls have been successful in identifying broad interest in collaboration and bulk buying. They also revealed significant barriers to collaboration that need to be addressed including issues related to coordination within governments, among governments and with other organizations. We are now undertaking activities to address these barriers to collaboration at three levels: First we are conducting focused regional workshops throughout the state. By bringing interested governments in each region together with experts in collaboration, governance, finance, and purchasing we will identify specific projects and design the mechanisms to put the projects in place. Second, are expanding our statewide dialogue on a more systematic basis and share the insights and successes of our regional workshops. Third, we are working with universities and other partners throughout the U.S. to share strategies and insights and help replicate our successes in other states. By expanding our efforts and formalizing the network we will make large scale energy savings a reality. **Budget:** $125,424 ***This project has been completed***
	Title: Development of a Renewable Energy Research Web Portal **PI:** Charles R. McClure, **Co-PIs**: Ian Douglas, Chris Hinnant - FSU **Description:** This project identified, organized, and made available via a web portal, research generated as

	part of the FESC effort as well as other selected related information resources and tools as identified by FESC participants. The goal of this project was to provide IESES, FESC, researchers, and others in the state of Florida with the research information they need to accomplish statewide energy goals. An initial product from this project was an operational web portal that identifies, organizes, and provides access to a range of FESC and other research related to renewable and alternative energy information. A second product was research results on extending technologies that allow users to share information and grow/sustain the web portal through a range of social networking techniques. This research attempts to position FSU to seek additional external funding related to interactive databases and web portals. The ultimate expected outcomes resulting from the project include increased IESES and FESC researcher productivity; increased leverage and collaboration of FESC resources and funding; and improved policy- and decision-making regarding the future uses and development of renewable and alternative energy in Florida. **Budget:** $194,542 ***This project has been completed***
	Title: Planning Grant: Hydrogen Storage Using Carbon-Based Adsorbent Materials **PI:** Efstratios Manousakis - FSU **Description:** This project was a theoretical investigation of a variety of carbon based nano-porous materials, such as activated carbon or single-wall or multi-wall carbon nanotubes, which can be used to store and transport hydrogen. We find that by doping with metallic elements, the micro-surfaces of these carbon-based porous materials provide increased van der Waals forces to the adsorbed hydrogen molecules; this effect significantly enhances the volumetric energy density for hydrogen storage and we caried out a full theoretical investigation to find the optimum conditions. This project is complete. **Budget: $15,000** ***This project has been completed***
Education and Outreach	
	Title: Florida Advanced Technological Education Center (FLATE) **PI:** Marilyn Barger - UF **Description:** FLATE (Florida Advanced Technological Education Center) is FESC's partner to develop statewide curriculum frameworks for technical A.S./A.A.S. degree programs supporting existing and new energy business sectors. FLATE develops the frameworks and facilitates their progress through the multiple sequential industry-validation, student competencies based, FLUS DOE procedure. FLATE also develops new courses and provides faculty professional development as required for each new program of study. Additionally FLATE helps colleges in the State College System implement the new frameworks in their institutions. To support the new curriculum, FLATE will work closely with the FESC Public Outreach and Industry Partnership programs to provide additional professional development opportunities for teachers and faculty to upgrade and update their STEM knowledge base. **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 **Description:** Developing 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. **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) **Description:** The goal of this project is to contribute to a major initiative on design, licensing and construction of a fully digital control system for the University of Florida Training Reactor (UFTR). 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. With this effort, a new focus/certificate on digital control and instrumentation will be developed at the Nuclear and Radiological Engineering (NRE) Department. Further, 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). The project has already received significant funding from industry and government in form of grants, contracts, equipment/systems, and engineers' time. **Budget:** $308,000 **External Collaborators:** Several engineers from AREVA NP Inc & Siemens Corporation
	Title: Energy and Efficiency Video Public Service Announcements **PI:** Andy Opel, **Co-PIs:** Phil Steinberg, Leslie France-Patterson, Laura Arpan, Ian Weir - FSU **Description:** This interdisciplinary team produced 6-8 short (30-second/one-minute) video public service announcements (PSAs) that address issues of energy and efficiency and one 12-15 minute informational documentary targeted to Florida legislators and the Governor's office. These videos will be tailored to reinforce existing IESES efforts. **Budget:** $200,720 ***This project has been completed***
	Title: Planning Grant: Climate modeling and Outreach Activities **PI:** Shawn R. Smith, **Co-PIs**: Steve Cocke, David Zierden, James O'Brien, Julie Harrington - FSU The objective of the planning grant is to develop at least one external funding proposal that focuses on areas of climate modeling and/or climate outreach that support the activities of the IESES. The focus of our activities has centered on evaluating the potential offshore wind resource in the northeastern Gulf of Mexico and elsewhere in Florida's waters. Preliminary research has been completed using observations from instrumented Air Force towers and buoys in the waters around Florida. The existence of wind power capacity has been identified at the assessed locations. Due to the sparseness of in-situ wind data in the region, a numerical modeling approach will need to be pursued to develop a wind climatology with sufficient spatial and temporal scales to further define the offshore wind power capacity. A vast portion of the work conducted focused on outreach and education. When we began our project, the idea of offshore wind power in Florida was not even on the radar of the Florida Legislature or the

	renewable energy sector at large. We worked to raise the visibility of offshore wind as an energy resource for Florida by attending meetings, connecting with the wind power industry in Florida, and briefing two members of the Florida Legislature and presenting to the Florida Energy and Climate Commission. As a result of these connections, we submitted a preliminary proposal to Siemens Wind Power and have developed a network of colleagues both within FSU and the private sector that are interested in further developing Florida's offshore wind resource. **Budget:** $15,000 ***This project has been completed***
	Title: Visiting Law Professor **Principal Investigator:** JB Ruhl, Jim Rossi **Co-PI:** Uma Outka - FSU **Description:** Two-year Visiting Scholar, Uma Outka, at the College of Law researched the interface between land use law and innovative energy solutions and delivering academic symposia and graduate student seminars on the research scope, comprising Sustainable Energy Research Project (SERP) within Environmental and Land Use Law Program. This project is complete. **Budget:** $214,603 ***This project has been completed***
FESC Phase 2 Technology Commercialization	
	Title: Development of a Low Cost Concentrating Solar Energy System Using Solar Sausages **PIs:** David VanWinkle, Sean Barton – UF **Description:** Beginning in late 2010, weekly meetings have been held at HHH offices in Tallahassee that include representatives of the several entities involved in deploying the "Solar Sausage" concentrating system at the Yulee St. site in Tallahassee. The entities include Pro Solar Inc., Barkley Consulting Engineers Inc., Winton Engineering PA, and Applied Research and Design Inc. A series of 50-foot long prototype sausages were made and inflated on site. Many issues were identified that needed to be resolved before manufacturing and deploying several hundred solar sausages on site including methods of constructing, mounting, and operating the balloons, distribution of air and electricity, and removal of heat. **Industry Partner:** Hunter and Harp Holdings (HHH)
	Title: Stress Evolution in Solid-State Li-Ion Battery Materials **PI:** Kevin S. Jones – UF **Description:** Li-ion battery (LIB) technology is promising for use in electric drive vehicle (EDV) and stationary energy storage applications. However, challenges with materials safety, performance, cost, and manufacturing scalability have largely prohibited LIB implementation in these situations. Challenges in stress evolution during the fabrication and processing of the elements of the cells remain and are not well understood. In this study the roles of component fabrication and processing conditions on the resulting stresses in the materials are being evaluated. Thin film battery components will be deposited on stainless substrates using a novel fabrication method invented and patented by Planar Energy and the components will be subjected to different annealing treatments. A novel curvature measurement system will be used to characterize the stress in the component layers both after deposition and annealing and structural analysis techniques will be used to correlate the resultant component material microstructure and crystallographic phase(s) with the measured stresses. **Industry Partner:** Planar Energy
	Title: SWNT Based Air Cathodes for Fuel Cells & Metal Air Batteries **PI:** Andrew G. Rinzler – UF **Description:** The goal of this project is to develop and use novel gas diffusion oxygen reducing electrode (air cathode) based on single wall carbon nanotube (SWNT) films in zinc-air batteries and fuel cells. Metal-air batteries, utilizing surrounding air as an inexhaustible cathode material have the highest specific and volumetric energy density of any primary battery system available. Gas diffusion oxygen

	electrodes, where molecular oxygen is electrocatalytically reduced, are vital to battery and fuel cell performance. The air cathode should be permeable to air or another source of oxygen, but must be substantially hydrophobic so that electrolyte will not leak though it, and have an electrically conductive element connected to external circuitry. Generally, conventional air cathode is a thick multilayer film comprising carbonaceous powder mixed with nanoscale metal catalyst to promote oxygen reduction and hydrophobic polymer additive pressed onto electrically conductive layer. While noble metals such as platinum that are commonly used as catalysts in conventional air cathodes offer the advantages of intrinsic catalytic activity, their deficiency in resource, high costs, and susceptibility to catalyst poisoning, have become a serious concern for commercial applications. An optimized SWNT based air cathode catalyst that would constitute a significant improvement in existing technologies is being developed. This new system avoids precious metals, is not poisoned, is thin, light-weight, and resists electrolyte flooding. **Industry Partner:** nRadiance LL
	Title: Uni-Directional Impulse Turbine for the Powering of Offshore Monitoring Systems **PI:** Zhihua Qu, **Co-PI:** Kuo-chi Lin – UCF **Description:** Numerical modeling and experimental testing of turbine for wave energy conversion. 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. **Industry Partner:** Harris Corporation
	Title: Development of high efficiency polymer solar cells **PI:** Frank So – UF **Description:** Polymer solar cells have emerged as a potential alternative to conventional silicon based solar cells for sustainable energy sources. The key advantage of polymer solar cells is the ability to manufacture solar panel by low cost roll-to-roll processes. While the external quantum efficiencies at the peak response in polymer cells can exceed 70%, the power conversion efficiency of polymer solar cells has been limited to about 5-7%. There are three factors limiting the power conversion efficiency of polymer solar cells. First, the absorption bands of most polymers used in solar cells are fairly narrow. In fact, most polymers used cannot absorb all the light within the visible part of the solar spectrum and it will be desirable to extend the photoresponse to the near-IR region. Second, the nanophase morphology of the bulk heterojunctions needs to be well controlled. Once light is absorbed, excitions generated need to diffuse to the heterojunction interface to be dissociated. This condition requires that the dimensions of the donor and acceptor phase domains need to be less than the exciton diffusion length. Third, charge carriers need to be transported to the electrodes with least resistance once excitions are dissociated. Therefore, it is important that the carrier mobilities of both electrons and holes in the polymer blends need to be sufficiently high (10-4 to 10-3 cm2/Vs) and well-balanced. 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 □m with carrier mobilities higher than 10-4 cm2/Vs. Polymer-fullerene (both PC60BM and PC70BM 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 8% at the end of the first year and 10% at the end of the second year of the program. To commercialize the polymer photovoltaic cells developed under this program, through our sponsor Sestar, LLC., we will be working with the Denmark Technical University and Xenia, a UK commercial inkjet printing technology development company to explore high volume manufacturing of polymer solar cells **Industry Partner:** SestarTechnologies, LLC
Other	
	Title: Development of a Highly Efficient Photocatalyst for CO2 Reduction with H2O by Hybrid Construction of Transparent, Conductive Composite (TCC) and nano-Sized MOX/INVO4/AL2O3 Particles **PI:** Norma Alcantar, John Wolan (deceased) **Description:** Our research focused on three technologies to produce films able to respond to external stimuli. We used conductivity as the intrinsic property that was a prime parameter to consider when performance was measured. We also were interested on the fundamental structure that would make our conducting films and materials to enhance their performance. **Universities:** Department of Chemical and Biomedical Engineering, USF **External Collaborators:** Mote Marine Laboratories

APPENDIX B – FUNDING OPPORTUNITIES SENT TO FESC FACULTY

#	Title	Call #	Agency	Total Funding
1	Air Transportation Center of Excellence (COE) for Alternative Jet Fuels and Environment (AJF&E)	13-C-AJFE	Federal Aviation Administration	$40M
2	2013 Agriculture and Food Research Initiative Sustainable Bioenergy Competitive Grants Program	2013 AFRI -Bio	NIFA	$10M
3	Natural Gas	AGDF	AGDF	$50K
4	Environmental Security Technology Certification Program (ESTCP)-Installation Energy	BAA-13-0004	Dept of Army	
5	Research Interests of the Air Force Office of Scientific Research	BAA-AFOSR-2013-0001	AFOSR	$350M
6	Proposed Research on Safety of Oil and Gas Operations in the US Outer Continental	BAA-E13PS00017	Dep of Interior	$900K
7	BIRD Energy	BIRD	BIRD Foundation	
8	Electrochemical Storage Technologies Suitable for Automobile Industry Applications	DE-FOA-0000722	DOE	$62.5M
9	Nonproliferation & International Security Research, Training, & Outreach	DE-FOA-0000741	DOE	$1.5M
10	Academia-Industry Collaboration (AIC) - Synchrophasor Engineering Education Program	DE-FOA-0000767	DOE	$1.1M
11	Advanced Gasification Technologies Program	DE-FOA-0000784	DOE	$13M
12	Bench and Pilot-Scaled applications for R&D of Post-Comnustion and Pre-Combustion CO2 Capture Technologies for Coal-Fired Power Plants	DE-FOA-0000785	DOE	$80M
13	Rooftop Solar Challenge II	DE-FOA-0000788	DOE	

14	Solid-State Lighting Manufacturing Research and Development-Round 4	DE-FOA-0000792	DOE	$11M
15	Solid-State Lighting Manufacturing Research and Development-Round 4	DE-FOA-0000792	DOE	$11M
16	Fiscal Year 2013 Vehicle Technologies Program	DE-FOA-0000793	DOE	$3.5M
17	University Turbine Systems Research	DE-FOA-0000795	DOE	$3M
18	Innovation for Increasing Cybersecurity for Energy Delivery Systems (I2CEDS) – 2013	DE-FOA-0000797	DOE	$20M
19	Advanced Technologies for Monitoring CO2 in Geologic Storage and Utilization Operations - NETL	DE-FOA-0000798	DOE	$9.6M
20	nnovative Nuclear Energy Research and Development	DE-FOA-0000799	DOE	$33M
21	Cost-Shared Development of innovative Small Modular Reactor Designs	DE-FOA-0000800	DOE	$452M
22	Foundational Program Advance Cell Efficiency II (FPACE II) - Model Systems	DE-FOA-0000806	DOE	$12M
23	Nuclear Energy University Programs-Fellowship and Scholarship Support	DE-FOA-0000807	DOE	$5M
24	Advancements in Algal Biomass Yield	DE-FOA-0000811	DOE	$20M
25	Carbon, Hydrogen, and Separation Efficiencies in Bio-Oil Conversion pathways (Chase Bio-Oil Pathways)	DE-FOA-0000812	DOE	$12M
26	Marine and Hydrokinetic (MHK) Environmental	DE-FOA-0000816	DOE	$1.9M
27	Advanced Reactor Research and Development	DE-FOA-0000818	DOE	$3M
28	“Turn Key” Open Source Software Solutions for Energy Management of Small to Medium Sized Buildings	DE-FOA-0000822	DOE	$3M
29	Better Buildings: Commercial Energy Efficiency Solutions	DE-FOA-0000829	DOE	$12M

30	Advanced Biomass Feedstock Logistics Systems II	DE-FOA-0000836	DOE	$5.7M
31	SunShot Incubator Program	DE-FOA-0000838	DOE	$10M
32	Grid Engineering for Accelerated Renewable Energy Deployment (GEARED)	DE-FOA-0000856	DOE	$12M
33	Diversity in Science and Technology Advances National Clean Energy in Solar (DISTANCE-Solar)	DE-FOA-0000857	DOE	$3M
34	Physics of Reliability: Evaluating Design Insights for Component Technologies in Solar (PREDICTS)	DE-FOA-0000861	DOE	$5M
35	Solar Manufacturing Technology (SolarMat)	DE-FOA-0000862	DOE	
36	Solar Utility Networks: Replicable Innovations In Solar Energy (SUNRISE)	DE-FOA-0000865	DOE	$10M-$12M
37	Systems Biology Enabled Research on the Role of Microbial Communities in Carbon Cycling	DE-FOA-0000866	DOE	
38	ARPA-E: Robust Affordable Next Generation Ev-Storage (RANGE)	DE-FOA-0000869	DOE	$20M
39	Combined Heat and Power Technical Assistance Partnerships	DE-FOA-0000876	DOE	$11M
40	Theoretical Research in Magnetic Fusion Energy Science	DE-FOA-0000879	DOE	$3.8M
41	Reducing Emissions Using Methanotrophic Organisms For Transportation Energy (REMOTE)	DE-FOA-0000881	DOE	$20M
42	Modern Electro/Thermochemical Advances In Light- Metal Systems (METALS)	DE-FOA-0000882	DOE	$20M
43	Uncertainty Quantification Methodologies for Enabling Extreme-Scale Science	DE-FOA-0000895	DOE	$5M/year

44	Crosscutting Research: Development of Novel Architecture For Optimization of Advanced Energy Systems Architecture For Optimization of Advanced Energy Systems	DO-FOA-0000864	DOE	$9M
45	Broad Agency Announcement (BAA) Number E13PS00032 for Proposed Research on Oil Spill	E13PS00032	Dep. of the Interior	$6M
46	Unconventional Gas Technical Engagement	ENR-13-01	Dep of State	$500K
47	Gulf ofMexico Research Initiative Request For Proposals	GoMRI Research Consortia	GoMRI	$35M
48	An Analysis of the Impacts of the Deepwater Horison on the Seafood Industry	M13 PS00027	Dep. of the Interior	$360K
49	Solicitaion NSF 13-545	NSF 13-545	NSF	$1.5M
50	Hybrid Energy Storage Module (HESM) Proof of Concept Demonstrations	ONRBAA13-009	ONR	$14.3M
51	National Oceanographic Partnership Program (NOPP)	ONRBAA13-011	ONR	$15M
52	Asia-Pacific Technology and Education Program	ONRFOA13-006	DoD	$30M
53	Woody Biomass Utilization Grant	USDA-FS-2013-WBU	USDA	