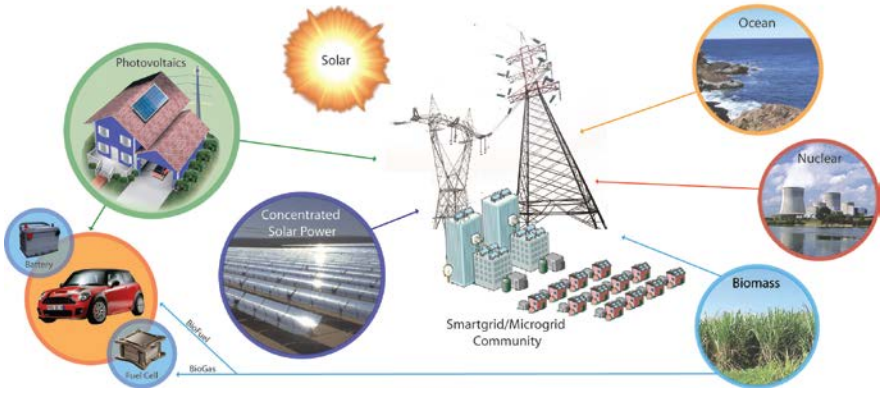
FESC
Florida Energy Systems Consortium

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

May 2014

Reporting Period: Oct 1, 2013 – April 1, 2014



FAU Florida Atlantic University
Florida State University 1851
Florida Agricultural and Mechanical University
Florida Gulf Coast University
Florida Polytechnic University
FIU Florida International University
Novum Collegium Floridae MCMLX
UCF
UF University of Florida
USF University of South Florida
UNF University of North Florida
UWF

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EXECUTIVE SUMMARY

Overview: The Florida Energy Systems Consortium administration office worked very closely with the Office of Energy, the FESC Oversight Board, the FESC Steering Committee, and the FESC Industrial Advisory Board to request new recurring research funding from the state. Both the FESC Oversight Board and the FESC Industrial Advisory Board fully supported the FESC funding request. Budget request documents were prepared and submitted to the Office of Energy before August 2013 as requested by Commissioner Putnam. The FESC administration office had several meetings with the Office of Energy during this reporting period to present the budget request and elucidated its positive impacts on the future of our state in the energy area. The Office of Energy approved $175K of bridge funding with $175K in cost sharing from the UF VP of Research office to support the FESC administration office in continuing its functions; however FESC was recently informed that there will not be any new research funds for the fiscal year 2014-2015. Instead, the Office of Energy is working towards having a matching funds program. These matching funds will be used to provide some of the mandatory cost share requirements of the Federal Grants. This program will be open to both industry and faculty.

With the inclusion of Polytechnic University, FESC now has 12 state universities and 1 guest member. The guest member is Florida Institute of Technology (FIT). We are working with the University of Miami (UM) faculty as well.

FESC is organizing an Energy Workshop in collaboration with Office of Energy and the FESC Steering Committee members. The workshop is scheduled to be on May 12-13, 2014 at the Hilton Conference Center, Gainesville, Florida. Over 130 abstracts were submitted and they were reviewed by the review committee. All the applicants were informed about the review results. The invited speakers were identified. The full agenda is posted at the workshop web site.
Link to the workshop agenda: http://reg.conferences.dce.ufl.edu/docs/FESC/Agendav11.pdf

The 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. The FL CAN grant was completed on March 31, 2014. The last quarterly report was submitted to the program manager. The IP and user facility catalog information was moved to a new web site: http://www.innovationconcourse.com/resources/catalogs. The FESC office will continue to collaborate with the team members to provide FESC user facility support to the Florida energy industry.

FESC continues to produce results in energy research, technology transfer, education, and outreach activities. The FESC administrative office is successfully facilitating interactions among Florida's energy industry and researchers at the 12 state universities, Florida's State and Community Colleges, and the Florida Institute of Technology. The FESC has developed over 900 faculty/industry contacts. This comprehensive network enables and facilitates the transfer of FESC technologies quickly for maximum benefit to Florida's economy. FESC coordinates research teams to develop and submit a significant number of joint proposals. FESC continues to contribute to energy education and outreach programs. Four new energy education projects were funded recently. Their descriptions and brief progress reports are given in the "education" section of this report.

The FESC web site continues to be a widely used tool by energy specialists worldwide. Based on a Google Analytics report, the FESC web site was viewed by 8,262 (6,624 unique visitors, 78.46% new visitors) Google visitors during the period Oct 1, 2013 to April 1, 2014. The viewers visited 19,898 pages. Viewers were from US, Canada, India, China, Europe, Middle East, Russia, South America, Australia, and Africa. In addition, FESC prepares and distributes electronic newsletters every other month to over 900 FESC industry/faculty contacts. The newsletters are posted on the FESC web site.

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 have been spent ~95% of the projects have been completed. The Principal Investigators of the remaining 9 FESC-funded research projects continue to make considerable progress on their research. The progress reports on these 9 projects are given in 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/.

During this reporting period, FESC distributed 65 announcements of funding opportunities with the goal of leveraging state funds. Appendix B contains the list of announcements. All funding opportunities were also posted on the FESC web site. Although the FESC office only collects data on proposal submission and funding once a year, we have summarized information on some of the proposals that were supported by FESC, with the details given in the "New Program Development" section of this report (p. 9). 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 assisting with cost share development. 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. 12).

The FESC leadership visited or communicated via teleconference with the Florida Energy Industry, State of Florida offices as well as the Department of Energy, and National Energy Laboratories 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. There are no new projects in this area, because these funds are depleted.

Twenty three (23) companies have been formed over the last four 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. The 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. FESC works with the Technology Transfer directors at each University, FL CAN Market Research team, and the mentor networks to assist with technology commercialization. The FL CAN grant was completed on March 31, 2014. The last quarterly report was submitted to the program manager. The IP and user facility catalog information was moved to a new web site: http://www.innovationconcourse.com/resources/catalogs. FESC office will continue to collaborate with the team members to provide FESC user facility support to the Florida energy industry.

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 office and faculty are currently in communication with over 100 companies to provide technical assistance. To facilitate the faculty-industry interaction, FESC administrative office has posted a FESC industry database at the FESC website. The site is updated regularly and new industry partners are added to the site and the FESC industry database.
Link to the FL Energy Industry: *http://www.floridaenergy.ufl.edu/?page_id=11727*.

Education and Outreach: Assisting in preparation of 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 and working with FLATE to develop new frameworks. 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. FESC office funded 4 new energy education programs. Their descriptions are given in the "Education" section of this report. The FESC outreach program is using the statewide Agricultural Extension; however FESC outreach has expended their FESC funding, and further efforts are on hold until additional funding is secured. The FESC web site, FESC e-newsletter, and FESC workshop are employed for outreach efforts. The progress reports on education and outreach programs are given in this report (p. 14 and 25).

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 8,262 (6,624 unique visitors, 78.46% new visitors) Google visitors during the period Oct 1, 2013 to April 1, 2014. The viewers visited 19,898 pages. Viewers were from US, Canada, India, China, Europe, Middle East, Russia, South America, Australia, and Africa.

FESC e-Newsletter: FESC prepares and distributes electronic newsletters every other month to over 900 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.

FESC Workshop: FESC Workshop is scheduled to be on May 12-13, 2014 at the Hilton Conference Center, Gainesville, Florida. Over 130 abstracts were submitted and they were reviewed by the review committee. All the applicants were informed about the review results. The invited speakers were identified. The full agenda is posted at the workshop web site.
Link to the workshop agenda: http://reg.conferences.dce.ufl.edu/docs/FESC/Agendav11.pdf

The invited speakers and the title of their presentations are given below:

- Biomass: Paul Bryan, Professor at UC Berkeley and former Program Manager for US-DOE Efficiency and Renewable Energy's Biomass Program
- Smart Grid: Electric Energy Systems of the Future - Visions, Challenges, and Opportunities - Pramod P. Khargonekar, Head of Engineering Directorate, National Science Foundation
- Solar Energy: Solar Energy: What's Next? - Dr. Ryne Raffaelle, Vice President for Research and Associate Provost, Rochester Institute of Technology
- Energy Efficiency: DOE Building Technologies Office: Energy Efficiency R&D - Patrick Phelan, Supervisor, Building Technologies Program, US-DOE, Energy Efficiency and Renewable Energy
- Natural Gas: Natural Gas: Serving Florida's Energy Needs Today and in the Future - John R. Mclelland, Director Gas Supply and Wholesale Origination, TECO Peoples Gas
- Marine Energy: Camille Coley, Assistant Vice President for Research, Associate Director for the Southeast National Marine Renewable Energy Center, Florida Atlantic University
- Education: Trends in Energy Education and Workforce Development - Dr. Dean Evasius, Vice President and Director of Science Education Programs, Oak Ridge Associated Universities

2nd Interdisciplinary Workshop on Smart Grid Design & Implementation: The workshop was organized by Dr. Sean Meyn, Department of Electrical & Computer Engineering in collaboration with the Warrington College of Business Administration. It was held at the University of Florida on March 28 - 29, 2014. Link to the event: http://ccc.centers.ufl.edu/?q=SG2014. Lectures slides and video can be downloaded here http://ccc.centers.ufl.edu/?q=SG2014_Schedule

The goal of the workshop was to examine how best to maximize the contribution of renewable energy and a "smart grid" to realize a sustainable energy future. Engineers, economists, policymakers and industry members from utilities participated in the workshop. Industry members included Xavier Brossat - EDF Paris, Patrick Gannon - S-G Interoperability, Buck Martinez - FP&L, John D. McDonald - GE Energy Management, Tariq Samad – Honeywell, Raiford Smith - Duke Energy, and Jakob Stoustrup - PNNL.

RESEARCH PROGRAM

The FESC research program included 84 FESC funded projects within the seven strategic thrusts. The project descriptions are all 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, only the lead university information is listed in the table. The majority of these projects have been completed. Table 1 below presents the list of the 9 active FESC projects. Four of them are the recently funded energy education projects. The project progress reports of all the currently funded projects are given in 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 the Office of Energy'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. The projects are also given in this file:

2013 FL University Energy Projects.docx

Table 1: Active FESC Projects During This Reporting Period

Projects	Summary
THRUST 2: Enhancing Energy Efficiency and Conservation	
	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 4: Harnessing Florida's Solar Resources	
Solar Thermal	
	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**
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**
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: 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:** $45,000 (Addition to initial budget of $308,000) **External Collaborators:** Several engineers from AREVA NP Inc & Siemens Corporation **Status: Active**
	Title: Energy Sustainability Course **PI:** Mark Jamison **Budget:** $58,000 **External Collaborators:** NA **Status: Active**
	Title: Buildings and Energy: Design and Operation Vs. Sustainability"- An Energy Engineering Course for Florida-specific Building Design & Operation **PI:** Prabir Barooah **Budget:** $67,960 **External Collaborators:** Dr. Timothy Middelkoop, University of Missouri **Status: Active**
	Title: Renewable Energy Education Program at USF's Patel College of Global Sustainability **PI:** George Philippidis, University of South Florida **Budget:** $85,101 **External Collaborators:** NA **Status: Active**
	Title: Introducing Specialization in "Sustainable Energy Systems" for Under-Graduate Students in Engineering at the University of West Florida **PI:** Bhuvana Ramachandran and Co-PI: Muhammad Rashid, University of West Florida **Budget:** $92,169 **External Collaborators:** NA **Status: Active**

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. 65 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 concept papers/proposals facilitated or supported by FESC during the last 6 months include:

RHD-4-23073 for "Regional Wind Deployment Resource Centers": FESC collaborated with SE Coastal Wind Coalition for a proposal development to respond to US DOE's call on Regional Wind Deployment Resource Centers. FESC faculty in this area was introduced to the proposal team. This is a wining proposal and FESC office/faculty will continue to work with the SE Coastal Wind Coalition.
DE-FOA-0001042 - National Incubator Initiative For Clean Energy: Led by the **UCF** Office of Technology Licensing Office. FESC provided a support letter.
DE-FOA-0001043 - Scientific Data Management, Analysis and Visualization at Extreme Scale 2: **UF Lead**
DE-FOA-0001052 - Solid Oxide Fuel Core Technology Program: **UF Lead**. FESC provided a support letter.
DE-FOA-0001060 - Systems Biology of Bioenergy-Relevant Microbes to Enable Production of Next-Generation Biofuels: **FAMU Lead**. Submitted a pre-proposal then invited for a full proposal. Collaborative effort of FAMU, UF, USF, and Pacific Northwest National Lab.
DE-FOA-0000971: Environmental Stewardship for Renewable Energy Technologies: MHK Environmental and Resource Characterization Instrumentation: **FAU Lead**
DE-FOA-0001098 - Marine and Hydrokinetic (MHK) Research And Development (R&D) University Consortium: **FAU Lead**
DE-FOA-0001027, Building Energy Efficiency Frontiers & Incubator Technologies (BENEFIT) – 2014: UF lead in collaboration with Hydromatic Technologies and 3 other concept papers from UF.
DE-FOA-0001071 - Solar Market Pathways: **UCF/FSEC Lead**
DE-FOA-0000974: Bioenergy Technologies Incubator: **UF Lead** in collaboration with FreeStan USA
DE-FOA-0000974: **UF Lead** with UF algae faculty.
DE-FOA-0000974: **USF Lead**
DE-FOA-0000997 - Microgrid Research, Development, and System Design: **USF Lead** in collaboration with UF and FIU faculty. FESC provided a support letter.
NSF 14-534 - Sustainability Research Networks Competition (SRN): Three **UF Led** proposals submitted.
NSF "Sustainable Energy Pathways": UF Lead. FESC provided a support letter.

FESC administration attends conferences and workshops to expand the FESC network by developing new partnerships. The list of the conferences and workshops attended during the reporting period is given below:

- October 14-15 : Florida Energy Summit, Orlando FL: http://www.floridaenergysummit.com/agenda.html

- November 6, 2013, Tallahassee, FL: NG Symposium and showcase http://www.cngshowcase.com/agenda/

- February 10-11, 2014: The International Brassica Carinata Workshop. Visited ARA and carinata fields during this workshop. Met faculty involved in this research, farmers, and seeds growers (Agrisoma, Wise Seed).

- February 19-20, 2014: 41st Annual PURC Conference - Politics & Policy: What is Next for Utilities? *http://warrington.ufl.edu/centers/purc/training/conference.asp*

- March 6-7, 2014: iiSBE Net Zero Built Environment 2014. The agenda is posted at: *http://www.cce.ufl.edu/iisbe-net-zero/agenda/* . The symposium brought together design professionals, researchers, industry, and government to exchange information on research, case studies, and emerging best practices centered on the net zero built environment concept strategy.

- March 24-26, 2014: International Biomass Conference & Expo. The agenda is posted at: *http://biomassconference.com/ema/DisplayPage.aspx?pageId=Agenda1*
  There were over 150 industry at the exhibit session. Communicated with a lot of industry representatives and established new contacts. One of them being the Idaho NL. In communication with their Biomass User facility representatives for potential collaboration.

Some of the funding opportunities sent to FESC faculty and industry partners are given below:

Title	Call #	Agency	Total Funding
Small Business Innovation Research (SBIR) Program	541712	Department of Transportation	Phase 1: $150K, Phase 2: $1M
Microgrid Research, Development, and System Design	DE-FOA-0000997	DOE	$7M
Environmental Stewardship for Renewable Energy Technol ogies: MHK Environmental and Resource Characterization Instrumentation	DE-FOA-0000971	DOE	$3.5M
Bioenergy Technologies Incubator	DE-FOA-0000974	DOE	$10M
Vehicles Technologies Incubator	DE-FOA-0000988	DOE	$10M
Advanced Gasification and Novel Transformational Coal Conversion Technologies	DE-FOA-0001051	DOE	$10M
Solid Oxide Fuel Cell Core Technology Program	DE-FOA-0001052	DOE	$6.4M
Improved Reliability of Solid Oxide Fuel Cell Systems	DE-FOA-0001058	DOE	$15M
Commercial Building Technology Demonstrations	DE-FOA-0001084	DOE	$10M
NSF/DOE Partnership on Advanced Frontiers in Renewable Hydrogen Fuel Production Via Solar Water Splitting Technologies	NSF 14-511	NSF/DOE	$6M to 18M

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

Both Phase I and II projects were completed. New projects will be funded when new funding is received. FESC office continues to work with faculty and industry to create new collaborative projects.

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 ($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.

The FL CAN grant was completed on March 31, 2014. The last quarterly report was submitted to the program manager. The IP and user facility catalog information was moved to a new web site. It can be viewed at http://www.innovationconcourse.com/resources/catalogs. The potential technology seekers such as strategic investors, customers or end users that are looking for innovative technology companies to invest in, and products to commercialize will be provided with this link: http://www.innovationconcourse.com/Seekers. The seeker, then can review the small business in this area and review the available IP.
http://www.innovationconcourse.com/seekers/subcategories/improved-building-efficiencies
The FESC office will continue to collaborate with the team members to provide FESC IP information and user facility support to the Florida energy industry.

Companies Contacted and/or Assisted

The companies we are in communication with are listed at FESC web site based on area of expertise (under different sub menus): http://www.floridaenergy.ufl.edu/?page_id=11727
Companies/organizations contacted and/or assisted during the reporting period includes Lockheed Martin, TerViva Inc., Sicarga, Citizen Energy, The Balmoral Group, Duke Energy, Siemens, Gulf Coast Energy network, Dayaway, EcoUrbana, CAAFI, EIW Corp., Pi-Innovation Inc., International Institute for Sustainable Laboratories (I2SL), World Housing solutions, SafGlass, Hydromatic Technologies, Mainstraem Enegineering, USDA, ARA, Canadian Consulate, BioFuelNet - Canada, Agrisoma, Harvest Power, Viesel Fuel LLC, and Urjanet.

Some examples of collaborations:

CAAFI – Communicated with Rich Altman, Executive Director Emeritus, Commercial Aviation Alternative Fuels Initiative (CAAFI). Introduced our faculty with expertise in Alternative Aviation Fuels to the CAAFI team. Met with the local USDA office representative and shared our expertise and functions. Communicated with co-directors FAA Center of Excellence, Dr. Ralph P. Cavalieri, Ph.D., P.E., Associate Vice-President for Alternative Energy, Director, Northwest Advanced Renewables Alliance, Director, FAA Center of Excellence - Alternative Jet Fuels & Environment, Washington State University, and Dr. John Hansman, MIT, Professor of Aeronautics and Astronautics, Head, Division of Humans and Automation, Director, International Center for Air Transportation to share FESC expertise in this area. Invited their members to the FESC workshop that will be held on May 12-13.

Applied Research Associates, Inc. (ARA) – Visited their facility in Panama City FL for a facility tour. Tour their labs and bio jet fuel pilot plant. Shared FESC faculty expertise for potential collaboration.

TerViva Inc.: TerViva develops new crops for underproductive agriculture land. In Florida, they are focused on an oilseed tree crop that can make lost citrus land productive again. The downstream products from this crop target the deep-demand markets for fuel, feed, fertilizer, and biochemicals. Organized a meeting with

UF IFAS Faculty and Terviva representatives for collaborative work. Faculty members are in communication with the company representatives.

Idaho National Lab: Communicating with the biomass characterization user facility director. FESC faculty will be introduced to this team for potential collaboration.

SAF-GLAS, LLC – Located in Riviera Beach, FL. In addition to disaster resistant and security glass products, the company is developing Energy Glass which is an optically clear Vertical Building Photovoltaic Window System that produces continuous energy from sunlight, diffused, ambient light and ground reflectance. Visited the company with FESC faculty members for potential collaborative work. Faculty members are in communication to define the collaborative research.

Hydromatic Technologies (Kissimmee, FL) – An energy efficient device company specializing in energy efficient heating technologies for clothes dryers and other appliances. Connected the company president to UF faculty for collaborative US DOE proposal development. The proposal was submitted to the US DOE.

Sigarca, Inc. (Archer, FL) – A "waste to energy" company. The owner was funded by State Office of Energy several years ago for digestor development. The owner improved his system and now looking into new markets. Visited the facility and had a meeting with the owner later on in our office to discuss his business strategy. Introduced the owner to the FL CAN team for business/marketing support.

Viesel Fuel LLC – Located in Stuart, Florida. They have a 7.5 million gallon per year biodiesel facility that is pioneering the use of enzymes and resins to access lower-quality feedstocks in the production of ASTM D6751 certified biodiesel. The enzymatic and resin technologies employed by Viesel require less energy than traditional biodiesel production, thereby reducing greenhouse gas emissions, and can be constructed for a lower capital cost than traditional biodiesel plants. Communicated with the owner and shared FESC faculty expertise for potential collaborative proposal development.

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

Four new grants were awarded to develop new energy education programs. Progress reports on existing and new programs are given below.

Florida Advanced Technological Education Center (FLATE)

By Dr. Marilyn Barger and Nina Stokes

Project Description
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 FL 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. To support the new curriculum, FLATE will work closely with the FESC Public Outreach and Industry Partnership programs to provide professional development opportunities for teachers and faculty to upgrade and update their knowledge base.

Budget: $300,000.
Universities: Hillsborough Community College

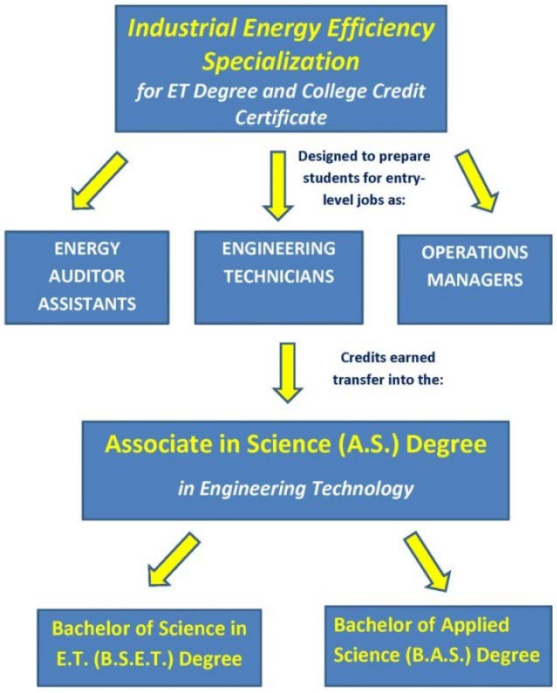
FLATE External Collaborators: Brevard Community College; Tallahassee Community College; Daytona State College; Central Florida Community College; Polk State College; Florida State College at Jacksonville; Valencia Community College; Palm Beach State College; School District Hillsborough County; Florida 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.

Progress Report

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.

Together with the National Science Foundation-funded Energy Systems Technology Technicians (EST²) project team, FLATE has developed a new Industrial Energy Efficiency specialization for the Engineering Technology (ET) Degree and associated College Credit Certificate, in addition to the existing Alternative Energy Specialization. Experts from industry, government and academia have been involved in this collaborative effort and instrumental in ensuring that the new specialization is directly aligned with current industry needs. It will help students prepare to become a **SEP-Superior Energy Performance Certified Systems Practitioners** and **CEM Certified Energy Managers**.



In addition, the program will 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. Credits earned in this certificate will transfer into the Associate in Science (A.S.) degree in Engineering Technology. The IEET program framework has been approved by the FL Department of Education, curriculum content modules to support the newly defined courses are complete, and colleges will be able to implement it in the 2014-2015 academic year.

Industrial Energy Efficiency Course List

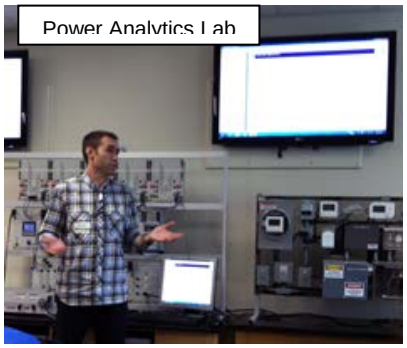
1. Fundamentals of Industrial Energy Efficiency (3 CH)
2. Industrial Systems (3 CH) *pre or co-requisite of Fundamentals of Industrial Energy Efficiency*
3. Energy benchmarking and performance analysis (3 CH) *pre or co-requisite of Fundamentals of Industrial Energy Efficiency*
4. Industrial Energy Analytics and Troubleshooting (3 CH) *pre or co-requisite of Fundamentals of Industrial Energy Efficiency and Industrial Systems*

5. Energy Efficiency Instrumentation and Measurement (3 CH) *prereq of Fundamentals of Industrial Energy Efficiency and Industrial Systems*
6. Industrial Controls and System Integration (3CH) *prereq of Fundamentals of Industrial Energy Efficiency and Industrial Systems*
7. Industrial Energy Efficiency Capstone (3CH or variable)

Engineering Technology Energy-Related Programs as of January 2014

COLLEGE CREDIT CERTIFICATES	COLLEGES OFFERING
Alternative Energy Systems Specialist (CCC) Career Cluster: Manufacturing CIP #: 0615000003 Program Length: 18 (Primary) or 15 (Secondary)Credits	Brevard Community College, Tallahassee Community College, State College of Florida, Gulf Coast State College
Industrial Energy Efficiency Specialist (CCC) Career Cluster: Manufacturing CIP #: 061500000x Program Length: 21 (Primary) or 24 (Secondary) Credits	Florida State College at Jacksonville (2013)
A.S. DEGREE SPECIALIZATIONS (60 credit hours)	COLLEGE OFFERING
A.S. Eng Tech Alternative Energy Technology	Brevard Community College, State College of Florida, and Gulf Coast State College
A.S. Eng Tech Industrial Energy Efficiency	Florida State College at Jacksonville (2013)

Frameworks are posted on the FLDOE website: *http://www.fldoe.org/workforce/dwdframe/mfg_cluster_frame12.asp*


Power Analytics Lab

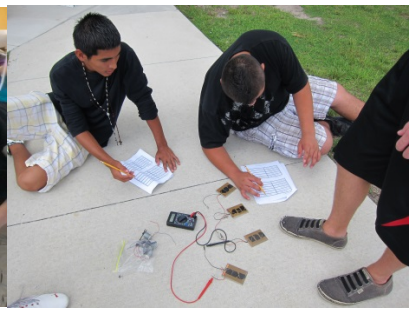
FLATE coordinated a third highly successful energy workshop/forum (the previous workshops were held in Gainesville and Cocoa), for high school and college educators, as well as industry partners, hosted by the Institute for Energy and Environmental Sustainability at Palm Beach State College on January 31, 2014. Forty attendees attended a wide variety of presentations, were treated and participated in a Power Analytics Development activity.

The morning session included presentations about electric vehicles, algal biofuel and marine renewable energy, as well as a Florida Department of Education update from Kathryn Frederick Wheeler, Supervisor of Energy and Architecture and Construction Career Clusters.


Attendees examine

Florida Power and Light Company brought a selection of electric cars/truck for participants to explore up-close, during the lunch hour. The afternoon session included a panel discussion on turbines and advanced fuels followed by a power analytics professional development activity held in IEES' state-of-the art power analytics lab. For the first time, thanks to Palm Beach State College's Media Technology and Instructional Services, the meeting was also broadcast live via the Internet, so that folks that wanted to attend, but couldn't travel could participate "remotely".

FLATE's Fourth **Annual Summer Energy Camp** is scheduled for July 7 – 10, 2014 at Hillsborough Community College's SouthShore campus which is LEED (Leadership in Energy and Environmental Design) silver-certified by the USGBC (U.S. Green Building Council), and boasts an earth-friendly, energy-conscious functionality incorporating a number of sustainable features. Last year's camp was a huge success with the highest attendance ever and feedback from both teachers and students overwhelmingly positive! Thirty 7th and 8th grade students were treated to four days of exciting, hands-on activities centered on capturing and keeping their interest in STEM (Science, Technology, Engineering and Math) subjects – specifically renewable energy. Camp participants were all part of Hillsborough County School District's AVID (Advancement Via Individual Determination) Excel Program, consisting of first generation college-bound, English language learners. The possibility of adding a high school energy camp in 2015 is being discussed.



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 3-4 in Bartow, FL at Polk Community College, where the new Industrial Energy Efficiency Specialization and College Credit Certificate courses were presented.

Activities for the 2013-2014 year are listed below.

- Attended the Manufacturers Association of Florida Summit in St. Petersburg, FL, December 3 – 5, 2013
- Coordinated a third Community College Energy workshop for 40 attendees at the Institute for Energy and Environmental Sustainability at Palm Beach State College on January 31, 2014.

- Presented "Integrating Environmental Sustainability Concepts and Practices into Florida's Engineering Technology Education System" at the American Society for Engineering Education's Conference for Industry and Education Collaboration in February, 2014 in Savannah, GA.
- Attended the 2014 Beyond Sustainability 38th Annual Conference at Hillsborough Community College, Ybor City, February 28 – March 1.
- FLATE hosted the Engineering Technology (ET) Forum in Tampa in October, 2013 and in Bartow, April 3-4, where the Energy Efficiency Specialization courses and content were presented.
- FESC Workshop May 12-13, Gainesville. Presenting a poster, "Matching Training to Industry Needs: Industrial Energy Efficiency Education".
- Fourth Summer Energy Camp for under-represented middle school students is scheduled for July 7-10 at HCC's South Shore Campus in Ruskin, FL in conjunction with the EST2 grant partners (BCC, TCC and FSCJ). This year Palm Beach State College will be joining us to host camps at Institute for Energy and Environmental Sustainability.

Funds leveraged/new partnerships created

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

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, University of Florida

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.

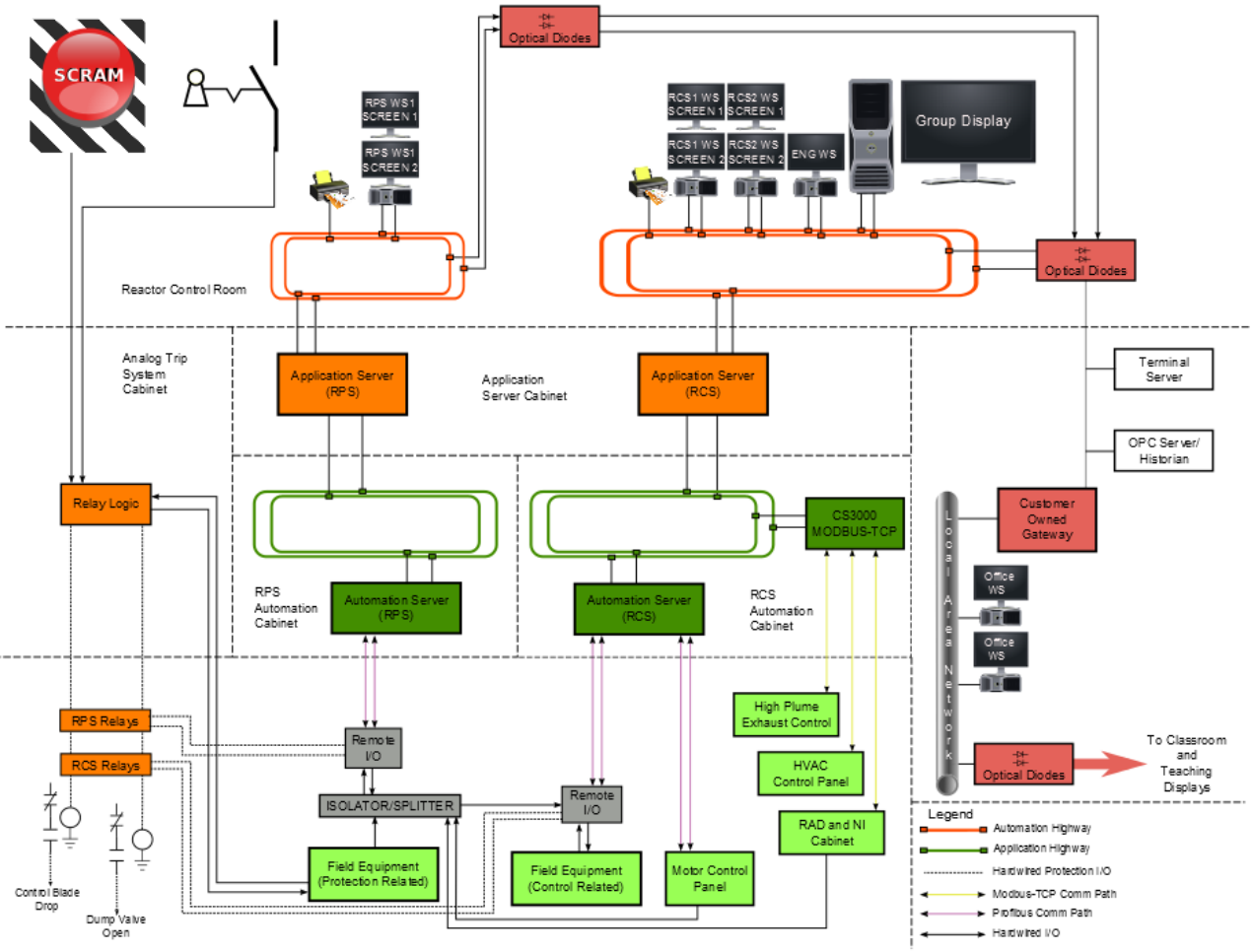
Progress Report

Since October 1, 2013, the University of Florida Training Reactor has continued the detailed design work for the digital controls system, which has resulted in a final Functional Requirements Specification document transmitted to the system manufacturer for construction. The UFTR is scheduled for recomissioning of operations in Fall of 2014. The digital system will be integrated into operations after an extensive testing and monitoring phase designed to satisfy requirements of the Nuclear Regulatory Commission.

The final system concept design, showing the system breakdown into a separate shutdown and control sections is shown below:

FESC funds were spent in this period as follows:

- $35,000 to Siemens for digital control hardware
- $3,921 to contractors for the UFTR high plume exhaust control system
- $1,441 for electronics for the temperature monitoring system.



The high plume exhaust system was funded by a Department of Energy grant in 2012. FESC funds were used for hardware and contracting work to integrate the exhaust system with the digital control system. Funds for the temperature monitoring system were used similarly. Approximately $4,600 remain unexpended.

Funds leveraged/new partnerships created

The funds provided by FESC for the digital controls upgrade have been used to further the overall digital controls project. The new capabilities that the upgraded reactor will enable have been leveraged in several proposals, listed in the table below. Most significant is a new collaboration with the University of Florida Cancer Center in the UF College of Medicine which utilizes the neutron production capability of the reactor for experimental studies of radiation exposure for astronauts on a Mars mission and other applications for cancer treatment.

Work on development of new technology for analysis and safeguarding of spent nuclear fuel that benefits from reactor experimentation has also had application for funding in this reporting period.

Title	Agency	PI, Co-investigators and collaborators	Funding requested	Project time frame (1 year, 2 years, etc.)	Date submitted
Center for Space Radiation Research	NASA	PI: P. Okunieff, UF College of Medicine	$5,774,463	2 years	01-2014
Planning for a National Center for Particle Beam Radiation Therapy Research	NIH/NCI	PI: P. Okunieff, UF College of Medicine	$1,000,000	1 year	02-2014
Academic Consortium for Verification Technologies	NNSA	PI: H. Hall, UT-Knoxville, Dept. of Nuclear Engineering	$3,000,000	5 years	12-2013
Used Fuel Storage Monitoring Using Novel He-4 Scintillation Fast Neutron Detectors	DOE	PI: K. Jordan; Co-PI:A. Enqvist, UF NEP	$800,000	3 years	03-2014
Nuclear Reactor Fuel Rod Instrumentation using Direct Printing Technology	DOE	PI: K. Jordan	$20,000	1 year	02-2014
Replacement Control Blade Drives for the UFTR	DOE	PI: K. Jordan	$112,000	2 years	03-2014

Energy Sustainability Course

By Dr. Mark Jamison, Public Utility Research Center, University of Florida

Project Description
This project creates the course GEB 4930 *Energy Sustainability* as a general business class. It examines issues in energy sustainability that confront policy-makers and managers around the world. It also covers energy utility markets and regulation, challenges in addressing environmental externalities, methods for encouraging environmentally friendly energy solutions, and the hard realities of the economics and science of energy. The capstone is a research paper that examines alternative energy futures for the State of Florida. Top papers will have the opportunity to participate in a moderated forum sponsored by the Bob Graham Center for Public Service focused on Energy Sustainability in Florida. The course will be videotaped and made available to non-UF students in 2015.

Budget: $58,000

Progress Report

The course will be first taught in Fall 2014. The instructor has been hired and starts work on July 1, 2014. A draft course syllabus has been created. The instructor has begun assembling readings for the class. This project leverages funds from PURC, including PURC's sponsors, grants from the World Bank to create a Body of Knowledge on Infrastructure Regulation (which includes significant materials on renewable energy and energy efficiency), and funds from PURC's courses. The FESC funding will enable PURC to reach out to additional Floridians who are interested in energy sustainability. The resources created by the FESC grant will be marketed at PURC training events and information outlets (which reach thousands of people annually from 151 countries) and PURC's annual conference (which reaches about 100 Floridians annually).

"Buildings and Energy: Design and Operation Vs. Sustainability"- An Energy Engineering Course for Florida-specific Building Design & Operation

By Dr. Prabir Barooah, Associate Professor, Mechanical and Aerospace Engineering

Co-PI's:
Duzgun Agdas, Lecturer, Engineering School of Sustainable Infrastructure and Environment
Ravi Srinivasan, Assistant Professor, M.E. Rinker, Sr. School of Building Construction

Project Description
The building sector is the largest consumer of energy in the US and the State of Florida, ahead of transportation and industry. A typical energy use by Florida households is 40% higher than the U.S. average. As energy resources are dwindling, it is crucial to proactively seek ways to improve new and existing buildings' energy efficiency. To achieve higher standards in building design and operation, a solid foundation of energy engineering and sustainability principles is essential. Currently, there are no courses offered to students or industry professionals with a distinct focus on energy in built environment, specifically for the design and operation in Florida's distinct climate conditions. Another limitation of existing courses is that they are focused on either design or operation, while they impact energy use in an intertwined manner. This course therefore emphasizes operation of buildings as much as their design. Operational aspects of buildings mostly involve operation and control of their HVAC and lighting systems. The course is therefore highly interdisciplinary, with lectures delivered to educate students on building control systems and its impact on the energy use, in addition to the design aspects.

The project doesn't support any students since it is a course development project. A number of external collaborators will be leveraged, including Dr. Herbert Ingley at the Mechanical and Aerospace Engineering Dept at the University of Florida and Dr. Timothy Middelkoop at the University of Missouri to design course content.

Budget: $67,960 (includes course design and instructors times for one semester of teaching).

Progress Report
The course is planned to be offered starting Fall 2014 in a distance education format through the University of Florida's EDGE (Electronic Delivery of Gator Engineering) program. Course material will also be made available through FESC website. At present the PIs are in the course design stage. A textbook has been selected out of a number of possible choices. A set of reading materials has also been prepared. Approximately 20% of the lecture content has been developed by the PIs so far.

Since the project is in its infancy, the project hasn't been leveraged for external grant applications so far. However, this project is likely to lead to greater collaboration among the PIs and other collaborating faculty, which is envisioned to lead to successful collaborative grant applications to external agencies.

Renewable Energy Education Program at USF's Patel College of Global Sustainability

By Dr. George Philippidis, University of South Florida

Project Description
Given the strong international outlook for renewable energy and Florida's rich natural assets of year-round warm weather, sunshine, and biomass (top generator in the US), the State of Florida has a unique opportunity to become a national leader in the development of sustainable power and fuels. A key component of such an undertaking is the specialized education required to prepare a green workforce, a workforce capable of running and managing the green economy. Professionals skilled in sustainable practices and renewable energy are already in high demand by companies in the solar, wind, and biomass sectors and by technology innovators developing the next generation of solar cells, biofuels and green hydrocarbons from biomass and algae, smart grid, energy efficiency, and energy storage. The goal of this project is to establish an education program in renewable energy at USF's Patel College of Global Sustainability (PCGS). We will implement a new, fully online and in-class concentration in Renewable Energy as part of the College's existing M.A. in Global Sustainability. The project will draw on the expertise and resources of three key USF entities to ensure its successful development: the PCGS, the Clean Energy Research Center (CERC), and the Media Innovation Team (MIT). Our goal is to place the State of Florida in a position to educate, train, and prepare students for the green jobs of today and tomorrow.

Budget: $85,101

Progress Report
The project started in January 2014. We have initiated the design of the new concentration in renewable energy by starting to develop two graduate courses of 3 credit hours each, which will be mandatory for all students selecting the Energy concentration (in addition to the 4 core requirements of the M.A. degree program).

The courses will address the two constituents of renewable energy: power and fuels. The first course is *"Renewable Transportation Fuels"* and the second *"Renewable Power Portfolio"*. The Fuels course is intended to educate students in the technology and business aspects of green fuel production, markets, economics, finance, and sustainability for the entire transportation sector. The Power course is intended to

educate students in the technology and business aspects of the various forms of renewable power generation, including solar, wind, biomass, geothermal, and ocean.

An application for the new concentration was submitted to USF and was approved by the University this quarter. In addition, an application for course numbers has been submitted to the State, and issuance of the numbers is expected during summer time. The concentration and the courses are already being included in the marketing material of the MA program inviting applicants interested in Energy. Graduate students are being screened to assist in the development of the courses.

Development of the material for the Fuels course has started and is currently in progress. The Fuels course will be launched in Fall 2014, whereas the Power course will be launched in Spring 2015. The courses will be offered both in class and on line.

In summary, the project is progressing according to schedule.

*Financial Report:*No expenses were charged to the project during the present quarter, hence no invoice for payment is submitted.

Introducing Specialization in "Sustainable Energy Systems" for Under-Graduate Students in Engineering at the University of West Florida

By Dr. Bhuvana Ramachandran
Co-PI: Muhammad Rashid, University of West Florida

Project Description
The objective of this proposal is to introduce a specialization in "Sustainable Energy Systems" for Undergraduate Engineering students at the University of West Florida (UWF) that could also be used to educate industry professionals towards workforce development. University of West Florida in Pensacola is in the panhandle region and is home to Southern Company's Gulf Power, an investor owned electric utility industry with nearly $400,000 customers. Gulf Power offers internships and Co-Op opportunities for students studying at UWF. Due to the significance of sustainable energy in the power industry and with the smart grid evolution taking over the conventional electric grid, it is critical for the undergraduate students to learn about sustainable energy and how their integration into the grid would impact the economy, efficiency of transmission and distribution, and environment in the US. Hence the courses for specialization in "Sustainable Energy Systems" have been designed from the perspective of energy system planning, a subject that has always been complex and evolving rapidly during the past 10-15 years to accommodate dramatic changes in the industry. With this effort, a new certificate course on Sustainable Energy Systems will also be offered by Continuing Education Department of UWF.

Budget: $92,169

Progress Report
The Department of Electrical and Computer Engineering at UWF proposes to introduce a specialization in "Sustainable Energy Systems" for Undergraduate Engineering students at UWF. The courses designed under this specialization will assist professionals in understanding the limits of our present energy systems and lead us to a future in which we can continue to provide reasonable energy resources for human quality of life. The specialization program focuses on electrical engineering sources and systems that are non-polluting, conserving of energy and natural resources, economically viable and safe for workers, communities and consumers. Coursework takes a systems level and interdisciplinary approach to solving seemingly intractable sustainable energy problems, as opposed to single disciplinary and locally optimized approaches destined to

yield marginal positive impacts. A unique feature of the course is its broad approach to the development of sustainable routes to the generation and supply of energy within which renewable energy is a key theme. Students will be able to create study programs suited to their interests and aspirations through their choice of electives and design projects. The course is electrical engineering-based but also covers a wider range of topics including economics, sustainability and environmental studies. The program will cater to the needs of working professional in the public or private sector, including public agencies, utilities involved with energy conservation, energy consultants, business owners and sustainability managers.

The proposed scheme is to introduce this specialization from fall of 2014 for a 2 year cycle ending spring 2016. All courses listed under this program are to be offered as online courses to enable working industry professionals to enroll in this course. The courses will be developed as asynchronous modules which will enable a widespread audience in the community. Preparation of study material and lecture presentations for online classes will be carried out during summer of 2014. The preliminary setting up of computer equipment for teaching is being performed presently. The courses will be taught by the PI, Co-PI and a faculty from the Department of Ethics, Law and Policy. Each of the faculty will have a student assistant to help them with researching topics and study material. Hiring of student is presently being carried out by the faculties.

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.

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.

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 8,262 (6,624 unique visitors , 78.46% new visitors) Google visitors during the period Oct 1, 2013 to April 1, 2014. The viewers visited 19,898 pages. Viewers were from US, Canada, India, China, Europe, Middle East, Russia, South America, Australia, and Africa.

FESC e-Newsletter: FESC prepares and distributes electronic newsletters every other month to over 900 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. The most recent newsletters is given below as an example.

FESC Newsletter April2014.pdf

Unifying Home Asset & Operational Ratings: Adaptive Management via Open Data & Participation

***PI*:** Mark Hostetler (Associate Professor, UF Department of Wildlife Ecology & Conservation)
***Co-PI*:** Hal S. Knowles, III (Change Agent, UF Program for Resource Efficient Communities)
Supported Student(s): Hal S. Knowles, III (Ph.D. Candidate, UF School of Natural Resources & Environment)
***External Collaborators*:** Nick Taylor (Ph.D. Student, UF School of Natural Resources & Environment), Jennison Kipp (Assistant In, UF Program for Resource Efficient Communities)

Budget: $24,000

Project 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.

The secondary supplemental research will expand on themes and insights gained through the first phase of this existing FESC project. Specifically, these insights suggest that even when adding operational data to building asset data, the reductionist approach to evaluating home energy performance by controlling for known variables may continue to offer an incomplete picture of the complexities of performance trends and the influence of unknown and/or misunderstood variables. Furthermore, the home improvement industry may need to consider the possibility that the magnitude of total energy consumption, while a worthwhile metric and with its net reduction a worthwhile goal, is also an incomplete indicator of home energy performance optimization.

[1] See, http://www.whitehouse.gov/assets/documents/Recovery_Through_Retrofit_Final_Report.pdf

Progress Report

Data networking and collaborative negotiations have been ongoing. JEA in Jacksonville has provided several million meter readings at 15-minute time intervals for approximately 400 homes from fiscal year 2011 through the 1st quarter of 2014. TalGov Utility Billing Services Division has provided several million meter readings at monthly time intervals for approximately 100,000 homes. Both utilities are currently processing additional datasets for various aspects of the research. 15-minute, hourly, and daily weather data has been procured from the Florida Automated Weather Network for Station #160 in Monticello (near Tallahassee) and for Station #180 in Macclenny (near Jacksonville).

Additionally, Dr. Larry Liebovitch has been invited, and accepted, into Hal's Ph.D. advisory committee due to his long standing knowledge and experience with fractal dimensional statistical methods in the social and physiological sciences. Methodology and research parameters are in development as applicable to the use of the SAS Enterprise Guide for data cleaning, screening, sorting, filtering, querying, and related statistical data management and to MATLAB for fractal dimensional statistical analytics.

Funds Leveraged/New Partnerships Created

New collaborations		
Partner name	Title or short description of the collaboration	Funding, if applicable
Larry Liebovitch, Ph.D.	Larry has been officially integrated into Hal's Ph.D. advisory committee as a "Special Member" from Queens College CUNY (http://people.qc.cuny.edu/faculty/Larry.Liebovitch/Pages/Default.aspx)	Not applicable
Several Building Contractors	UF/PREC is currently building partnerships with building professionals to serve as "Participating Independent Contractors" in the loan program.	Tied to revenue from the delivery of the loan program

"Design, Construction and Operation of CSP Solar Thermal Power Plants in Florida"

PI: Dr. D. Yogi Goswami (goswami@eng.usf.edu)

Co-PI's: Dr. Elias Stefanakos, Dr. Muhammad M. Rahman, Dr. Chand Jotshi, Dr. Manoj Ram, Dr. Jaspreet Dhau, Dr. Burton Krakow (University of South Florida)

Graduate Students (name/degree sought)

Huijuan Chen (Ph.D. Mechanical Engineering);
Ricardo Vasquez Padilla (Ph.D. Mechanical Engineering);
Gokmen Demirkaya (Ph.D. Mechanical Engineering);
Rachana Vidhi (Ph.D. Chemical Engineering);
Saeb Besarati (Ph.D. Chemical Engineering);
Antonio Archibold (Ph.D. Mechanical Engineering);
Abhinav Bhardwaj (Ph.D. Chemical Engineering);
Phillip Myers (Ph.D. Chemical Engineering);
Chatura Wikramaratne (Ph.D. Chemical Engineering);
Jamie Trahan (Ph.D. Mechanical Engineering);
Tanvir Alam (Ph.D. Mechanical Engineering);

Project Period: **Nov. 2008- May 2014**

Budget: **$882,000**

Project Description

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 still high. 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.

Universities: USF, UF, UCF

Research Objectives for Current Reporting Period*:* The main research objectives for the current reporting period include the development of a test facility and pilot demonstration systems based on parabolic trough technology.

Progress Made Toward Objectives During Reporting Period: This project consists of 4 tasks. The first 2 tasks were completed earlier and their reports were submitted. Task 3 is for design, installation and operation of a 50 kW CSP power plant. Task 4 is for the development of a thermal energy storage system for CSP power plants.

Design and installation of the solar field and the 50 kW power block have been completed. Fig. 1 shows the solar field and the power block of the 50 kW_e CSP solar power system. The Soponova 4.0 (Sopogy Inc.) parabolic trough collectors have been used in the solar field designed to provide 430 W/m^2 of thermal energy after losses. The power block that will convert the thermal energy to electricity is based on Organic Rankine Cycle. This power block has a nominal capacity of 50 kW_e. The power block uses a dry cooled condenser, which demonstrates the operation of a CSP power plant without using water. This is an important development as we try to reduce water consumption in solar thermal power. The power block will be commissioned in May 2014 which will complete the task 3 of this project.

A thermal energy storage system has been developed based on encapsulated phase change materials. This system can be used at this solar thermal power plant as well as any other solar thermal power plant. This development has reduced the cost of thermal energy storage from the present estimated \$45/kWh_{th} down to \$15/kWh_{th}. This completes the task 4 of this project.

Fig. 1. Solar Field for 50 kW_e power generation

Task 1: Development of simulation and design methodology for parabolic trough and parabolic dish
The objective of the task one is to develop a simulation and design methodology for the parabolic trough and parabolic dish based technologies for Florida conditions. Solar radiation, solar collector and thermal storage topics are the subtasks, and following progresses have been made during the period.
This task was completed and its report was submitted earlier.

Task 2: Development of a test facility and pilot demonstration

The second task targets the development of a test facility and pilot demonstration systems based on parabolic trough and dish technologies. The experimental combined power and cooling setup will be used as a preliminary study of the demonstration system that will be developed.
This task was completed and its report was submitted earlier.

Task 3. Installation and Operation of 50kWe Solar Power Plant

Sopogy Inc. Honolulu, Hawai is the main contractor for installation and operation of 50kWe Solar Power Plant at USF. Parabolic collectors (Soponova 4.0) were received from Sopogy and were assembled. Power block for generating electricity from GulfCoast Green Energy was also received and installed. Power block is a Green Machine Elite 4000 manufactured by Electratherm. This machine will produce about 50kWh electricity from the thermal energy produces by solar field that will have 199 Soponova 4.0 parabolic concentrators from Sopogy Inc. Fig. 12 shows the photo of Electratherm power generator with air-cooled condenser. Installation and commissioning of the solar field is complete. Installation of Electratherm power generating unit is complete, commissioning of this system will take place in May 2014. Figures 2 to 5 shows various parts of the CSP solar power plant.

Fig. 2 Power block with air-cooled condenser

Fig. 3 Solar collectors showing the header connections

Fig. 4 A row of parabolic trough solar collectors

Fig. 5 Expansion tank and pump for the heat transfer fluid

Fig. 6 Pump, piping and expansion tank for heat transfer fluid flow to and from the collector field

Task 4: Thermal Energy Storage

We have developed a low cost thermal energy storage (TES) system for Concentrating Solar Power (CSP) based on encapsulated phase change materials (PCMs). The system will be able to meet the utility-scale base-load concentrated solar power plant requirements at much lower system costs compared to the existing TES concepts. This project is developing a TES system concept that will allow for an increase of the capacity factor of the present CSP technologies to as much as 75% and reduce the cost to less than $\$15/kWh_{th}$ as compared to the present cost of about $\$45/kWh_{th}$.

We have successfully prepared porous pellets of phase change materials that will allow for the volumetric expansion during PCM melting and hence impose less stress on the encapsulating material. We have developed the encapsulation techniques and selected the low cost encapsulating materials that will be used to encapsulate the PCM. The following pictures show some of the developed capsules.

Fig. 7 Ceramic encapsulated PCM for high temperature thermal energy storage

Fig. 8 Metal encapsulated PCM for medium temperature thermal energy storage

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Southeast National Marine Renewable Energy Center (SNMREC)

PI: Susan H. Skemp

***Co-PIs*:** Howard P. Hanson, Taghi Khoshgoftaar, Pierre-Phillippe Beaujean, Len Berry, Megan Davis, Jeanette Wyneken, Manhar Dhanak, Eric Chassignet, John Reed, Charles Messing, James VanZwieten, Karl vonEllenrieder, Julie Lambert, Hassan Mahfuz, Stewart Glegg, George Frisk, Bassem Alhalabi, Hari Kalva, Steve Kajura, Madasamy Arockiasamy, Francisco Presuel-Moreno, Isaac Elishakoff

Note: Student listing is appended

Developing Florida's Ocean Energy Resources
Marine Renewable Energy (MRE) is the availability of energy in ocean currents, waves, tides, and thermal gradients. Tapping MRE resources will reduce our reliance on fossil fuels and help Florida along the road to energy self-sufficiency, energy security, and prosperity. Research areas of focus include improving understanding of ocean current and thermal-gradient resources, implementing testing capabilities to expedite commercial development of these resources, and understanding potential environmental impacts and how to mitigate them.

Project Description: The Southeast National Marine Renewable Energy Center (SNMREC) at Florida Atlantic University (FAU) was established by an award from the U.S. Department of Energy (DOE) in 2010 as an extension of FAU's Center for Ocean Energy Technology, which was originally founded in 2007 by the 2006 Florida State University System Center of Excellence Program. The SNMREC is investigating harnessing power from ocean currents, such as the Gulf Stream, as well as ocean thermal energy conversion to generate base-load electricity. This baseload, sustainable resource will make a unique contribution to a broadly diversified portfolio of renewable energy for the nation's future. Key drivers for investigation are determined by the regulatory process at State and Federal levels and by market and technology gaps needed to commercialize MRE. The SNMREC's role is to bridge the gap between concept and commercial deployment of ocean energy technologies by providing at-sea testing facilities and technology development for both ocean current and thermal energy systems. Research areas span environmental, resource, economic, education, and technology topics.

Budget: $8,750,000 and Funding **Leveraged:** U.S. Department of Energy, National Science Foundation and Industry - $5.766,000

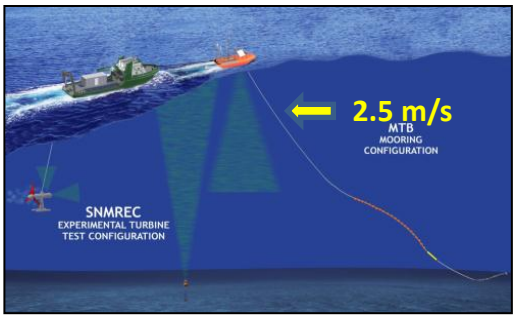
Universities: Florida Atlantic University, collaborating with the University of Central Florida, Florida State University, University of South Florida, Embry-Riddle Aeronautical University, University of Miami, Oregon State University, University of Washington, Pennsylvania State University, University of New Hampshire, University of Hawaii, University of Edinburgh, Heriot-Watt University, Nova Southeastern University, Virginia Polytechnic Institute and State University, and Florida Institute of Technology, North Carolina Coastal Studies Institute, University of the Azores, and Stellenbosch University.

External Collaborators: Numerous industry partners, state and federal government agencies, FFRDCs such as the National Renewable Energy Laboratory, Oak Ridge National Laboratory, Woods Hole Oceanographic Institution, U.S. Department of Energy (Office of Energy Efficiency and Renewable Energy), U.S. Department of Interior (Bureau of Ocean Energy Management, Regulation, and Enforcement), U.S. Department of Commerce (National Oceanic and Atmospheric Administration), the Florida Fish and Wildlife

Conservation Commission, and Florida Departments of Agriculture and Consumer Services, and Environmental Protection.

Bi-annual Progress Report: October 1, 2013 – April 30, 2014

The Southeast National Marine Renewable Energy Center is developing an open-ocean energy laboratory and test capability to advance research on marine and hydrokinetic (MHK) ocean current energy and thermal potential energy. The SNMREC is moving forward with strategically selected research, developing and testing key technology, infrastructure and systems as well as standards criteria to meet this need. The successful implementation of an in-water testing infrastructure for MHK off the coastline of Florida will be the first and only such capability globally. Already, companies from both the U.S. and internationally have expressed a desire to work with the SNMREC in defining not only their test requirements based on their design, but also are exploring both short term occupancy in Florida and potentially longer term manufacturing and grid connection in developing arrays for commercial enterprises.



An MHK lease application on the outer continental shelf (OCS) was submitted to the U.S. Department of Interior, Bureau of Ocean Energy Management (BOEM). This is the first national application which will form the model for future lease applications. BOEM released the Final Environmental Assessment (EA) with a Finding of No Significant Impact (FONSI) on 12 August 2013. The EA and FONSI can be found on the Department of Interior's website at http://www.boem.gov/Florida-Revised-EA-FONSI-August2013/. The Department of Environmental Protection, as the State of Florida's lead Coastal Zone Management Act agency, conducted a consistency determination review of the BOEM EA and FONSI. They notified the BOEM on 25 September 2013 that the issuance of a lease to SNMREC for hydrokinetic technology testing is consistent to the maximum extent practicable with the provisions of the Florida Coastal Management Program. In addition, the DOE NEPA office reviewed the EA and issued a FONSI on 13 November 2013. It is anticipated that a lease will be granted to FAU and SNMREC in FY14.

An offshore scaled device test berth (approximately 12 nm offshore of Ft. Lauderdale, FL) is under construction and will be installed to accommodate up to 100kW max instantaneous power production and/or 7m rotor diameter turbine testing. This initial group of industrial devices will provide insight into individual device extraction methods, dynamics, and basic system operability.

A centralized, standardized testing capability will be provided for testing current energy conversion prototypes; initially, scaled versions and eventually full-scale devices. In addition, critical environmental measurements will be obtained on a continuous basis from the observational platform and submerged instrumentation. Companies from both the U.S. and internationally are working with the SNMREC in defining test requirements based on their design, as well as both short term occupancy in Florida and potentially longer term manufacturing and grid connection options in developing arrays for commercial enterprises.

When the program was initiated, the industry was in its infancy. Few designs were being conceived, but even today there has not been a convergence of commercial ocean current turbine technology to one design. And no commercial scaled devices were available as a test and development platform. SNMREC took on to design a universal non-commercial experimental research turbine. This 3-meter rotor diameter, 20kW generically designed experimental research turbine (Figure 2) will provide a non-proprietary platform for

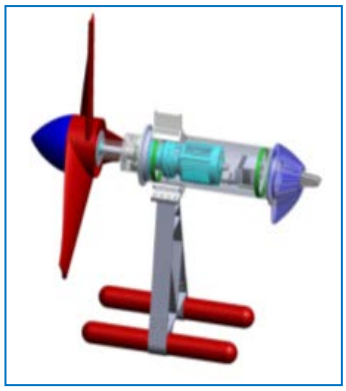


Figure 2. SNMREC 3-meter dia Rotor, 20kW Instantaneous Max Power Prototype Turbine

component development at small scales. The test procedure/plan is laid out to incorporate monitoring and failure prediction systems, to gain experience in at-sea operations of this nature, and to support standards and protocol development. Industrial beneficiaries will be able to use the results of testing to enhance and accelerate prototype development.

Finally, as commercial prototypes and subsystems are brought to SNMREC for testing, all aspects of experiment set up, instrument calibration, data handling, and organizational checks/balances are expected to comply with international quality standards (ISO/IEC 17025, *General requirements for the competence of testing and calibration laboratories*). The SNMREC is preparing its processes and organization to fully comply with this standard and achieve accreditation. The selected approach is recommended by Agilent Technologies (Huber, 2009) and involves the following steps towards accreditation:

1. Investigation Phase (where an organization defines its scope, gaps, tasks required to achieve accreditation, and estimated costs/ROI)
2. Management Decision
3. Implementation Phase (where an accreditation body is selected, documentation developed, training performed, internal audits and corrections performed, and pre-assessment conducted)
4. Accreditation Audit

The SNMREC is engaged in sensor and instrument acquisition, deployment, and analysis to more fully characterize offshore energy resources, and the benthic and pelagic environment. Second, fabrication of a small-scale hydrokinetic turbine system is in the final stages of completion. Testing is ongoing for components, sub-systems, and major systems of the turbine. Assembly and tow testing of the prototype prior to deployment of the test infrastructure is on hold pending completion of the EA.

SNMREC's research ocean current turbine (OCT) was tested at sea to evaluate its design stability and tow characteristics. A "mock" tow test (MTT) was conducted on December 11, 2013 offshore Fort Pierce, Florida, near FAU's Harbor Branch Oceanographic Institute (HBOI) campus. The OCT was equipped with a steel ballast weight to simulate the weight of the electrical generator, rather than putting at-risk electric and power equipment. Several monitoring systems were also evaluated, including three underwater video cameras to observe the rotor and attachment point, two acoustic current meters, and an inertial measurement unit (IMU) to measure turbine motion in six degrees of freedom.

With the DOC van, line handling winches, and other auxiliary equipment, the OCT was towed by a chartered work vessel at various speeds, approximately 50 ft. below the sea surface, in two groups of tests. First, the rotor was fixed so that it would not spin. The purpose of this series of tests was to determine the stability of the turbine without a predominant lateral drag force induced by a rotor producing torque. Although the crew was prepared to affix a drogue chute to provide stability, the OCT behaved well and did not require intervention with a "bow" line attached to the "nose" of the OCT.

During Mobilization at HBOI

At Sea After Successful Deployment

Because of the success of the first series of tests, a second was performed which allowed the rotor to spin freely (only affected by friction from seals and bearings, not motor resistances since one was not installed). At approximately 5.5 kts. (speed over water), seals were "bedded-in" and the rotor began to spin. The vessel and turbine tow speeds were then reduced in 0.5 kt. Increments to determine the minimum relative speed required to continue to turn the rotor. However, even with engines all-stop and the turbine at the surface, the rotor continued to spin freely. Therefore, the actual motor-less drive train cut-in speed is near zero knots.

Throughout all tests, tow line tension was measured and recorded, along with vessel speed and course, to obtain drag values for use in computer modeling optimization and verification. Overall, the OCT performed as predicted, and no major issues with stability or deck-handling/deployment were observed.

Final sea trials were successfully conducted of a mooring and telemetry buoy to ready it for at-sea deployment. Additional sub-sea surveys of installation sites will be conducted to identify deep water coral distribution and determine appropriate anchor areas.

One of the biggest unknowns in the operation of ocean current turbine (OCT) systems concerns the behavior of the generator sub-system as it experiences both variable loads and the torque differentials associated with changing currents acting on the rotor. In order to provide a capability to test generators and/or associated instrumentation under realistic conditions, the SNMREC has developed a computer-controlled dynamometer system, located at the FAU SeaTech facility in Dania Beach. This basic capability has been further enhanced with simulated oceanographic conditions to emulate rotor behavior on the test stand as it would occur in an actual ocean current. The 20 kW dynamometer has been fitted with the SNMREC's experimental research turbine power quality and health management systems, and has continued generating data for Prognostics and Health Monitoring (PHM) research. Preliminary work has been completed to emulate rotor behavior in wave conditions and from collected offshore measurements. A laboratory capability feasibility study for ocean current turbine testing was completed, and the results are available in an M.S. Thesis format.

In May 2013, four ADCPs were deployed in a modified diamond configuration to measure both latitude and longitudinal effects of variability in the current. Recovery of the ADCPs is planned for May 2014.

Twenty-four months of cross-channel aerial surveys and over forty coastal surveys were completed to determine offshore turtle and marine mammal distribution and activity prior to install/test of MHK devices. Because preliminary data suggests significant population activity near shore, these transects will provide higher resolution data to support analysis efforts. The research team is working with the National Oceanic and Atmospheric Administration's, National Marine Fisheries Service to evaluate the SNMREC's enhanced approach as an expansion of currently accepted methods. The survey areas being assessed are depicted in Figure 3.

Figure 3. Aerial survey areas offshore Ft. Lauderdale, to determine sea turtle and marine mammal population

The SNMREC, with FAU's Harbor Branch Oceanographic Institute (HBOI) has established an internship program for up to 4 United States Coast Guard Cadets. The cadets participated in the summer of 2013, during their summer rotation. Cadets have submitted applications for the 2014 program, which are under review. This program will enhance cooperation between the U.S. Coast Guard and the SNMREC while educating future officers about projects which will be installed in coastal areas.

SNMREC staff continue to work with professors and students at FAU's School of Communications and Multimedia Studies' to create an interactive educational display game. A kiosk is being designed for the Ocean Discovery Center at FAU's Harbor Branch Oceanographic Institute. The kiosk will create a hands-on experience which educates the public about future ocean energy projects. This effort will be leveraged to provide similar kiosks to science and discovery museums. The intent is to provide an opportunity to engage all ages in a hands-on, fun and educational experience about ocean renewable energy production. The kiosks will increase knowledge of real, cutting-edge research in renewable energy from the ocean as well as, incorporating valuable Science Technology Engineering & Math (STEM) content to inform the public.

The Center developed a curriculum for upper-division high-school students to introduce the topic within secondary education. An additional topic on policy and social interaction with renewable energy, with an emphasis on ocean energy, will be added this summer.

Over fifty upper-division graduates and Principle Investigators have been engaged in research in marine renewable energy (MRE) to date. Approximately a dozen of these students have secured positions in energy-related companies. One of the PhD students was selected as a Knauss Fellow after graduation and is currently serving in the U.S. Department of Energy's Energy Efficiency and Renewable Energy focus in the Wind and Water Power Program. Partnerships between the SNMREC and the marine industry continue to expand.

More than 45 Non-Disclosure Agreements (NDA) have been signed with companies across the global marine industry. Language within the NDAs does not allow for the release of information of the details of the collaborations at this time. Industry sponsored funding is at a level of $155,000.

To date, with the State of Florida funding, the SNMREC has successfully leveraged $5,766M of U.S. Department of Energy and National Science Foundation funds. Five proposals are in process and will be submitted in May.

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*^{2} 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***
	Title: Energy Sustainability Course **PI:** Mark Jamison **Budget:** $58,000 **External Collaborators:** NA **Status: Active**
	Title: Buildings and Energy: Design and Operation Vs. Sustainability"- An Energy Engineering Course for Florida-specific Building Design & Operation **PI:** Prabir Barooah **Budget:** $67,960 **External Collaborators:** Dr. Timothy Middelkoop, University of Missouri **Status: Active**
	Title: Renewable Energy Education Program at USF's Patel College of Global Sustainability **PI:** George Philippidis, University of South Florida **Budget:** $85,101 **External Collaborators:** NA **Status: Active**
	Title: Introducing Specialization in "Sustainable Energy Systems" for Under-Graduate Students in Engineering at the University of West Florida **PI:** Bhuvana Ramachandran and Co-PI: Muhammad Rashid, University of West Florida **Budget:** $92,169 **External Collaborators:** NA **Status: Active**
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 [illegible] 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	Cade Museum Prize	NA	Cade Museum	$50k
2	2015 Competition Bioenergy and Biomass Conversion From Plant-Based Research to Prototype Bio-Materials	NA	CPBR	$185K/year
3	Small Business Innovation Research (SBIR) Program	541712	Department of Transportation	Phase 1: $150K, Phase 2: $1M
4	Environmental Security Technology Certification Program (ESTCP) - Installation Energy Technology Demonstrations	BAA-14-0004	DOD	Open
5	Environmental Technologies Solicitation		DoD	Open
6	Microgrid Research, Development, and System Design	DE-FOA-0000997	DOE	$7M
7	Integrated Enhanced Geothermal Systems (EGS) Research and Development	DE-EE0000842	DOE	$10M
8	Support of Advanced Coal Research at United States (U.S.) Colleges and Universities	DE-FOA-00001032	DOE	$2.1M, max 400,000 per
9	Hydrogen Delivery Technologies	DE-FOA-0000821	DOE	$4M
10	Hydrogen Production Research And Development	DE-FOA-0000826	DOE	$4M
11	RFI on Frontier Observatory for Research in Geothermal Energy (FORGE)	DE-FOA-0000890	DOE	NA
12	Sunshot Incubator Program	DE-FOA-0000923	DOE	$10M
13	SOLAR DECATHLON 2015	DE-FOA-0000959	DOE	$1M
14	Environmental Stewardship for Renewable Energy Techn ologies: MHK Environmental and Resource Characterizat ion Instrumentation	DE-FOA-0000971	DOE	$3.5M
15	Bioenergy Technologies Incubator	DE-FOA-0000974	DOE	$10M
16	Clean Energy Manufacturing Innovation Institute for Composite Materials and Structure	DE-FOA-0000977	DOE	$70M
17	Administration of the Wave Energy Converter Prize	DE-FOA-0000979	DOE	$6.5M
18	U.S. Wind Manufacturing: Taller Hub Heights To Access Higher Wind Resources And Lower Cost Of Energy	DE-FOA-0000982	DOE	$2M

19	Vehicles Technologies Incubator	DE-FOA-0000988	DOE	$10M
20	NEXT GENERATION PHOTOVOLTAIC TECHNOLOGIES III	DE-FOA-0000990	DOE	$9M
21	FY2014 Scientific Infrastructure Support for Consolidated Innovative Nuclear Research Grant	DE-FOA-0000999	DOE	$3M, 3.5M
22	CERTIFICATION AND RATING OF ATTACHMENTS FOR FENESTRATION TECHNOLOGIES (CRAFT)	DE-FOA-0001000	DOE	$1.6M
23	Low Temperature Geothermal Mineral Recovery Program	DE-FOA-0001016	DOE	$3M
24	Solar Manufacturing Technology 2 (SolarMat2)	DE-FOA-0001018	DOE	$25M
25	Fossil Energy Research and Developments	DE-FOA-0001023	DOE	$80M
26	Plant Feedstock Genomics for Bioenergy: A Joint Research Funding Opportunity Announcement USDA, DOE	DE-FOA-0001034	DOE	$5M
27	Climate and Earth System Modeling: SciDAC and Climate Variability and Change	DE-FOA-0001036	DOE	$8M
28	Research for Safe and Permanent Geologic Storage of CO2	DE-FOA-0001037	DOE	$6M
29	Notice of Intent to Issue DE-FOA-0001027, Building Energy Efficiency Frontiers & Incubator Technologies (BENEFIT) - 2014	DE-FOA-0001039	DOE	NA
30	NATIONAL INCUBATOR INITIATIVE FOR CLEAN ENERGY	DE-FOA-0001042	DOE	$3M
31	Scientific Data Management, Analysis and Visualization at Extreme Scale 2	DE-FOA-0001043	DOE	$100 to $500K
32	Advanced Gasification and Novel Transformational Coal Conversion Technologies	DE-FOA-0001051	DOE	$10M
33	Solid Oxide Fuel Cell Core Technology Program	DE-FOA-0001052	DOE	$6.4M
34	Improved Reliability of Solid Oxide Fuel Cell Systems	DE-FOA-0001058	DOE	$15M
35	Systems Biology of Bioenergy-Relevant Microbes to Enable Production of Next-Generation Biofuels	DE-FOA-0001060	DOE	$8M
36	Notice of Intent to Issue Funding Opportunity Announcement No. DE-FOA-0001016 "Low Temperature Mineral Recovery Program"	DE-FOA-0001069	DOE	NA
37	Research and Development for Next Generation Nuclear Physics Accelerator Facilities	DE-FOA-0001082	DOE	$1.87M
38	Commerical Building Technology Demonstrations	DE-FOA-0001084	DOE	$10M
39	Analytical Modeling for Extreme-Scale Computing Environments	DE-FOA-0001088	DOE	$4.5M

40	Scientific Discovery through Ultrafast Materials and Chemical Sciences	DE-FOA-0001089	DOE	$4M
41	Notice of Intent: Fuel Cell Technologies Incubator: Innovations in Fuel Cell and Hydrogen Fuels Technologies	DE-FOA-0001094	DOE	NA
42	High Impact Commercial Building Technology Deployment	DE-FOA-0001086	DOE	N/A
43	Scientific Discovery through Advanced Computing(SciDAC): Multiscale Integrated Modeling for Fusion Energy Science	DE-FOA-0001096	DOE Office of Science	1.25M
44	Clean Energy Activities- Addendum under APS No.: APS-OAA-13-00003	APS-596-14-000001	El Salvador USAID-San Salvador	$18 M
45	11th Annual P3 Awards: A National Student Design Competition for Sustainability Focusing on People, Prosperity and the Planet	EPA-G2014-P3-Q1	EPA	$1M
46	Gulf of Mexico Research Initiative Request for Proposals for 2015-2017 GoMRI Research Consortia (RFP-IV)	RFP-IV	GoMRI	$35M
47	Hydro Research Foundation Research Awards Program		Hydro Research Foundation	$18K living stipend + tuition
48	Sustainability Research Networks Competition (SRN)	NSF 14-534	NSF	$12M
49	NSF/DOE Partnership on Advanced Frontiers in Renewable Hydrogen Fuel Production Via Solar Water Splitting Technologies	NSF 14-511	NSF/DOE	$6M to 18M
50	Operational Energy Plans and Programs - Fuel Hedge Research	HQ0034-OEPP-14-BAA-0001	Other Defense Agency	Open
51	Gilbert F. White Postdoctoral Fellowship Program		Resources for the Future (RFF)	Annual Stipend
52	Fellowships at the Center for International Security and Cooperation		Center for Inter.Security & Cooperation (CISAC)	
53	ACRP 02-56 - Developing an Airport Business Case for Renewable Energy	ACRP 02-56	Transportation Research Board (TRB)	$300k
54	Agriculture and Food Research Initiative Competitive Grants Program	AFRI 2014 RFA	USDA	$3M
55	Travel Grants - Oak Ridge Associated Universities (ORAU) ; Internal LOI due to the Office of Research (Required)			$800
56	Alternative Energy Funding	BAA-RQKM-2014-0005	Air Force Research Laboratory	37M

57	Mickey Leland 2014 Internship Program	N/A	DOE	N/A
58	Vehicles Technologies Program Wide	DE-FOA-0000991	DOE	51.4M
59	Higher Education Challenge Grants Program	USDA-NIFA-CGP-004425	USDA	4.77M
60	Geothermal Play Fairway Analysis	DE-FOA-0000841	DOE	3-5M
61	The U.S. Army Engineer R&D Center 2014 BAA	W912HZ-14-BAA-01	DOD	N/A
62	Renewable Carbon Fibers	DE-FOA-0000996	DOE	12M
63	Research, Development and Training in Isotope Production	DE-FOA-0001099	DOE	2.6M
64	FY 2014 Continuation of Solicitation for the Office of Science Financial Assistance Program	DE-FOA-0000995	DOE	400M
65	Exploratory Research for Extreme-Scale Science	DE-FOA-0001003	DOE	2M