Florida Energy Systems Consortium

Annual Report

to

Office of the Governor

Office of the President of the Senate

Office of the Speaker of the House of Representatives

Florida Energy and Climate Commission

Pursuant to

Florida Statute 1004.648

Reporting Period: October 1, 2009 – September 30, 2010

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EXECUTIVE SUMMARY

Overview The Florida Energy Systems Consortium completed its second year of energy research, technology transfer, education, and outreach activities. As one the first states to establish a state-wide, university-based center for energy research and related activities, Florida has benefited from this timely investment. A critical role of FESC is to facilitate interactions among researchers in the 11 state universities and with the state's energy industry. Success is evident from the significant number of joint proposals submitted and funded, the growth of the FESC Summit, and the success of its team activities. FESC also serves as a portal for information on energy in Florida. Measures of our impact in this area include the significant number of communications with in-state and out-of state industry seeking assistance, the popularity of our web site, the MOUs signed with other entities, and the success of our outreach program. But perhaps the most important role of this consortium is contributing to the state's economic development. Success here is evident from the number of invention disclosures submitted and patents received, technologies licensed, students educated, and contributions to creating a favorable climate for attracting industry.

During the past year, FESC completed Phase I and initiated Phase II of our Technology Commercialization program, prepared a comprehensive energy strategy report to the Governor's Energy Office on economic opportunities, contributed energy education and outreach programs, and organized the second FESC summit, bringing together over 260 people with interest in Florida's energy future.

Research Highlights The Principal Investigators in the more than 80 FESC-funded research projects continue to make considerable progress on their research, often leading to added external support. For this report, each PI submitted a one-page progress summary, which is posted at the FESC website http://www.floridaenergy.ufl.edu/. Appendix A contains brief descriptions of each project while detailed progress summaries are compiled in a separate document and provided as an attachment to this report.

To facilitate the leveraging the state funds and expertise, the FESC administrative office distributed and facilitated responses to over 100 announcements of funding opportunities to the SUS energy faculty during this reporting period. These are posted at the FESC web site. The FESC leadership made frequent visits to the State of Florida offices as well as to the Department of Energy, National Energy Laboratories, and NASA Glenn to discuss potential FESC collaboration on their energy programs.

The importance of having state universities under one umbrella was especially evident in our response to the three Energy Innovation Hub calls from the US DOE this past year. These calls focused on Fuels from Sunlight, Energy Efficient Building Systems Regional Innovation Cluster Initiative (E-RIC), and Modeling and Simulation for Nuclear Reactors. FESC led the Fuels from Sunlight Hub and the E-RIC with multiple external partners, and participated in the Nuclear Hub. An additional Request for Proposals (RFP) is anticipated in the area of energy storage. To respond to this new call, a FESC core planning team has already been formed and the team members are communicating with the potential partners. FESC used a similar strategy to respond to the "Photovoltaics (PV) Manufacturing Initiative" call from US DOE.

In response to these call for proposals, SUS energy faculty submitted 531funding proposals requesting $580,692,518 during the twelve-month period October 1, 2009 thru September 30, 2010. The SUS energy faculty received 374 research and education awards totaling $84,402,932.[1] In many instances, funding

[1] Note many of the awards were based on proposals submitted prior to this period, but the number demonstrates the competitiveness of the SUS faculty in this arena. The information was collected through the databases at each university, published news releases, and faculty input. The database information was reviewed carefully and listings that are not energy related to energy were deleted.

provided by FESC was used for required cost sharing or instrumental in providing preliminary results to enhance the competitiveness of proposals. The details are given in the accountability measures section of the report in Appendix D.

State Energy Expertise Resource The consortium also serves as an information resource for the state governing entities. At the behest of Florida Energy and Climate Commission, the Governor's Energy Office asked FESC to provide a framework for transition to clean and renewable energy sources as well as energy efficiencies, with regard to market driven forces. The ensuing report examined three areas: 1) Current Incentive Mix (both State and Federal) in renewable energy and cleantech, 2) Cleantech Barriers to Commercialization and Project Finance, and 3) Effects of Regulatory Change – Renewable Portfolio Standard (RPS) Implementation. FESC reviewed existing statutory incentives supporting the deployment of energy efficiency and renewable energy in Florida, and then discussed effective mechanisms to overcome barriers to commercialization and project finance. The report culminated with an analysis of a potential state renewable portfolio standard. The study provided baseline recommendations toward the next step in renewable energy and energy efficiency strategic planning and implementation. The study was submitted to the Florida Energy and Climate Commission and is posted at: http://www.floridaenergy.ufl.edu/?page_id=24. As another example, the House State Universities and Private Colleges Committee requested that FESC present an analysis regarding programs within the SUS and Community Colleges that are preparing the State's energy workforce.

The 2nd FESC Summit was held on September 28-29, 2010 on the University of Central Florida campus. Participants were drawn from faculty members from the consortium and community colleges, undergraduate and graduate students, industry leaders, and government representatives. The Summit was preceded by two workshops, one on Photovoltaics and another on Technology Commercialization. The Summit brought together energy experts within the State to share their energy-related research findings and to promote future collaborations amongst themselves and with industrial partners. FESC also had out of state attendees and one international attendee this year. The detailed Summit information and program are provided in this report. The summit survey results are given in Appendix B.

Technology Transfer Also in this reporting period, FESC completed Phase I of our Technology Commercialization Program and initiated the Phase II program. For Phase I, FESC worked with technology transfer offices at 5 FESC universities to identify energy related technologies with high commercial potential. Out of 28 proposals, fifteen technologies were funded at $7,500 for market studies or business plans. These studies and plans are being shared with industry representatives that are interested in the technology to accelerate the path of FESC research to commercialization. One page descriptions of these technologies are posted at FESC web site. Phase II of the FESC technology commercialization funding program is modeled on the very successful Florida High Tech Corridor Council Matching Grants Research Program. In this program, FESC provides up to $50K in matching funds for each of up to 5 such projects, with an industry match on each project, attracting in excess of $500K of industry support to these FESC-funded projects. The solicitation was prepared in May and two proposals have already been selected for funding.

The Consortium has worked closely with technology transfer and economic development offices to attract industry to the State. As examples, FESC has provided assistance to attract a German-based PV manufacturing and installation company to Florida. We are also working with NASA Glenn, Spaceport Research & Technology Institute, NASA Kennedy Space Center, and a local firm for a potential algae and halophytes test bed in Florida. NASA scientists introduced us to an Israel based company looking for a power company in the US with a CO_2 source and available land to implement their algae technology. We introduced this company to FPL and TECO for potential partnership. A FESC-wide MOU and NDA are now in place and were used for the first time on the two FESC-led Hub proposals. FESC has signed an MOU with NASA Glenn and Yeungnum University to facilitate collaboration.

Education and Outreach Assisting in preparing a qualified workforce is vital for Florida's evolving energy industry. FESC is strategically focused on workforce preparation for the existing and emerging energy industry. The SUS universities are collaborating on Master's level energy education programs that are integrated across multiple disciplines and will provide advanced technical training and keep students current in energy and sustainability research. Existing distance education facilities at each university will be utilized to make this program available via on-line courses. UF has already launched its online Energy Certificate program in Solar Energy, Wind Turbines, Gas Turbines, and Energy management. In addition, UF is offering a Sustainable Engineering Certificate program. FSU is establishing a program in Sustainable Energy. A UCF program will include Turbo-Power Generation, Generation and Smart Grids, Photo-Voltaics, and/or Smart Buildings. Additionally, FAU, USF, and FIU submitted a consortium proposal to the National Science Foundation (NSF) proposing to develop and deliver a multidisciplinary science Master's degree program in renewable energy and sustainability for Fall 2010. The FESC outreach program is using the statewide Agricultural Extension Service as well as other avenues to provide Florida residents with new approaches to energy efficiency.

The FESC website continues to be an important communication tool for our program. It is updated regularly to remain current and to better serve our users. FESC distributes electronic newsletters by email and available on the FESC web site. Summaries of FESC expertise in the areas of Algal Biofuels, Small Molecule Chemistry to Energy, and Building Efficiency were developed and posted at the FESC web site. Based on a Google Analytics report, the FESC web site was viewed by 20,326 Google visitors (we are not tracking the users of other search engines) during the period Oct 19, 2009 to Oct 19, 2010. The viewers visited 61,114 pages. Viewers were from a total of 121 countries, including those in North and South America, Europe, Asia, Australia, and Africa.

As this report illustrates, the Florida Energy Systems Consortium is effectively implementing its research, education, industrial collaboration, and technology commercialization agenda. FESC faculty members statewide are successfully collaborating in research and proposal development toward new sustainable energy technologies for Florida's future. FESC education programs are being readied for Florida's clean energy workforce, and our industry partners are actively participating in technology transfer and commercialization of FESC-developed technologies.

ACCOUNTABILITY MEASURES

The accountability measures are summarized in Table 1. The supported data is provided in Appendix D.

Table 1: Accountability Measures

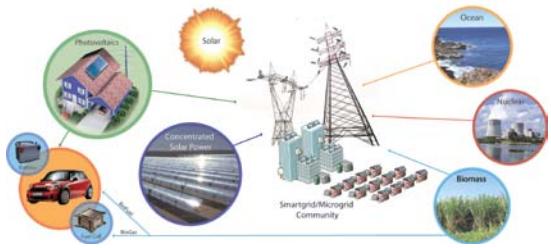
FLORIDA ENERGY SYSTEMS CONSORTIUM October 1, 2009 – September 30, 2010	
Research Effectiveness (FESC and Associated Research)	
Competitive Contracts and Grants Applied (SUS energy faculty)	# of Applications: 531 Requested Funding: $580,692,518
Competitive Contracts and Grants Received (SUS energy faculty)	# of Awards: 374 Award Amount: $84,402,932
Publications in Refereed Journals and Other (FESC funded faculty)	Total: 252 Refereed: 175 Other: 77
Professional Presentations (FESC funded faculty)	329
Invention Disclosures Submitted and/or Patents Received	47
Technologies Licensed/Revenues Received	16/NA
Collaboration Effectiveness (FESC and Associated Research)	
Collaborations with Other Postsecondary Institutions (FESC funded faculty)	51
Collaborations with Private Industry (FESC funded faculty)	66
Students Supported with Consortium Funds (FESC funded faculty)	Total: 268 Undergraduate: 22 Master: 82 PhD: 137 Post-docs: 27
Students Graduated (FESC funded faculty)	Total: 41 Master: 19 PhD: 22
Economic Development Effectiveness (FESC and Associated Research)	
Business Start-Ups in Florida	7
Specialized Industry Training and Education (Outreach)	36 training events

PROGRESS MADE IN EACH THRUST AREA

The FESC research program is focused on seven strategic research thrusts, including the overarching Energy Systems thrust. These thrusts were defined on the basis of Florida resources and also the perceived needs of the State of Florida.

A brief description of each thrust and tasks under the thrust areas are given below.

1. Overarching Strategic Research Thrust: Understanding Florida's Energy Systems



An inherent advantage of the consortium is that it collects the research expertise across the entire SUS and thus can conduct energy research more broadly. FESC's key strategy is to inject a systems approach to energy research. This thrust provides a platform for each of the other thrusts and allows direct connection to Florida's energy economy. This thrust unites existing strengths in energy science and engineering with recognized expertise in non-traditionally studied energy areas, including Law, Public Administration and Policy, Economics, Environmental Studies, Geography, Urban and Regional Planning, Information Systems, Social Sciences, and Media Arts. Experts from these areas will assist Florida's governing bodies in the development and implementation of a comprehensive, long-term, environmentally compatible, sustainable, and efficient energy strategic plan by performing select and recurring analyses to provide objective and quantitative policy assessments. It will help evaluate and identify critical energy infrastructure, such as sighting, de-risking, capitalization, licensing, permitting, and governing. We have 11 FESC funded projects under this thrust and the progress reports of these projects are given in this report.

In addition to the existing projects, a systems analysis platform will be established to provide oversight and assist in decision making. Systems analysis will define breakthrough characteristics of any energy related project at the system level, and an economic analysis to assist in decision making.

Managing integration of the transformative changes will be a key challenge in any project. Our approach is to develop a systems level modeling platform to provide the integration of advances at the molecular scale with those at the integrated device scale, and at the full process plant scale. The platform will provide oversight and assist in decision-making, define breakthrough characteristics and connect the molecular level research to required scales, rates, and efficiencies.

Systems analysis of energy systems is increasingly being used to study a variety of problems. At the component level, commercial simulation packages exist to describe the operation of some of the individual energy components (e.g., solar cell), but less refined models are available for other components (e.g., fuel cells). While these research efforts are similar to our planned work, our vision for systems level modeling, analysis, simulation, and design is to a take a "full system approach" where all individual components (technologies, subsystems) are integrated into a full input-output model. With this vision, our major research goals of this Thrust Area are as follows:

1. Create a platform for modeling, simulation, analysis, and design of the total system
2. Collaborate with the experts in the other Thrust Areas to build models for components and subsystems
3. Conduct what-if scenario analysis to aid in making key decisions on scientific and engineering priorities and directions, and efficiently test concepts.
4. Perform systems optimization, not only at the operations level but also identifying opportunities for process intensification.

It is anticipated that the systems modeling will be implemented in several phases. In the initial phase, we will use simple models for the different components as placeholders until we develop the more detailed and realistic models. While our ultimate interest is in modeling the entire system, we will develop the modeling framework in a modular approach. Such a modular approach will allow us to model, simulate, and analyze portions of the entire systems.

2- Enhancing Energy Efficiency and Conservation

In the U. S., buildings account for 39% of our primary energy use and 72% of our electrical use. Thus, the reduction in energy usage in buildings is one of the highest priorities of the country's energy challenges. Advances in building and energy efficiency technologies will provide substantial value to Florida, not only for energy use and Green House Gas emissions reduction but also for economic development and job creation. Additional building energy research and development is needed to achieve the efficiency requirements cost effectively. Human behavior is also an important factor in the implementation of energy efficiency and conservation.

The Consortium's focus is to improve residential and commercial building efficiency, integrate energy systems in sustainable community developments, support industry energy auditing, develop integrated energy-water management systems, study human behavior to implement energy efficiency effectively, and provide outreach and education. Developing innovative energy-efficient building technologies that minimize the use of natural resources and utilize renewable and sustainable materials will result in sustainable and economically viable communities.

There are nine FESC funded projects under this thrust. The detailed progress report for each project is given in the attachment provided with this report. During this reporting period, UCF conducted 89 home energy audits and completed 31retrofits. 20 retrofits are in progress. The Sarasota County home, (one of the 31 retrofits) has met the Builders Challenge level for new homes with a HERS index of 66. UCF is building side-by-side residential test structures and great progress has been made during this reporting period. USF is leading the Zero Energy Home Learning Center (ZEHLC) project in collaboration with FSU and the Florida Solar Energy Center, construction and interior design experts from UF, and industry partner Palm Harbor Homes. The project is in Design Development phase. The researchers developed a hybrid envelope that can be opened during the cooler/dryer months of the year and closed when temperature and humidity levels are too high to achieve an acceptable comfort range in the house. Informed by FSEC studies that have shown that the majority of heat gain comes through the roof of Florida homes, the ZEHLC employs a shading device that covers the entire roof and the east and west walls to reduce heat gain by eliminating direct solar radiation through the building envelope.

3- Developing Florida's Biomass Resources

The State of Florida produces more biomass than any other state in the U.S. (~7% of total). Given the state's dependence on imported oil for transportation fuels and the value of transportation to our tourism industry, developing methods to convert this resource to fuels is important. The Consortium is pursuing microbial and gasification routes to produce this carbon-neutral fuel. In addition, algae production systems promise a direct route to fuel, along with its use for bioremediation of agricultural waste water

and production of products from the residual biomass.

There are 13 FESC funded projects under this thrust in the areas of algae, energy crops, biochemical conversion (cellulosic ethanol, plastics from biomass, etc), and thermochemical conversion (biofuels, waste to energy, new catalyst development), and biogasification.

There is great progress in the energy crop research. The chemical composition of biomass is a critical determinant of the yield of energy from biomass. Biomass that has higher carbohydrate levels are expected to increase the yield of biofuel with a bioconversion process. In contrast, biofuel yields from gasification and pyrolysis are expected to be greater from biomass with higher lignin and oleoresin contents. To identify genetic and environmental control of biomass chemical content Dr. Peter and team at UF are testing the utility of near and mid-infrared spectroscopy together with multivariate statistical modeling for rapid biomass chemical composition analyses. Miscanthus, giant reed, erianthus, sugarcane, elephantgrass, and energycane are being compared in regional trials throughout Florida by Dr. Sollenberger and team at UF.


Portable 20 KW Biomass Power Plant

The 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 requires efficient catalyst. Researchers at USF performed catalyst design by using density functional theory (DFT) simulations in the molecular scale. The testing moved up to pilot scale. The liquid product produced has been analyzed and report good yield in the diesel and jet fuel range. Dr. Chung and Dr. Lear at UF are collaborating with Planet Green Solutions. The portable 20 KW biomass power plant built in collaboration was demonstrated at the FESC summit.

FSU is developing a state-of-the-art, off-the-grid algal cultivation facility to produce algae with a minimal ecological footprint and made great progress in algal strain selection and growth optimization, biomass analysis and conversion, and the use of green power in sustainable, carbon neutral algal cultivation.

UCF (led by Dr. Ali Raissi) fabricated a small-scale gasifier and completed testing by using pine wood charcoal pellets as feedstock and oxygen and steam as the gasification agents. In addition, the team built 5' in length, 17.5" ID 304SS Biomass Gasification system. The aim is to produce liquid hydrocarbon fuels derived from Florida's biomass resources utilizing a two-step thermocatalytic process.

Dr. Shanmugam at UF is working with Engineered B. coagulans for ethanol production. Dr. Pullammanappallil at UF is developing processes for biogasification and clean-up of cellulosic ethanol stillage and for preparation of enzymes to saccharify pectin rich biomass feedstocks. In addition, he is developing biocatalyst for conversion of waste plastics (PLA based) to ethanol.

A systems approach is being pursued to optimize water and land use, energy crops, biomass harvesting and transport, and refining processes. The internationally recognized SUS researchers, the biomass production

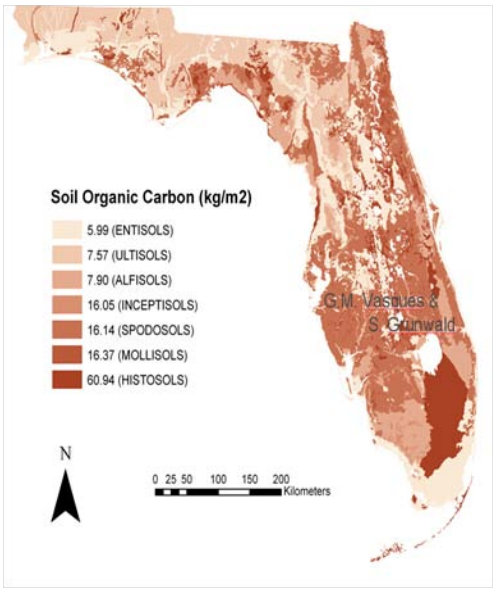
potential, and significant demonstrations projects provide promise to establish a leadership position by the SUS.

4- Harnessing Florida's Solar Resources

The Sunshine State has more solar insolation than any state east of the Mississippi River and the conversion of sunlight to electric power or fuel promises to be an important contribution to the State's renewable energy portfolio. Photovoltaics (PV) directly converts light to electricity and can be deployed in a distributed manner. Both thin film and organic PV technologies as well as systems integration are being pursued by Consortium faculty. Concentrated solar thermal energy is also being explored for conversion to electricity, production fuels and feed stocks as well as water desalination. The faculty research expertise in solar thermal and PV across the Consortium is well recognized for its excellence.

There are 22 FESC funded projects under this thrust in the areas of low cost PV manufacturing, advanced PV device, PV integration, PV/Storage/Lighting, PV pilot line, solar thermal, and clean drinking water via solar energy. USF is about to complete their new PV pilot line. The design and construction of the deposition system underwent a significant re-direction. This was driven by the formation of a partnership with Mustang Solar, a division of Mustang Vacuum Systems (MVS) which is located in the Sarasota area. MVS's experience in developing and selling large vacuum deposition systems had a significant impact on the design of the pilot line system. To pursue a roll-to-roll (RTR) format rather than the batch format of the original design was jointly determined. Substantial cost sharing by MVS in construction of the machine also made this transition possible. The deposition system is currently being built and is expected to be in operation in the first quarter of next year. Detailed progress reports on all projects are given.

5- Ensuring Nuclear Energy & Carbon Constrained Technologies for Electric Power in Florida



Nuclear energy is a major contributor to meeting Florida's energy needs today and will continue to be so in the future. Nuclear energy is a stable source of large-scale base load electric power with virtually no carbon emissions from operations. It's projected that a significant portion of the nuclear workforce at Florida's five existing nuclear facilities will retire over the next 10 years. This comes at a time when aggressive expansion of Florida's nuclear portfolio is being pursued, driving an even greater need for a trained workforce.

The State University System of Florida will soon have the only digitally controlled training reactor in the country. This system will provide training in critical areas such as design, construction, operation, fuel reprocessing, and waste remediation.

Dr. Alireza Haghighat at UF is working towards this 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 an environment for training and education of the necessary workforce in the area of digital control and instrumentation for nuclear reactors.

Thus far, the design for the AREVA's TXS protection system was completed. The UFTR-TXS system, includes three major components: Acquisition and Processing (AQP), Monitoring Service Interface (MSI), and Main Control Room (MCR). This design will be housed into two cabinets. Further, with support from AREVA, sixteen licensing documents were prepared, which have been submitted to the NRC as part of the UFTR Licensing Amendment Request (LAR).These documents address various aspects of the project including Quality Assurance (QA), planning, system description and analysis, and unique issues of a digital system such as diversity, redundancy, and common cause failure (CCF). Currently, the team is in the process of training the personnel on the planning documents and development of the UFTR specific application software.

Carbon Capture and Sequestration for Carbon-Constrained Technologies

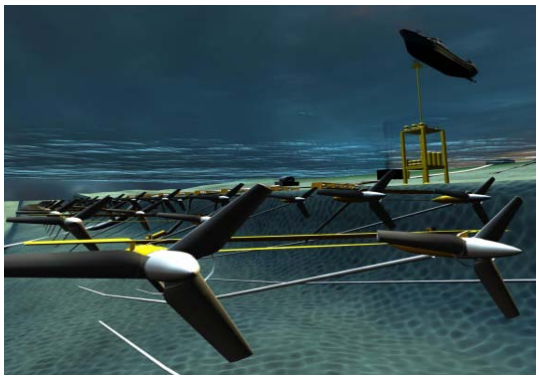
With the prevalence of fossil fuels in base load power generation, development of clean coal and natural gas power generation with carbon capture and sequestration is critical to the future of the state and nation. Increasing national and international concern over rising levels of greenhouse gases, particularly carbon dioxide, are increasing the probability of regulatory or economic incentives for large, fixed carbon sources to restrict carbon emissions. In addition, major financial institutions are seeing increasing risk in providing capital investments for large fossil-fuel power plants without a plan for carbon capture and sequestration. To remain competitive in a carbon-constrained economy and to continue to provide abundant and affordable energy, Florida's electric power utilities need access to technologies that can effectively and economically constrain carbon emissions. Such technologies include systems in development at FESC universities to capture carbon dioxide directly from power plant exhaust, to use carbon dioxide from power plants to grow algae for biofuels, and to enhance the ability of Florida's soils and forests to capture and sequester carbon dioxide. FESC researchers are also developing state-of-art chemical and numerical models to predict the physical and chemical effects of carbon dioxide sequestration in the deep, saline carbonate aquifers of Florida.

Florida lies atop the largest carbonate platform in the World. The carbonate rocks that comprise the Florida Platform have very high porosities and good geologic seals, making the Florida Peninsula an excellent site for geologic sequestration of carbon dioxide in deep, saline aquifers. FESC studies, to be published in early 2011, have shown that Florida has several very large potential reservoirs for the long-term sequestration of captured carbon dioxide. The widespread occurrence of these reservoirs means most large carbon sources in peninsular Florida overlie or are close to a potential sequestration reservoir. At least one of these potential reservoirs also contains residual oil remaining after conventional oil development. Deep sequestration of carbon dioxide in depleted oil fields may allow as much as 1-3 million additional barrels of oil to be produced, while sequestering carbon.

Feasibility studies conducted by FESC researchers, in partnership with TECO Energy, have produced information which has contributed to a large DOE-funded project through Research Triangle Institute (RTI) to construct a pilot carbon capture and sequestration at Polk Power Station, an integrated gasification combined cycle (IGCC) power plant in Polk County. In partnership with TECO, FESC investigators are studying the geochemical effects of the injection of carbon dioxide at the Polk Power Station. TECO is partnering with RTI International and the Shaw Group to conduct a study on a new technology to clean synthesis gas (syngas) at elevated temperatures. The study will evaluate the construction of a pilot project to demonstrate the technology on a 30 percent side stream at the Tampa Electric Polk Power Station's 250-megawatt IGCC plant. TECO also announced that the company has partnered with Siemens to pilot a project at Tampa Electric's Big

Bend Power Station to capture CO_2 emissions from conventional coal-fired power plants using an environmentally friendly process developed by Siemens.

6- Exploring Florida's Ocean Energy Resources



Ocean energy is an emerging technology that uses the power of ocean currents, waves, tides, thermal gradient, and salinity gradient to create renewable energy. Tapping ocean energy resources will reduce our reliance on fossil fuels. Unique to Florida, the Gulf Stream comes closest to the US coastline off the shores of South Florida, which is a major population center and home to one of the leading ocean energy research centers in the nation. Research areas of focus include ocean current and thermal differential systems, cold, deep ocean water-based air-conditioning, underwater hydrogen generation and storage, and environmental impact and mitigation.

On August 03, 2010, the U.S. Department of Energy (DOE) announced that Florida Atlantic University (FAU) has been designated a national center for ocean energy research and development. This new Southeast National Marine Renewable Energy Center (SNMREC) joins centers in the Pacific Northwest and in Hawaii that also work to advance the operational readiness of ocean energy technologies. In addition to the $1 million in funding appropriated to FAU last year, with this designation DOE has awarded the Center $250,000 to undertake research and development of technologies capable of generating renewable power from ocean currents and ocean thermal energy. FAU is ideally located to oversee development of equipment that can generate sustainable, cost-competitive electricity from ocean energy resources in the Florida Straits and the Gulf Stream.

SNMREC's primary focus is to determine the potential of Florida's ocean-current resource and on ocean thermal energy conversion in waters offshore. SNMREC's role 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 areas. Over the past several years, the regulatory environment associated with MRE development on the continental shelf has evolved considerably, and the Center's initial strategy has expanded as well to accommodate the regulatory requirements. In particular, the Center has continued to move forward in strategic research, in pursuing key technology, and in defining standards criteria; it has also become more and more deeply engaged in regulatory process formation, which will influence the development of MRE in Florida, while continuing to educate and engage the public.

Research and development for an ocean energy industry is being addressed with a system-level, phased approach. Joint research is ongoing at FAU, with FESC partners, and other industrial, government, and academic partners. Initial research in areas such as ocean resource analysis and modeling, prognostics and health monitoring systems, materials and anti-fouling, mooring and anchor systems, and environmental/benthic baseline assessment have been funded.

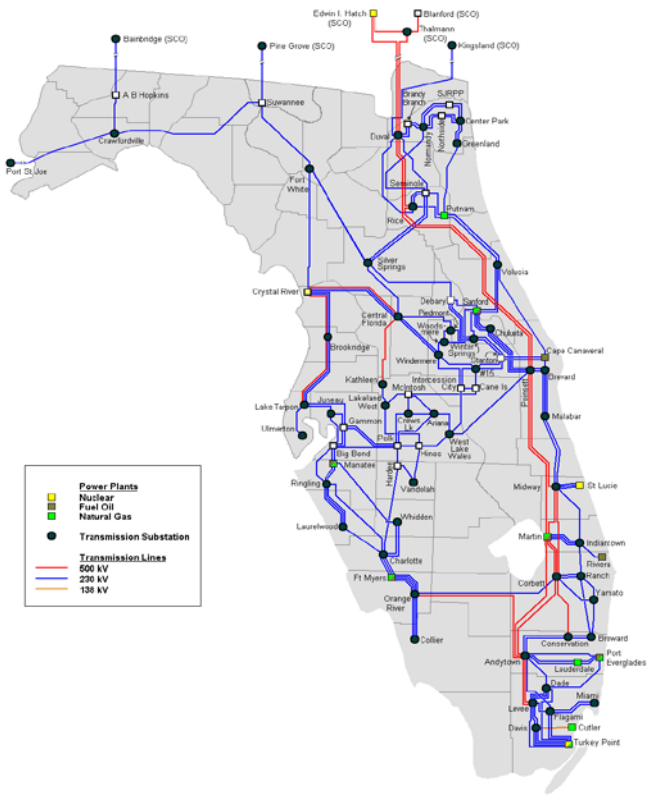
SNMREC's technology and industry support efforts are underway in three distinct but inter-related tracks. First, the Center is actively engaged in sensor and instrument acquisition, deployment, and analysis to more fully characterize offshore energy resources, as well as the benthic and pelagic environment. Second, in support of ongoing research and to further an operational and technical understanding of offshore energy systems and challenges, the Center has designed, partially fabricated, and will begin testing a small-scale hydrokinetic turbine system. Testing will be completed for components, sub-systems, and major systems of the turbine, eventually evolving to full system testing in a phased, risk-reduction process. Finally, the

Center is working to begin early development of system-level test operations and data collection infrastructure. This effort is intended to support and promote a phased approach for early-stage testing to minimize risk and further scaled development for the growing industry, as well as to help establish standards criteria and practice for the future sector.

Notable accomplishments during the past year include completed milestones in resource assessment, research, regulatory process activity, partner relationships, infrastructure development, and outreach. Stand-alone instruments deployed offshore in 2009 were recovered, and the data obtained reveals new and important features of the Florida Current that will influence design of offshore MRE systems. An application to lease deployment sites has been submitted to and is being reviewed by the US Bureau of Ocean Energy Management, Regulation, and Enforcement. An onshore 20 kW dynamometer system, for testing MRE system components, is installed and is currently undergoing operational testing. In March, SNMREC hosted an industry / government / academe workshop on issues associated with MRE development that produced a clear consensus about the importance of negotiating the maze of regulatory issues if the endeavor is to succeed. And the Center developed a curriculum for upper-division high-school students to introduce the topic within secondary education.

7- Securing our Energy Storage and Delivery Infrastructure

Energy generation, consumption, transmission, distribution, and storage together comprise a dynamic and interconnected system. This complexity will grow very significantly as the transportation sector connects with the electricity sector through plug-in hybrid electric vehicles. At the same time, renewable energy sources such as wind, solar, and biomass are becoming increasingly important parts of the energy system; however renewable energy sources are intermittent. Smart grid technologies offer new capabilities for monitoring and control of the electric energy system while simultaneously exposing new avenues for adversarial attacks.



This thrust addresses the need in the areas of smart grids, energy storage, and energy security.

Smart Grid

The aim 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 base load (nuclear), and incorporation of new power conversion, transmission, measurement, communication and control technologies (smart grid).

FESC Smart Grid technology group consists of faculty at FSU, UF, USF, UCF, FIU, and FAU. There are 10 FESC funded projects under this thrust.

On the supply side FESC already has significant reputation in FSU's CAPS, UF's PURC and USF's PCUE. Funding is needed in demand side technology, economics and policy expertise to round out FESC Smart Grid portfolio.

This thrust is also supporting broader FESC goals to attract new funding and build a strong collaborative Florida-based energy research and development, education, outreach, innovation, and technology transfer eco-system in Florida. To that end, the project team has submitted eight (8) proposals for federal and industry funding totaling approximately $41.6 M. Proposal efforts have resulted in one successful federal award, the Sunshine State Solar Grid Initiative (SUNGRIN), a $4.5M project, with $3.6M in funding from the US DOE, and one utility industry-funded project at $100K, with other proposals still awaiting notification, and, new proposals in development.

The team members have 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.

There has been substantial progress this period in the development of research-oriented models of the Florida electric power grid, the ultimate aim being models with sufficiently representative in behavior for investigation of wide-ranging scenarios and options in future development of the grid. The analysis of the Florida Power Grid Disturbance of February 2008 has been used as a means for comparing and validating behavior against real grid response. This approach has been demonstrated using an aggregated 14-Bus dynamic model with refinements in the data and protection related switching events, with results matching the recorded data observed in the incident report with minor discrepancies. Results suggest that the reduced, 14-bus model version may be useful, with reasonable assumptions, for some simplistic studies. Work is underway to construct parametric studies to determine the parameters sensitivity in the simulation using factor screening and other statistical techniques.

The development of a dynamic solar PV model with Maximum Power Point Tracking (MPPT) has been initiated and completed in this period. The model will contribute to the general power system modeling and simulation community as we intend to make it publically available and to the envisioned Florida Grid studies of future load and generation growth specifically. Initial studies of the impact of solar PV-based resources have been undertaken, and significant implications for power system operation and stability have been observed.

A simulation effort was completed for a major municipal electric utility in the state to examine power system restoration from a complete system outage. This is expected to continue with further examination of system dynamics under different scenarios and possible development of simulation-assisted training.

Electric Storage

In the electric storage area, the Consortium faculty is working towards improving battery and capacitor based storage. To reduce system-wide power outages and for more stable and reliable power delivery, the Consortium is pursuing research in micro grids and smart grids. Micro grids provide islanding capabilities allowing grids to separate from each other. This streamlines integration of both stationary and non-stationary energy storage devices. Smart grids allow control strategies and two way communications via Smart Meter system, provide intelligent energy management and improve energy efficiency.

Florida being a relatively flat sandy peninsula cannot effectively use pumped hydroelectric storage (PHES) technology or compressed air energy storage (CAES) and other than its Northern border Florida cannot easily purchase electricity across state lines. With these constraints electrochemical energy storage using

batteries is Florida's best option. This is also coupled with the opportunities led by various Utilities in Florida putting large scale PV installations throughout the state which could benefit from battery storage to satisfy peaking demand. The addition of 10-KW PV powered with lead acid battery emergency power systems to 90 emergency shelters throughout the state presents opportunities for demonstrations between Florida Universities and the local Utility. In some cases Utilities may want to pursue demonstrations of battery load-leveling with their PV installations that are coming on line.

There is a great deal of interest in, and enthusiasm for, utilizing renewable energy sources effectively in order to reduce utilization of fossil fuels, which in turn reduces CO_2 emissions significantly, and to move toward a more sustainable energy system. On utility scale, energy storage is critical to utilize renewable energy because of the intermittent nature of renewable energy sources such as photovoltaic and wind turbine. The technology will allow utilities to use the distribution network more efficiently, as power plants can be operated at a higher percentage of capacity while ensuring electrical supply at all times, thereby reducing the demand for peaking power plants that have the lowest efficiency with highest operating cost. Electrochemical energy storage using batteries is considered to be one of the most promising technologies satisfying gigawatt power and gigawatt-hours energy density requirements for large scale storage applications.

Research areas in battery technology includes new materials development (electrodes, separators, electrolytes and other components), new chemistry & concepts development for ultra low cost, high efficiency and long lasting energy storage systems.

Energy Security

Concern over global warming, geopolitics of oil production, and natural and man-made threats make it imperative that we have a solid understanding of the security of our energy systems.

It is clear that changes in one part of this interconnected grid system have a significant impact on the other parts. For example, capacity constraints in transmission limit choices on generation and consumption of energy. Consequently, we must take a "total systems" view of the challenges posed by the energy issues. It should be kept in mind that a system view is applicable at various levels of granularity: global, national, state, regional, city, military base, city, island, enterprise, etc. Indeed, this "systems theme" is central to the vision of the Florida Energy Systems Consortium.

The rising cost of energy, the need for increased energy security, and the expansion in energy innovation has encouraged a reexamination of energy systems at Federal facilities. It is clear that a federal facility such as an USAF Air Base or USN Air Station needs to be prepared to operate its data centers and supply fuel for its fighting force in the event that its external connections to energy supplies are severed. It is also clear that the facility needs to operate with the highest energy efficiency to control costs in periods of normal operation. The problem, however, is that the tools to guide decision making in the design and operation of a facility's energy system are not available. Our research is aimed at creating a framework and methodology for performing the necessary energy systems analysis. This 'toolbox' will incorporate a full range of energy generation, storage, conversion, and transmission technologies, as well as capabilities for integrating 'smart' systems, risk assessment, and optimization for making sensible systems design. FESC could partner with a federal facility in Florida to provide a meaningful test bed for the development of our systems analysis and design package. Furthermore, we will leverage the FESC and its research investment to help build this energy systems tool.

Providing secure energy systems to existing DoD, DOE, or NASA facilities in Florida provide a good opportunity for economic impact to the state as well as a longer term renewable energy test bed and development facility for expansion throughout the State of Florida and the nation. As examples, Florida currently has a number of Naval Stations, Naval Air Stations and Naval Hospitals in Jacksonville, Key West, Pensacola, Whiting Field, Mayport, and Panama which employ and house over 63,000 enlisted

personnel, civilians, officers, and contractors. Some of the smaller of these facilities would be an excellent proving ground for development and installation of renewable energy systems and policy / protocol to provide energy secure facilities. Additionally, the Navy has indicated interest in providing energy security, as is generally described in this overview, to their facilities nationally and internationally.

This research direction provides for a substantial mix of near term and longer term/next generation economy jobs across the spectrum of energy programs (i.e., biomass, solar, ocean, water, smart grid/microgrid) as each facility will be customized to make best use of the renewable energy natural resources of the region. It will lead to jobs for highly skilled engineers and scientists (e.g., development of next generation renewable energy systems and components for testing and deployment across multiple facilities).

Additionally, there are opportunities in private sector facilities such as international company campuses and critical facilities that can benefit from a secure energy systems approach as outlined above. Also, local communities may also have a strong interest in the security of their energy supply.

Finally, expertise in systems analysis of energy generation and distribution can complement other research efforts within FESC. Thus, we can participate on multidisciplinary research collaborations to increase the competitiveness of the FESC research community.

RESEARCH PROGRAM

The FESC research program at this point includes 69 FESC funded projects within the 7 strategic thrusts. Table 1 below gives the list of the projects under each thrust area. Project descriptions are given in Appendix A. Eight projects from FIU (not funded by FESC) and 1 project from UWF (not funded by FESC) are also included. FESC funded project progress reports are given as a separate attachment. Some of the projects are collaborative multi-university projects; however since funding was appropriated to each institution, only the lead university information is given in the table.

Table 1 – FESC Research Thrust and Project Summary
(Only lead university information is given)

Projects	Title/PI/Lead Institution
THRUST 1: Overarching	
	Power Generation Expansion under a CO_2 Cap-and-Trade Program PI: Tapas Das; Co-PI: Ralph Fehr - USF
	Joint Optimization of Urban Energy-Water Systems in Florida (Thrust 2: Efficiency) PI: James P. Heaney - UF
	Combined Cooling, Heat, Power, and Biofuel from Biomass and Solid Waste (Thrust 3: Biomass) PI: William Lear - UF
	Design, Construction, and Operation of CSP Solar Thermal Power Plants in Florida (Thrust 4: Solar) PI : Yogi Goswami; Co-PI's: Lee Stefanakos, David Hahn, Robert Reddy - USF
	Development of High Throughput CIGS Manufacturing Process (Thrust 4: Solar) PI: N. Dhere – UCF/FSEC
	Solar Photovoltaic Manufacturing Facility to Enable a Significant Manufacturing Enterprise within the State and Provide Clean Renewable Energy (Thrust 4: Solar) PI: Don Morel, USF; Co-PI's: Chris Ferekides, USF, Lee Stefanakos, USF, Tim Anderson, UF, Neelkanth Dhere, UCF/FSEC
	Research to Improve Photovoltaic Cell Efficiency (Thrust 4: Solar) PIs: Nicoleta Sorloaica-Hickman, R. Reedy – UCF/FSEC
	PV Energy Conversion and System Integration (Thrust 4: Solar) PI: N. Kutkut Co-PI's: J. Shen, I. Batarseh, Z. Qu, X. Wu, W. Mikhael, L. Chow – UCF/FSEC
	An Integrated Sustainable Transportation System (Thrust 4: Solar) PI: Eric Wachsman Co-PI: Shirley Meng - UF
	Integrated PV/Storage and PV/Storage/Lighting Systems (Thrust 4: Solar) PI: Franky So, Co-PI: Jiangeng Xue, Shirley Meng - UF
	Reliable and Resilient Electrical Energy Transmission and Delivery Systems (Thrust 7: Storage & Delivery) PI: Steinar Dale - FSU
THRUST 2: Enhancing Energy Efficiency and Conservation	
	Innovative Proton Conducting Membranes for Fuel Cell Applications & Protein Enhanced Proton PI: Ongi Englander, Co-PIs: Anant Paravastu, Subramanian Ramakrishnian - FSU
	Sustainably Integrated Advanced Building Subsystems (OGZEB) PI: A. "Yulu" Krothapalli, Co-PI: Justin Kramer
	Insight into Membrane Degradation Mechanisms Through Verification of Chemical and Mechanical Degradation Test Capabilities PI: Darlene Slattery; Co-PI's: Len Bonville, Xinyu Huang, Marianne Rodgers – UCF/FSEC
	Energy Efficient Building Technologies and Zero Energy Homes PI: R. Vieira Co-PI's: P. Fairey, J. Sonne – UCF/FSEC
	Joint Optimization of Urban Energy-Water Systems in Florida

	PI: James P. Heaney - UF
	Planning Grant: High Performance and Low Cost Fuel Cells for Future Vehicles PI: Jim Zheng, Co-PIs: Richard Liang, Chuck Zhang, Ben Wang - FSU
	NIRT: C-MEMS/CNEMS for Miniature Biofuel Cells PI: Marc Madou, Co-PIs : Chunlei Wang, Sylvia Daunert and Leonidas Bachas -FIU
	Fabrication of Nano Fractal Electrodes for On-Chip Supercapacitors PI: Chunlei Wang - FIU
	Energy Efficient Technologies and The Zero Energy Home Learning Center PI: Stanley Russell Co-PI's: Yogi Goswami - USF
THRUST 3: Developing Florida's Biomass Resources	
High Energy Crops	
	Establishment of the Center for Marine Bioenergy Research: Systems Approach to BioEnergy Research (SABER) PI: Joel E. Kostka; Co-PIs: William Cooper, Ivonne Audirac, Amy Chan-Hilton, Ellen Granger - FSU
	Constructual Optimization of Solar Photo-Bioreactors for Algae Growth PI: Juan Ordonez - FSU
	Seeding Biofuel Entrepreneurship in South Florida PI: George Philippidis – FIU
	Energy Intensive Crop Development PI: Gary Peter , Matias Kirst, Don Rockwood - UF
	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
Biochemical Conversion	
	Development of Biofuel Production Processes From Synthetic and Biomass Wastes PI: Pratap Pullammanappallil - UF
	Assessment and Development of Pretreatment for Sugarcane Bagasse to Commercialize Cellulosic Ethanol Technology PI: George Philippidis - FIU
	Engineering Biocatalysts for Hemicelluloses Hydrolysis and Fermentation PI: James F. Preston - UF
	Thermophilic Biocatalysts for the Conversion of Cellulosic Substrates to Fuels and Chemicals PI: K.T. Shanmugam - UF
Bio gasification	
	Combined Cooling, Heat, Power, and Biofuel from Biomass and Solid Waste PI: William Lear - UF
Thermo-Chemical Conversion	
	Production of Liquid Fuels Biomass via Thermo-Chemical Conversion Processes PI: Babu Joseph Co-PI's: Yogi Goswami, Venkat Bhethanabotla, John Wolan, Vinay Gupta - USF
	Integrated Florida Bio-Energy Industry PI: Ali T-Raissi Co-PIs: Nazim Muradov, Amit Gujar, Gary Bokerman - USF
	Biofuels Through Thermochemical Processes: a Systems Approach to Produce Bio-jet Fuel PI: Anjaneyulu Krothapalli
THRUST 4: Harnessing Florida's Solar Resources	
Solar Thermal	
	Concentrating Solar Power Program PI: Charles Cromer Co-PI: R. Reedy – UCF/FSEC
	Enhanced and Expanded Solar Thermal Test Capabilities PI: J. Walters Co-PI: R. Reedy – UCF/FSEC
	Solar Fuels for Thermochemical Cycles at low pressures

	PI: Jörg Petrasch – UCF/FSEC
	Solar Thermal Power for Bulk Power and Distributed Generation PI: David Hahn, James Klausner, Renwei Mei, Joerg Petrasch, and Helena Weaver - UF
	Design, Construction and Operation of CSP Solar Thermal Power Plants in Florida PI : Yogi Goswami Co-PI's: Lee Stefanakos, David Hahn, Robert Reddy - USF
	Solar Water Heating Systems Facility PI: James Roland, David Block – UCF/FSEC
Clean Drinking Water	
	Solar Driven Desalination PI: James Klausner and Skip Ingley
	Clean Drinking Water using Advanced Solar Energy Technologies PI: Lee Stefanakos Co-PI's: Yogi Goswami, Matthias Batzill, Maya Trotz, Sesha Srinivasan - USF
Low Cost PV Manufacturing	
	Enhanced and Expanded PV Systems Testing Capabilities at FSEC PI: S. Barkaszi Co-PI: R. Reedy - USF
	Development of High Throughput CIGS Manufacturing Process PI: N. Dhere – UCF/FSEC
	PV Manufacturing Data Base and Florida Applications PI: R. Reedy Co-PI: D. Block – UCF/FSEC
	Development of Low Cost CIGS Thin Film Hot Carrier Solar Cells PI: Gijs Bosman, Co-PI: Tim Anderson
	Solar Photovoltaic Manufacturing Facility to Enable a Significant Manufacturing Enterprise within the State and Provide Clean Renewable Energy PI: Don Morel, USF; Co-PI's: Chris Ferekides, USF, Lee Stefanakos, USF, Tim Anderson, UF, Neelkanth Dhere, FSEC
Advanced PV Device Program	
	Research to Improve Photovoltaic (PV) Cell Efficiency by Hybrid Combination of PV and Thermoelectric Cell Elements. PIs: Nicoleta Sorloaica-Hickman, R. Reedy – UCF/FSEC
	Research and Develop PV Device Science and Laboratories PI: Nicoleta Sorloaica-Hickman, Robert Reedy – UCF/FSEC
	Beyond Photovoltaics: Productionizing of Rectenna Technology for Conversion of Solar radiation to Electrical Energy PI: Shekhar Bhansali Co-PI's: Lee Stefanakos, Yogi Goswami, Jing Wang - USF
PV Integration	
	PV Energy Conversion and System Integration PI: N. Kutkut Co-PI's: J. Shen, I. Batarseh, Z. Qu, X. Wu, W. Mikhael, L. Chow - UCF
	Non-Contact Energy Delivery for PV System and Wireless Charging Applications PI: Jenshan Lin - UF
	An Integrated Sustainable Transportation System PI: Eric Wachsman Co-PI: Shirley Meng
PV/Storage/Lighting	
	Planning Grant: Hydrogen storage using carbon-based adsorbent materials PI: Efstratios Manousakis - FSU
	PV Power Generation Using Plug-in Hybrid Vehicles as Energy Storage PI: J. Shen Co-PI's: I. Batarseh, N. Kutkut - UCF
	Integrated PV/Storage and PV/Storage/Lighting Systems PI: Franky So, Co-PI: Jiangeng Xue, Shirley Meng - UF
THRUST 5: Ensuring Nuclear Energy & Carbon Constrained Technologies for Electric Power in Florida	
	Reducing Residential Carbon Emission in Florida: Optional Scenarios Based on Energy Consumption, Transportation, and Land Use

	PI: Tingting Zhao, Co-PI: Mark Horner - FSU
	Planning Grant: Enhanced Thermal Performance and Microstructure Simulation of Nuclear Fuels Justin Schwartz - FSU
	Biocatalytic Lignin Modification for Carbon Sequestration PI: Jon Stewart - UF
	Carbon Capture and Sequestration PI: Sabine Grunwald. Co-PIs: Tim Martin, Howard Beck - UF
	Creation of Carbon Sequestration Data, Technologies and Professional Cohorts for Florida PI: Mark Stewart, Co-PIs: Jeffrey Cunningham, Yogi Goswami, Maya Trotz - USF
THRUST 6: Exploring Florida's Ocean Energy Resources	
	Southeast National Marine Renewable Energy Center PI: Susan H. Skemp, Co-PI: Howard P. Hanson - FAU
	Buoy Array for Ocean Wave Power Generation PI: P.I. Z. Qu, Co-PI: K. Lin - UCF
THRUST 7: Securing our Energy Storage and Delivery Infrastructure	
	Reliable and Resilient Electrical Energy Transmission and Delivery Systems PI: Steinar Dale - FSU
	Microgrids for a Sustainable Energy Future PI: Chris S. Edrington Co-PIs: Jim Zheng, Mischa Steurer, Dave Cartes - FSU
	Multi-Generation Capable Solar Thermal Technologies PI: A. Krothapalli; Co-PI: Brenton Greska –FSU
	Planning Grant: Real-Time Power Quality Study For Sustainable Energy Systems PI: Dr. U. Meyer-Baese, Co-PIs: Helen LI, Simon Foo, Anke Meyer-Baese, Juan Ordonez - FSU
	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
	Investigating the Effect of Appliance Interface Design on Energy-use Behavior PI: Paul Ward; Co-PIs: Ian Douglas, David Eccles - FSU
	Energy Delivery Infrastructure Design and Simulation PI: Alex Domijan Co-PI: Arif Islam - USF
	Micro Battery Defense Development PI: Chunlei Wang - FIU
	Electrostatic Spray Deposition of Nanostructured Porous Metal Oxide Composite PI: Chunlei Wang - FIU
	Fabrication and Investigation of Porous Tin Oxide Anodes for Li-Ion Micro Batteries PI: Chunlei Wang - FIU
	Very high energy-density ultracapacitors" PI: E. Bakhoum - UWF
	Secure Energy Systems – Vision and Architecture for Analysis and Design PI: Pramod Khargonekar - UF
Policy and Other	
	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
	Promoting Energy and Land Use Through Land Use, Transportation and Green Infrastructure Polices PI: Tim Chapin; Co-PIs: Ivonne Audirac, Chris Coutts, and Greg Thompson, Department of Urban & Regional Planning, and Mark Horner, Department of Geography - FSU
	Marketing Strategies to Incentivize Entrepreneurship and Innovation in the Development of Sustainable and Environmentally Friendly Goods and Services PI: Joe Cronin - FSU
	Energy Sustainable Florida Communities

	PI: Richard Fieock, Co-PIs: Ivonne Audirac, Keith Ihlanfeldt - FSU
	Political and Economic Institutions Regarding Siting of Energy Facilities: "Hold Out" and "NIMBY" problems, with concurrent developments in undergraduate education. PI: R. Mark Isaac, Co-PI's: Douglas Norton, Svetlana Pevnitskaya - FSU
	Development of a Renewable Energy Research Web Portal PI: Charles R. McClure, Co-PIs: Ian Douglas, Chris Hinnant - FSU
	Energy and Efficiency Video Public Service Announcements PI: Andy Opel, Co-PIs: Phil Steinberg, Leslie France-Patterson, Laura Arpan, Ian Weir - FSU
	An Experimental Investigation of Economic Incentives of Policies, Institutions and R&D in Environmental Conservation, Sustainability and Renewable Energy PI: Svetlana Pevnitskaya, Co-PI: Dmitry Ryvkin - FSU
	Planning Grant: Meteorological Factors Affecting Solar Energy Efficiency in the Tropics PI: Paul Ruscher, Co-PIs: Yaw Owusu, Hans Chapman - FSU
	Planning Grant: Climate modeling and outreach activities PI: Shawn R. Smith, Co-PI: Steve Cocke - FSU
	Visiting Scholar in Energy and Land Use Law, Florida State University College of Law PI: JB Ruhl and Jim Rossi, Co-PIs: Uma Outka - FSU
	Economic Impacts of Renewable Energy and Energy Efficiency Policies PI: Theodore Kury - UF
Education and Outreach	
	Florida Advanced Technological Education Center (FLATE) PI: Marilyn Barger – Hillsborough Community College
	Outreach Activities for FESC PI: Pierce Jones, Kathleen C. Ruppert, Hal S. Knowles III, Nicholas Taylor, Barbra Larson, Craig Miller - UF
	UFTR Digital Control System Upgrade for Education and Training of Engineers and Operators PI: Alireza Haghighat - UF

NEW PROGRAM DEVELOPMENT

The goal of the new program development effort is to significantly impact energy-related research, education, and outreach programs within the SUS. The strategies include:

- Provide exploratory research funding
- Facilitate competitive responses to solicitations; in particular larger-scale center proposals
- Serve as a communications hub

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. More than 100funding opportunities were distributed to the FESC faculty during this period. The funding opportunities are posted at the FESC web site: http://www.floridaenergy.ufl.edu/?page_id=912. Faculty teams were formed to respond to the funding opportunities based on the responses received from the faculty. The FESC office facilitates proposal development in a variety of ways beyond solicitation awareness, including identifying leaders, communicating with external partners in industry, national labs and other non-SUS universities, providing professional technical writing help, arranging telecons, and assisting with cost share development, budgets and boiler plates.

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

Competitive Funding Opportunities			
Title	Call #	Agency	Funding
Solar America Cities-Technical Outreach	DE-FOA-0000086	US DOE	$10.5M ($500K-$6M);
Energy Innovation Hub-Fuels from Sunlight	DE-FOA-0000214	US DOE/NETL	$122M
Energy Innovation Hub-Modeling and Simulation for Nuclear Reactors	DE-FOA-0000170	US DOE/Office of Nuclear Energy	$122M
Fiscal Year (FY) 2010 Energy Efficient Building Systems Regional Innovation Cluster Initiative	E-RIC	US DOE, DOC, EDA,NIST/MEP, DOL, ED,SBA, NSF	$129M
Science Master's Program (SMP)	NSF 09-607	NSF	$14.7M; 21 Awards
NSF ERC: Energy Systems for a Sustainable Future	NSF-09-545	NSF	$18.5M for 5 yrs
CHE-DMR-DMS Solar Energy Initiative (SOLAR)	NSF 09-604	NSF	$7M ($500K per year); 3 to 10 Awards
i6 Challenge	FFO	FFO	$1M each for a project period of up to two years

Finding partners outside of Florida is critical to respond to nationwide calls such as the Energy Innovation HUBS. A database of FESC expertise information, including faculty biographies, has been prepared in several areas such as Algae, Solar to Fuels, and Energy Efficiency and posted at FESC web site to better communicate to potential partners the capabilities of the SUS research enterprise. FESC responded to all three Hub solicitations (1- Fuels from Sunlight, 2- Simulation for Nuclear Reactors, 3- E-RIC):

- Energy Efficiency Hub Regional Innovation Cluster (E-RIC) proposal effort: FSEC led proposal effort for FESC for funding from four federal agencies for the amount of $120+ million. Teamed with UF, FSU, USF, FIU, U of Illinois, GTI, American Council for an Energy-Efficient Economy, Lighting Science Group, and Sunovia. Also had economic co-applicants Seminole State College, Florida High Tech Corridor Council, Small Business Development Center, and the Florida Manufacturing Extension Partnership. With the help of the Florida MEP, reached partnership projects with a number of manufacturers in the region. Proposal was submitted on May 5, 10. Department of Energy announced that Penn State had won the E-RIC funding.

  SUNFUELHUB Proposal effort: Led by USF for the consortium for $122M funding from US Department of Energy. Teamed with UF, UCF, WV, GIT, UGA, UVA, Emory University, NC A&T State University, Yale, ORNL, SRNL, , Scripps Energy Laboratories, Tuskegee University, Draper Lab, Eastman Chemical Co., Idaho NL, Sandia NL, Universal Oil Products, FPL, General Catalyst Partners, Rock Port Capital. Department of Energy announced that a team led by the California Institute of Technology (Caltech) will run the Fuels from Sunlight Energy Innovation Hub. This is a Joint Center for Artificial Photosynthesis (JCAP). It will be located in two California-based sites, operated under a unified management structure. The Southern California site is on the Caltech campus in Pasadena, California and the Northern California site is at Lawrence Berkeley National Laboratory in Berkeley, California. The FESC team is planning to respond to upcoming funding opportunities.

- Nuclear HUB Proposal Effort: Led by University of Utah for $122M funding from US Department of Energy. UF participated. Department of Energy announced that ORNL received the award.

In addition, FESC worked with number of PI's within the consortium to support their proposal efforts. Some examples are:

- Regional Approaches to Sustainable Bioenergy - Program Area Code – A6101; $45M over 5 years per award (Dr. M. Gallo, UF lead)
- DE-FOA 0000341 Biomass Research and Development Initiative in cooperation with USDA, $7M total per award (Dr. J. Wolan, USF lead)
- Photovoltaic (PV) Manufacturing Initiative, DE-FOA-0000259, $25M total per award over 5 years (Dr. Anderson, UF lead)

INDUSTRIAL COLLABORATION AND TECHNOLOGY COMMERCIALIZATION

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, and provide our students with an unparalleled educational experience to prepare them as R&D and innovation leaders of tomorrow. FESC's industrial collaboration program is designed to be an effective and efficient avenue for industry to guide FESC activities and benefit from the research, education and outreach activities of the Consortium. The program promotes a meaningful exchange between the partner 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.

The progress for this period is given below:

FECC Funded Study: Energy Efficiency and Renewable Energy in Florida

At the behest of Florida Energy and Climate Commission, the Governor's Energy Office asked FESC to provide a framework for transition to clean and renewable energy sources, and energy efficiencies, with regard to market driven forces. The report examined three areas:

- Current Incentive Mix (both State and Federal)
- Cleantech Barriers to Commercialization and Project Finance
- Effects of Regulatory Change – RPS Implementation

FESC reviewed existing statutory incentives supporting the deployment of energy efficiency and renewable energy in Florida, then discussed effective mechanisms to overcome barriers to commercialization and project finance. The report culminated with an analysis of a potential state renewable portfolio standard. The study provided baseline recommendations toward the next step in renewable energy and energy efficiency strategic planning and implementation. The study was submitted to the Florida Energy and Climate Commission on February 26th, 2010. The executive summary and full report are posted at: http://myfloridaclimate.com/climate_quick_links/florida_energy_climate_commission/policy_and_resources2/florida_energy_systems_consortium_economic_analysis and also at the FESC web site.

The study was performed by: Erik Sander, UF, Ted Kury, UF PURC, Dr. Julie Harrington, FSU CEFA, Jack Sullivan, FRC, and Dr. Aster R. Adams

Industrial Collaboration

Multi-university Proposal Industrial Partnerships
FESC researchers have identified number of partnering companies and entities for broad research projects and proposals as shown below.

Energy Innovation Hub-Fuels from Sunlight : $122M (5 years)

FESC Universities: USF (Lead), UF, UCF
External Collaborators: Sandia National Laboratories, Savannah River National Laboratory (SRNL), Oak Ridge National Laboratory (ORNL), Scripps Energy Laboratories (FL), Draper Laboratory, University of Virginia, Georgia Institute of Technology (GIT), Emory University, Tuskegee University, North Carolina A&T State University, West Virginia University, University of Georgia, Yale University
Industry Partners: FPL, Eastman Chemical Company, Universal Oil Products, General Catalyst Partners, Rock Port Capital

Energy Efficient Building Systems Regional Innovation Cluster Initiative (E-RIC): $129.6M (5 years)
FESC Universities: UCF (Lead), USF, UF, FSU, FIU
External Collaborators: FL MEP, FL SBDC, Florida High Tech Corridor Council (FHTCC), University of IL, ACEEE, Brevard (Workforce), Central Florida (Workforce), Daytona State College, Mid Florida Tech, Osceola Tech Education Center, Seminole State College (SSC)
Industry Partners: Lighting Science Group (Melbourne, Florida) and Sunovia (Sarasota), Coastal Caisson, Dais Analytic, ICS of Florida, Kingspan, LSG, PGT, Windoor, GTI

Energy Innovation Hub-Modeling and Simulation for Nuclear Reactors : $122M (5 years)
FESC Universities: UF
External Collaborators: University of Utah (Lead), Texas A&M University, Penn State University, Ohio State University, University of Missouri, University of Nevada, Wright State University, New Jersey Institute of Technology
Industry Partners: General Electric Hitachi, Energy Solutions, Edison Welding Institute, Oli Systems LLC, ARETE Inc. , Aspen Tech, Battelle

U.S. China Clean Energy Research Center (CERC): $12.5M (5 years)
FESC Universities: FIU (Lead), UF, USF, UCF
External Collaborators: Univ. of Nevada, Lighting Research Center at the Rensselaer Polytechnic Institute, Xi'an Jiao Tong University (Xi'an), Tsinghua University (Beijing), Tongji University (Shanghai), Southeast University (Nanjing), Chongqing University (Chongqing), Tianjin University, Center for Building Information, Ministry of Housing and Urban and Rural Development (MOURD), China, NREL, and ORNL
Industry Partners: Future House Real Estate Co., China Academy of Building Research (CABR), Ingersoll Rand Company (Trane's current owner), American Lighting Association (ALA), IBM, Academician of China Academy of Sciences, CNLight, South Gas Company

PV Manufacturing Initiative
a- University Led:
FESC Universities: UF, UCF, USF
External Collaborators: U of Maryland, U of Toledo, Oak Ridge, NREL PPG Industries Inc.
b- Industry Led: By Sematech
FESC Universities: UCF

Industrial Collaboration Project Examples
Additionally, FESC has been actively pursuing research, infrastructure improvement, and economic development collaborations with multiple companies and other entities to assure that the Consortium's research and education agenda are in tune with industry's needs and to move FESC technologies quickly to serve Florida's industry and economy. Outlined below is a sampling of specific of collaborations that FESC is fostering across Florida:

- Collaboration with NASA Glenn Research Center
  Canan Balaban, Associate Director, Industrial Collaboration & Commercialization, visited NASA Glenn on March 24, 2010 and gave an overview presentation about FESC and the Florida Institute for Sustainable Energy (FISE) at UF. Per NASA Glenn's request, an MOU between NASA Glenn and FESC has been signed. NASA Glenn is intrested in green energy and they have developed a sophisticated "Green Lab" with advanced algae technology and various eco systems including salt resistance algae and halophytes. Their goal is to have a test bed in Florida especially at the Kenndey Space Center. We are collaborating with the Spaceport Research & Technology Institute to find a suitable place for potential algae and halophytes test bed in Florida. NASA scientists intoduced us to an Israel based company looking for a power company in US with CO_2 source and available land to implement their algae technology. We established contact between this company and FL utilities (FPL, TECO) for potential partnership.

- Collaborations in Energy Storage Programs
  SAFT received $95M grant from the U.S. Department of Energy with $95M cost share to build a 235,000-square-foot plant in Jacksonville FL. SAFT has 16 wholly owned facilities worldwide and six in the United States, has more than 2 million lithium-ion battery customers around the world. FESC leadership team is communicating with SAFT management. In addition, FESC faculty was introduced to the SAFT key research scientist. SAFT is planning to build up to 1MW PV on the roof of the new manufacturing facility with their grid level storage. FESC is in discussions with SAFT team to use this installation as a hands-on training experience for FESC undergraduate and graduate students combined with internship opportunities at their manufacturing facility.

  As part of the team forming effort to respond to the anticipated Energy Storage Hub solicitation, FESC leadership team is in touch with Sandia National Lab and other national labs, universities, and companies.

This represents only a small set of examples of the industrial collaborations that FESC is initiating.

Industrial Database – Collaboration with Enterprise Florida

FESC has identified a need in Florida's energy related programs in that no single database exists cataloging the breadth of renewable energy companies and associations across Florida. While capturing and maintaining a 100% complete dataset of industrial contacts may not be feasible, FESC has initiated an effort to create a database of important industry players in order to quickly identify synergies between FESC's research, education, and technology commercialization programs and Florida industry. Sources of information for this database include Florida energy related trade associations, researcher and university contacts, Florida energy program grantees, and other sources. To date, FESC has compiled and is maintaining a relational database of over 250 companies and other entities in Florida that have a key stake in Florida's energy strategies. FESC is now collaborating with Enterprise Florida to combine their database with FESC industrial database. The combined database will be shared with Enterprise Florida. The database will be constantly updated and will provide an avenue for program information dissemination, industrial needs assessments, and potential collaborations.

FESC-Wide Blanket Confidentiality Agreement

As FESC increases its service to the SUS universities, faculty and student researchers are exploring greater numbers of industrial collaboration opportunities that include multiple universities working together. One challenge that will arise as this model is scaled up is the need to foster open discussion while protecting valuable confidential information and intellectual property of the SUS universities and the companies with which they work. Technical discussions that involve a private sector collaborator (e.g. company, entrepreneur, and investor) and multiple universities can be impeded by the requirements to execute

multiple university confidentiality agreements. To proactively address this issue, FESC initiated negotiation of the SUS's first blanket confidentiality agreement that spans FESC's core universities (FAU, FIU, FSU, UCF, UF, and USF). This blanket confidentiality agreement is a single instrument which a collaborating company can execute to freely discuss opportunities for research and technology collaborations with any of FESC's core universities. The FESC wide NDA was approved and the executed copy was sent to all the FESC core universities. It was used for the Hub proposals for the first time.

Technology Commercialization

FESC has a relatively limited budget dedicated specifically to spurring industrial collaboration and technology commercialization and the leadership team has consulted with partners and stakeholders from academia, the private sector, government-based entities, and economic development organizations across Florida to design our technology commercialization programs.

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. FESC distributed a Request for Proposals to all SUS universities, through their office of technology licensing, to initiate a competitive selection process. In response, the SUS universities submitted 27 proposals of leading energy technologies for market studies and business plans. FESC convened a panel of energy industry leaders, venture capitalists, and energy policy experts to review and down select to 15 projects that were selected for business plans and market research analyses. These deliverables can be used by FESC, the university technology licensing offices, and the Institute for Commercialization of Public Research to attract private sector partner for technology licensing and development or further sponsored research in the host university. The 15 projects selected for business plans and market research studies are:

University	Project	Energy Field
FIU	Novel Fabrication Method of Nanoscale Fibers and Tubes	Energy Storage and Distribution
FIU	Synthesis of Hydrides and the Vehicular Use of Hydrogen Producing Reactions	Renewable Fuels
FSU	High Efficiency Multijunction PVs for Solar Energy Harvesting	Solar Energy
FSU	Multi-Piece Wind Energy Blades	Wind Energy
FSU	Microgrid Controllers & Solar Wind Distributed System Controls	Energy Storage and Distribution
UCF	High Efficiency Air Conditioning Condenser Fan Blades	Energy Efficiency
UCF	Milling Technology Leads the Way to Cost Effective Ethanol Production	Bio-energy

UCF	Hybrid PV and Thermoelectric Cell Elements Improve Solar Cell Efficiency	Solar Energy
UCF	Wind and Solar Battery Chargers	Energy Storage and Distribution
UF	Advanced Membrane Reactors for H_2 Production	Renewable Fuels
UF	ChromaDynamics	Energy Efficiency
UF	Highly Efficient, Long-Life, Weather Compatible Nanomaterials-Based Display	High Performance Display Technologies
UF	High Power, Fuel Flexible, Cost-Effective Solid Oxide Fuel Cell	Energy Storage and Distribution
USF	Enhanced Lead Sulfide Quantum Dots for Solar Cells	Solar Energy
USF	A Practical Method of CO_2 Sequestration	Carbon Capture and Sequestration

FESC funded 15 business plans and market research studies at $7.5K each for FESC funded later stage technologies. All the reports have been received. The Office of Technology Licensing at each university is promoting these technologies. One page description of these technologies will be posted at FESC web site when they are received from the technology licensing offices of each university.

- 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 funding 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 is providing up to $50K in matching funds for each of up to 5 such projects, with an industry match on each project, attracting in excess of $500K of industry support to these FESC-funded projects. The solicitation was prepared in May and sent to FESC technology transfer offices.

FESC Phase II Company Match

Company Match	2:1 Cash & 2:1 In-Kind for large companies (100+ employees) 1:1 Cash & 1:1 In-kind for small companies (<100 employees)
FESC Award	$20K - $50K annual award

The Phase II solicitation was circulated twice. Two projects were funded during the 1st round. Six proposals were received during the 2nd round. They are being reviewed.

The Phase II projects are listed in the table below.

University	Phase II Projects Funded ($50,000/project)
UF	*Development of High Efficiency Polymer Solar Cells*
UF	*Cleaner, More Efficient Turbine Energy Production Using Robust, Miniature Solid-State Gas Sensors*
University	**Phase II Projects in Review**
FSU	*Deployment of a Low Cost Concentrating Solar Energy Systems Using Solar Sausages*
UCF	*Development of a Mo Back Contact Layer and CIGS PV Circuit*
UCF	*Development of Preproduction Components and Beta Testing of FESC's Smart Sensors*
UCF	*UCF and Harris Corp Joint Wave Energy Projects*
UF	*SWNT Based Air Cathodes for FC and Metal Air Batteries*
UF	*Stress Evolution in Solid-State Li-ion Battery Materials*

EDUCATION

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

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

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

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

Efforts in the Area of Masters Degree

UF has developed an online "Energy Certificate Program" for engineers and scientists to continue their education through graduate certification. The Energy Certificate has four tracks: Solar Energy, Wind Turbines, Gas Turbines, and Energy Management; and is delivered completely online; so it could serve as a means for energy education throughout FL and the nation. The certificate will be received from the Department of Mechanical &Aerospace Engineering. The link to the UF EDGE Energy Certificate and Sustainable Engineering Certificate program is: http://www.ufedge.ufl.edu/programs/certificates.php

Dr. Alvin Culaba, FSU, has begun work enhancing an existing Sustainable Energy degree program in the Mechanical Engineering department's Master of Science degree at the FAMU/FSU College of Engineering. He is building on the original efforts of Anjaneyulu Krothapalli of the FSU Energy and Sustainability Center. The concept is to create a prototype for a University-wide Professional Science Master's (PSM) with the ultimate goal of the existing program becoming the basis for establishing an entrepreneurship-based program with two degree tracks: (1) Natural & Engineering Science majors and (2) Social Science & Business majors. The existing program is targeted at students who are interested in the science, technology, engineering, and mathematics as well as applications and policy matters of sustainable energy. The new program will provide students with additional skills to address many of the energy and sustainability challenges faced by the nation and the world, specifically business and management.

Dr. Jay Kapat, UCF, has developed Professional Science Master (PSM) program on Energy. The initial track is on "Turbo-Power Generation (turbo-machinery based power generation that currently provides more than 98% of all electricity)" is being proposed, with significant support from related local industry. The future tracks on "Generation and Smart Grids", "Photo-Voltaics", and/or "Smart Buildings" are being discussed. This is a multidisciplinary and system focused program to address key systems in energy and power industry. It will have a highly challenging – 8 STEM courses and 5 Professional courses in 3 semesters. The industry partners will provide summer-long internship, 1:1 industrial mentor, co-instruction of key courses.

FAU, USF, and FIU submitted a consortium proposal to NSF proposing to develop and deliver a multidisciplinary science master degree program in renewable energy and sustainability for fall 2010. FSU added 3 new classes:

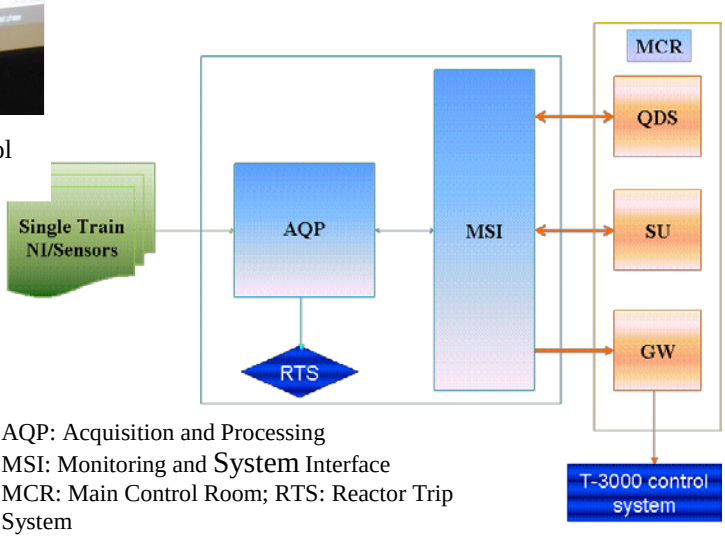
- The Economics of Sustainable Energy taught by Doug Norton (FSU, Spring, 2010)
- Sustainable Development Law taught by Uma Outka (FSU, Spring, 2010)
- Governing Sustainable Communities, Richard C. Feiock (FSU, Spring, 2010)

University of Florida Nuclear Training Reactor (UFTR) Digital Control System Upgrade for Education and Training of Engineers and Operators, Dr. Alireza Haghighat

Dr. Haghighat is presenting the UFTR Digital Control System at the 2nd FESC Summit

The UFTR is being upgraded to a fully digital control system. This makes the UFTR the first operating nuclear power plant in the United States that uses a fully digital control system. This facility will provide for the training and education of the necessary workforce in the area of digital control and instrumentation for nuclear reactors. 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 two major areas:

i) Design of the new digital system
ii) Preparation and submission of licensing documentation to the NRC

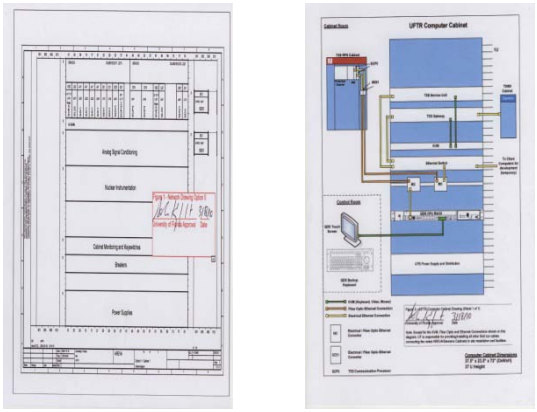


AQP: Acquisition and Processing
MSI: Monitoring and System Interface
MCR: Main Control Room; RTS: Reactor Trip System
QDS: Qualified Display System
SU: Service Unit; GW: GateWay

Fig. 1 - Schematic of the UFTR-TXS Protection System

A design for the AREVA's TXS protection system has been completed. Figure 1 shows the components of this design. The UFTR-TXS system includes three major components: Acquisition and Processing (AQP), Monitoring Service Interface (MSI), and Main Control Room (MCR). This design will be housed into two cabinets as shown in Figures 2a and 2b. Cabinet 1 includes the AQP and all the signal processing units, and the Cabinet 2 includes the MSI and all the MCR components.

With support from AREVA, several important documents were prepared, and since Jan 2010, seven documents were submitted to the NRC.



a) Cabinet 1 **b) Cabinet 2**

Fig. 2 – Schematic of UFTR-TXS protection system in two cabinets

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

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 FLDOE 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.

During the current reporting period, FLATE partnered with 10 Florida community colleges and their local industry to define curriculum standards for alternative energy that support industry needs, made several presentations both within and outside of Florida, and is working with Brevard Community College for a fall implementation of the Alternative Energy Systems Certificate. In April, FLATE added Jorge Monreal to the team as Project Manager to help drive implementation of this FESC project.

Specific accomplishments during the period are:

11/18/09	Presentation on Energy Curriculum in Florida at Interstate Renewable Energy Council's (IREC) third "New Ideas in Educating a Workforce in Renewable Energy and Energy Efficiency" Conference. (Albany, NY)
2/2/10	Co-presented, with Drs. Tim Anderson and Pierce Jones, to the Florida House Committee for Public Universities and Private Colleges Policy
3/10/10	Facilitated the approval by FL DOE of the new curriculum framework for Alternative Energy Technology Specialist (CIP: 0615000003) as a College Credit Certificate program under the Engineering Technology AS/AAS degree program. Brevard Community College (BCC) will adopt in Fall 2010.
4/5/10	Added Jorge Monreal as Project Manager- FESC project
4/23/10	Presented overview of FESC and its interactions with two year A.S. programs at the spring state wide Engineering Technology Forum held at FSCJ at Jacksonville.
5/7/10	Meeting with Broward College Associate Dean for A.S. programs to discuss alternate energy specialization in the state wide Engineering Technology A.S. degree program

The immediate focus is to help BCC implement the new Alternative Energy Technology Specialist program for the Fall of 2010 by helping to develop curriculum for the introductory course, as well as providing any

necessary aid in other courses. Additionally, FLATE is partnering with BCC on an NSF grant to support curriculum development and outreach for college energy programs and degrees.

In the next few months, FLATE in partnership with the FLDOE will conduct a survey to assess what, if any, alternative/renewable energy courses are currently being offered at public state and community colleges, private colleges and high schools. This follow-up to the 2009 Greensforce Florida survey will focus on specific courses currently offered at public and private 2-year degree granting institutions. It will also request enrollment data in courses and programs.

A list of Florida companies with products or services in the Alternative/Renewable energy sector is in the process of being compiled. The goal is to create industry focus groups to assess workforce education needs.

FLATE has partnered with FESC public outreach to develop a professional development workshop to be offered on July 27 at the Hi-TEC conference in Orlando.

FESC Fellows Program

FESC Fellows Program was organized by Dr. Marilyn Barger to facilitate the Community College faculty attendance to the FESC summit on September 28-29. The FESC Fellowship offered was $200 per attendee. Several Community and State Colleges were represented through the FESC Fellows program.

Pre-conference:
Prior to the summit, two FESC Fellows attended the Technology Commercialization Workshop: Idelia Phillips from State College of Florida and Ernest Friend from Florida State College at Jacksonville.

Advisory Board Meeting:
During the first day of the summit, the four-way partnership among Brevard Community College, Tallahassee Community College, Florida State College at Jacksonville, and FLATE held its first Industrial Advisory Committee meeting in the UCF campus to kick-off implementation of an AA/AAS Alternative Energy Specialization at each respective school. Sixteen people, with representatives from various industries, attended this meeting. The meeting included four FESC Fellows.

Posters presented:
FESC Fellow Sudeep Vyapari from Hillsborough Community College made a poster presentation entitled "Greenhouse Gas Emissions Inventory: A Road Map to Getting There!" It focused on the processes the school followed in establishing its baseline carbon footprint. In addition, FLATE, housed at HCC, presented a poster entitled "Building the Technician Workforce for Florida's Energy Workforce".
State and Community College representation:

A. FESC Fellows
    a. Tallahassee Community College: Rick Frazier and Marc Dick.
    b. State College of Florida: Idelia Phillips and Adrienne Gould-Choquette.
    c. Florida State College at Jacksonville: Jeremy Thompson and Ernest Friend.
    d. Hillsborough Community College: Sudeep Vyapari.
B. Non-FESC Fellows
    a. Brevard Community College: Sheryl Awtonomow and Bruce Hesher.
    b. Florida State College at Jacksonville: Richard Johnson.
    c. Santa Fe College: Kurt Morauer.

OUTREACH

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

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

Outreach Team Members:

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

The progress made is given below:

Energy/Climate Awareness Fact Sheets: Completed seven fact sheets for the FESC website with nine more currently in various stages of completion. Additional topics have been determined. Completed two books (*Greenhouse Gas Reduction and Energy Conservation: Development Impacts Under Florida's HB 697* and *Energy Efficiency Retrofit and Renewable Energy Programs Using Property Assessed Financing: Florida Guide for Local Governments*).

Energy Extension Service: The office staff offered three homeowner classes on energy efficient building construction in Florida. Natural Resources and Florida Yards and Neighborhoods faculty were informed about FESC opportunities and information via articles in their respective state-wide newsletters. In addition they also gave two presentations as part of in-service training at Family and Community Sciences Summit and held *Emerging Energy Issues and Topics* in-service training in Gainesville. Worked with Florida 4-H on the new *S.A.V.E.: Steps in Achieving Viable Energy* youth education project intended for middle/high school youth and 11-13 year-olds in afterschool programs. Co-developer of materials for the new *Sustainable Floridians* pilot program designed to motivate participants and create community-level leadership in sustainability education and actions in a variety of settings. A number of other energy and climate related presentations have been conducted (7 out of state and 40+ in state). Worked with IFAS writers/photographer to get information on energy included in the *UF/IFAS Extension 2011 Calendar and Annual Report*. Barbra Larson is a member of the Climate Variability and Change Focus Team. Hal Knowles passed the exam to be a Certified Greenhouse Gas Inventory Qualifier through the Canadian Standards Association.

Demand Side Management: Two articles published/accepted on Annual Community Baseline methodologies to evaluate demand-side management energy conservation programs and energy efficient new home programs. Currently working with Orlando Utilities Commission to analyze and target DSM programs. They worked with Gainesville Regional Utilities on platforms that address energy consumption in single family homes and operational expenses in multi-family housing. They are now in the planning phase for developing a visualization platform that will provide measurement and verification for the Osceola Energy Initiative weatherization program. Reports were created of findings to be shared with groups throughout Florida and the Southeast. The office worked with Tampa Bay Water to assess the carbon footprint of alternative water supplies. Evaluating various residential audit programs/protocols to establish a set of recommendations/standards for streamlining homeowner audit-to-retrofit programs.

Continuing Education: Developed and offered continuing education classes: *Greenhouse Gas Reduction and Energy Conservation I: Comprehensive Planning Under Florida's HB 697*; *Energy Efficient Building Construction in Florida; HVAC and IEQ; and Remodel Green & Profit*—see http://buildgreen.ufl.edu as they are scheduled. *Performing Home Energy Audits* and *Energy Finance Districts* are two training programs under development. Also developing and pilot testing an *Energy Efficient "Remodeling/Renovating/Weatherizing" in Florida* training program for five counties.

Demonstration House: Continued participation with Pinellas County Extension on structuring their $475,000 earmarked grant to build an energy-efficient demonstration facility.

Workforce Development: Met with Banner Center for Construction Center for Innovation and Economic Development (SFC) and Florida Works to collaborate on a renewable (solar PV) training program that can be duplicated around the state. CEU approved related courses developed include *Commercial Green Advantage*^{R} and *Residential Green Advantage*^{R}. Working with Osceola County Extension and the Technical Education Center-Osceola on the Osceola Energy Initiative (EECBG) project that received funding through the Florida Energy and Climate Commission. Exploring collaborative opportunities for grant funding for Weatherization Innovation Pilot Program with Sarasota County and the Community Weatherization Coalition.

Alternatively Fueled Vehicles: Held in-service training for county faculty representing 16 counties and panel discussion for the public on PHEV Prius and charging station, potential for PHEV and EVs in Florida, Solar Electric Low Speed Vehicles, Solar Bicycle ASES Photon, Compressed Natural Gas, Liquefied Natural Gas and Liquefied Petroleum Gas, and Bio-diesel March 18th in Gainesville. Working with Progress Energy to evaluate performance of PHEV using converted Toyota Prius equipped with GPS tracking system and software to monitor performance. FESC publications on AFVs are planned.

Collaboration on New Initiatives: Extending energy analysis techniques to assist utilities across the state. PREC will be working with Florida DCA on analysis of the Federal Weatherization Assistance program. This project will quantify energy savings for up to 19,000 participating households across the State of Florida. Results of this analysis will provide valuable feedback about post-consumer impacts of various common demand side management techniques. Worked with FESC to include automated Really Simple Syndication (RSS) feeds and create additional web addresses for use with PSAs, etc.

FESC Web Site Updates – The FESC website (www.FloridaEnergy.ufl.edu) continues to be an important part of our program. It is continually being updated to remain current and to better serve our users. FESC distributes electronic newsletters regularly by email and also posts them at the FESC web site. They can be viewed at the link: http://www.floridaenergy.ufl.edu/?page_id=1999. Summaries of FESC expertise in the areas of Algal Biofuels, Small Molecule Chemistry to Energy, and Building Efficiency were developed and posted at the FESC web site. Based on a Google Analytics report, the FESC web site was viewed by 20,326 Google visitors (we are not tracking the users of other web browsers) during the period Oct 19, 2009 to Oct 19, 2010. The viewers visited 61,114 pages. Viewers were from a total of 121 countries, including those in North and South America, Europe, Asia, Australia, and Africa.

The Public Outreach menu (http://www.floridaenergy.ufl.edu/?page_id=2183) now has the following submenus:

Upcoming Events

- Energy/Climate Awareness Fact Sheets
- Energy Extension Service
- Educational Programs/Workshops
- Demonstrations
- Consulting
- Public Service Announcements
- FESC Research Areas, News and Expertise

An automated Really Simple Syndication (RSS) feeds from over 2,500 academic journals within Science Direct using key word filters for each FESC Thrust Area are listed on "FESC Research Areas, News and Expertise" page (sub menu). Locating the latest research news from these Science Direct journals, as well as within Scientific American and Discover Magazine, on energy and climate related issues using RSS feeds is a distinct benefit for individuals seeking current research information on specific topics of interest. In addition, FESC faculty with specific expertise can now be easily located through these Thrust Area summaries. The outreach group is also working towards creating a new, shorter web address for use in PSAs that are being produced by FSU.

SECOND ANNUAL FESC SUMMIT

More than 260 people attended the second annual FESC Summit, held September 28-29, 2010 at the University of Central Florida's Student Union. Participants represented a broad cross-section of energy interests, ranging from government and industry to research, development, and education. The Summit is organized yearly to bring together energy experts in the State University System of Florida to share their energy-related research findings and to promote future collaboration. The complete program can be accessed at the FESC Website: http://www.floridaenergy.ufl.edu/wp-content/uploads/V12_2010-Summit-Program1.pdf

The Summit opened with a welcome from Tony Waldrop, the new Provost at the University of Central Florida. Following was a plenary session, "Future Directions," that featured Lonnie Ingram (Director, Florida Center for Renewable Chemicals and Fuels; Professor, Department of Microbiology and Cell Science, University of Florida), CD Hobbs (Senior Fellow, Public Utility Research Center, Warrington School of Business, University of Florida), Sena Black (Senior Vice President, Enterprise Florida), and Jeremy Susac (Director of Exploration, PCUE at USF; Executive Director, Florida BioEnergy Association, Inc., President and CEO, Real Energy Strategies Group).

The keynote address, entitled "Energy Efficiency and Renewable Energy: the 2020 Vision," was presented by Mr. John Lushetsky, Manager of the U.S. Department of Energy's Solar Energy Technology Program (SETP) with responsibility for all solar technology development, grid integration, and market transformation activities under the Solar America Initiative announced by President Bush in 2006.

The remainder of the day included the first technical session. Four sessions took place during the two days of the summit, focused on these research areas:

- Energy Efficiency & Conservation, Education & Outreach, Policy
- Biomass Resources, Carbon Capture
- Ocean Resources
- Energy Storage and Delivery, Energy Systems, Smart Grid
- Photovoltaics

A Round Table discussion followed, which was designed to garner ideas on a strategic energy plan for Florida. Groups discussed these topics: Solar (PV and Thermal), Bio-Energy, Grid Technologies and Electricity Distribution, Ocean Energy, Nuclear Education, Secure Energy Systems, Energy Efficiency, Conservation, Geothermal; Energy Storage; Carbon Capture; Wind Energy; and Policy. A poster overview presentation followed, where poster presenters were given two minutes and two slides to describe their posters. This approach allowed the audience to target posters of specific interest as the day culminated in a poster session and reception sponsored by FPL.

The Summit's second day began with more technical sessions, then moved to a panel discussion, "Florida's Energy Needs and Opportunities." Serving as panelists were Sen. Mike Haridopolos, Rep. Steve Precourt, and James Murley, Chair of the Florida Energy and Climate Commission.

During lunch, participants held informal technical discussions around these specific FESC research interests: Solar (PV and Thermal), Bio-Energy, Grid Technologies and Electricity Distribution, Ocean and Wind Power, Secure Energy Systems, Energy Efficiency and Conservation, Energy Storage, Carbon Capture, and Policy.

In addition to the Summit itself, two Pre-Summit Workshops were held on September 27. The first, led by FESC Director Tim Anderson and Dr. Chris Ferekides, Professor, Electrical Eng., USF, focused on Photovoltaics, while the second, Technology Transfer and Commercialization, was led by Erik Sander, Director of Industry Programs for the University of Florida College of Engineering.

Additionally, the Florida Energy and Climate Commission held their monthly meeting at the UCF student Union on the afternoon of Monday, September 27. FESC Director Tim Anderson was included in the agenda to welcome the Commissioners to the Summit.

Results from a survey of FESC Summit participants are given in Appendix B. Most agenda items were rated Very Useful or Extremely Useful.

The 2011 FESC Summit is planned for September 2010 at the University of Florida in Gainesville.

Photos from the Summit

Key note speaker John Lushetsky, Program Manager, Solar Energy Technology program, US Department of Energy

Energy Storage Group – Round Table Discussion

Round Table Discussions ("**©Photos by www.vgrin.com, used with permission**)

Policy Group – Round Table Discussion

Solar PV - Thermal Group – Round Table Discussion

Solar PV - Thermal Group – Round Table Discussion

Biomass Group – Round Table Discussion

Carbon Capture Group – Round Table Discussion

Prof. Donato Aranda, Federal University, Rio De Janeiro, presenting International Biofuels Trends ("**©Photos by www.ygrin.com, used with permission**)

Poster Session ("**©Photos by www.ygrin.com, used with permission**)

OTHER ACTIVITIES

FESC program was promoted at the following events/conferences/meetings:

- Clean Energy Webinar, Nov 12, 2009
- The United Nations Conference on Climate Change, Dec 12-19, 2009, Copenhagen
- Federal Laboratories in the Southeast US Region, Jan 21, 2010, Naples, FL
- American Ceramic Society (Electronic Materials and Applications 2010), Jan 22, 2010, Orlando, FL
- Comprehensive Energy and Climate Policy (workshop with IBM), Jan 26, 2010, Washington DC
- Green Renewable Oceanic Technology Transfer, February 22-23, 2010 Orlando, FL
- 2nd UF Water Institute Symposium, February 25, 2010, Gainesville, FL
- Offshore Ocean Energy: A University-Industry-Government Dialog, March 4, 2010, Boca Raton, FL
- 2010 Applied Surface Analysis and FL AVS/FSM Annual Joint Symposium & Exhibition, March 7-10, 2010, Orlando, FL
- NIST Diffusion Workshop March 23-24, 2010, Maryland
- NASA Glenn Research, March 24, 2010, Cleveland, OH MOU is signed between FESC and NASA Glenn after this trip).
- 2nd Annual Florida Alliance for Renewable Energy Conference, March 26 - 28, 2010, Orlando, FL
- International Conference on Eng. and Meta-Engineering: ICEME 2010, April 8, 2010, Orlando FL
- Renewable Energy Symposium, April 13th, 2010, Palm Beach (Beach Club), FL (Florida Crystals and Consorcio Energetico Punta Cana – Macao)
- 2010 International IEEE Microwave symposium, May 23-28, 2010, Anaheim, CA
- U.S. Department of Energy Program Review, May 24-27, 2010, Washington, DC
- Congressional Briefing: Oil and Water in the Gulf - Status of the Spill and How Gulf States University Researchers are Assisting, Assessing and Advising, May 26, 2010, Washington DC
- The University of Florida/IFAS Agronomy Department and Plant Science Research and Education Unit hosted the Grass Bioenergy Crop Field Day on July 15, 2010 at Citra, Florida (A summary is given below)
- A workshop for 10 students of Yeungnam University in Korea was organized by Drs. Anderson, Davidson, and Bosman at UF from Aug 23-27, 2010. Lectures and hands-on workshops explaining and demonstrating the growth, fabrication, characterization and simulation of thin film CIGS solar cells were presented by Dr. Anderson and chemical and electrical engineering graduate students supported by FESC.

Grass Bioenergy Crop Field Day, July 15, 10, Citra FL, By Dr. Lynn Sollenberger, UF

The University of Florida/IFAS Agronomy Department and Plant Science Research and Education Unit hosted the Grass Bioenergy Crop Field Day on July 15, 2010 at Citra, Florida. The field day was designed to provide the most recent information on bioenergy crop production in Florida. There were 100 attendees at the field day representing various state government agencies, private industry, growers, extension personnel, researchers, and students. Attendees had opportunity to tour field sites where research was ongoing, to receive results from studies that were carried out during 2008 and 2009, and to interact individually or in small groups with scientists who are conducting the research. The North American Biofuels Division of BP provided lunch for the field day.

Faculty from throughout the state participated in the field day. Robert Gilbert from Everglades Research and Education Center in Belle Glade described his research program aimed at developing new varieties of energycane for Florida. Joao Vendramini from the Range Cattle Research and Education Center showed results from his work evaluating a large number of perennial grasses for biomass production and for their ability to reduce phosphorus levels in soils with excessive phosphorus. Lynn Sollenberger from Gainesville showed results from his work on alternative nutrient sources for bioenergy crops and from studies on invasive potential of various bioenergy crops. John Erickson from Gainesville discussed water use of bioenergy crops, and he described a series of statewide experiments on sweet sorghum, targeting variety selection and optimum planting dates. Freddy Altpeter from Gainesville described ongoing plant genetics and breeding research aimed at developing superior varieties for biomass production and conversion. Sheila Gomez from the Microbiology and Cell Science Department in Gainesville presented information on conversion of grass biomass to energy and commercially important byproducts.

This team of scientists has also prepared an exhibit for display at the Sunbelt Agricultural Expo in Moultrie, Georgia from October 19-21, 2010. Team members will staff the display which will include live plants, demonstrations, and research summaries.

Florida Climate Institute (FCI)

Florida Climate Institute (FCI) is a newly approved joint venture between the University of Florida and the Florida State University. The FCI was developed by faculty at both universities in a grassroots effort that has been in process for about two years. It was approved by both universities in late June 2010. Both universities have been working together on climate-related research and extension projects for more than 10 years.

APPENDIX A – DESCRIPTION OF RESEARCH PROJECTS

Projects	Summary
THRUST 1: Overarching	
	Title: Power Generation Expansion under a CO_2 Cap-and-Trade Program **PI:** Tapas Das **Co-PI's**: Ralph Fehr **Description**: The objectives of the proposed research are to 1) develop a comprehensive generation technology based portfolio optimization (GTPO) model and its solution algorithm, and 2) 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 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 **University:** USF
	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: PV Energy Conversion and System Integration (Thrust 4: Solar)
	Title: An Integrated Sustainable Transportation System (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)
THRUST 2: Enhancing Energy Efficiency and Conservation	
	Title: Innovative Proton Conducting Membranes for Fuel Cell Applications & Protein Enhanced Proton Conduction Membranes for Advanced Fuel Cells **PI:** Ongi Englander, **Co-PIs:** Anant Paravastu, Subramanian Ramakrishnian **Description:** The objective of this proposal is to establish new research directions in the development of proton conducting materials for fuel cell applications. We will build novel high surface area silica particle based membranes as supports, and infuse in them newly discovered proton conducting protein nanomaterials as well as oxide-based nanocomposites. In order to test electrical transport mechanisms, we will build microfabricated electric testing structures, and subsequently integrate materials with fuel cell test setups. **Budget:** $30,000 **University:** FSU
	Title: Sustainably Integrated Advanced Building Subsystems (OGZEB) **PI:** A. "Yulu" Krothapalli, **Co-PI:** Justin Kramer **Description:** This project focuses 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 is the Off-Grid Zero Emissions Building, which will allow for the testing of these subsystems

	Budget: $503,168 **University:** FSU
	Title: Insight into Membrane Degradation Mechanisms Through Verification of Chemical and Mechanical Degradation Test Capabilities **PI:** Darlene Slattery **Co-PI's**: Len Bonville, Xinyu Huang, Marianne Rodgers **Description:** The objectives of the program are 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 will be revealed. . **Budget:** $324,000 **University:** UCF/FSEC
	Title: Energy Efficient Building Technologies and Zero Energy Homes **PI:** R. Vieira **Co-PI's:** P. Fairey, J. Sonne **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 **University:** UCF/FSEC
	Title: Joint Optimization of Urban Energy-Water Systems in Florida **PI:** James P. Heaney **Student:** Miguel Morales (M.E.) **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 **University:** UF 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

	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 following tasks are proposed to FSU for funding of the planning grant "High Performance and Low Cost Fuel Cells for Future Vehicles". The proposed tasks will be 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 will be conference proceedings and journal papers and proposal submissions for additional funding. **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 super capacitors – 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.
	Title: NIRT: C-MEMS/CNEMS for Miniature Biofuel Cells **PI:** Marc Madou, Co-PIs : Chunlei Wang, Sylvia Daunert and Leonidas Bachas **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 propose to integrate 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) **University**: FIU

	Title: Fabrication of Nano Fractal Electrodes for On-Chip Supercapacitors **PI:** Chunlei Wang **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 **Universities:** FIU
	Title: Energy Efficient Technologies and The Zero Energy Home Learning Center **PI:** Stanley Russell **Co-PI's:** Yogi Goswami **Graduate Assistant**: Mario Rodriguez **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 Zero Energy Home Learning Center [ZEHLC] 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 **University:** USF **External Collaborators: FSU, UF, UCF**
THRUST 3: Developing Florida's Biomass Resources	
High Energy Crops	
	Title: Establishment of the Center for Marine Bioenergy Research Systems Approach to BioEnergy Research (SABER) **PI:** Joel E. Kostka **Co-PIs**: William Cooper, Ivonne Audirac, Amy Chan-Hilton,Ellen Granger **Description:** This proposed SABER research center will blend fundamental and applied research to: 1. Develop sustainable, biologically-based fuel alternatives and renewable energy strategies. 2. Capture, recycle or clean up environmental pollution (greenhouse gases, excess nutrients) associated with energy production and use. Equally important to our research goals will be partnering with public and private institutions to immediately implement our research for the benefit of society. Biosolutions will be rapidly incorporated into the solid waste treatment and power plant industries. We will partner with the

	other IESES groups to promote awareness that the near-term realization of clean, cost-effective energy alternatives will occur only through a multidisciplinary systems-based approach from research to planning and implementation. We will assure sustainability by assessing the environmental impacts and promoting the mitigation of those impacts of alternative energy technologies on the geosphere. The centerpiece of the proposed project will be the development of sustainable practices for the production of transportation fuels from algal biomass feed-stocks. Algal cultivation practices will also be incorporated into industrial processes such as CO2 capture and sequestration from coal-fired power plants and wastewater treatment. **Budget:** $494,135 **Lead University:** FSU
	Title: Constructual Optimization of Solar Photo-Bioreactors for Algae Growth **PI:** Juan Ordonez **Description**: This is a planning grant (15K, only). As such, the work proposed, will be 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 expect to: (i) have a complete design of a small-scale photo-bioreactor for algae growth and, (ii) obtain additional funds that will allow us to build a large-scale photo-bioreactor and conduct the necessary research for its optimal design and operation. A technical report will be delivered by the end of the one-year period. **Budget:** $15,000 **University:** FSU **External Collaborators: Federal University of Parana, Brazil**
	Title: Seeding Biofuel Entrepreneurship in South Florida **PI:** George Philippidis **Description:** FIU's Pino Global Entrepreneurship Center has provided seed funding to facilitate the development of algal biofuels technologies in South Florida. The project's goal is to identify fast-growing high-lipid content native algae that will form the basis for lipid conversion to biofuels. A collection of Florida algae will be screened to select the one(s) with promising growth and lipid potential. Growth conditions will be manipulated to understand the effect of key process variables of lipid productivity. Cells will be harvested for lipid extraction and conversion to biodiesel using FIU's pilot-scale transesterification system. In parallel, biofuels will be introduced into the FIU curriculum to seed the development of a workforce educated and skilled in renewables. **Budget:** $15,000 **University:** FIU
	Title: Energy Intensive Crop Development **PI:** Gary Peter , Matias Kirst, Don Rockwood **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 **University:** UF
	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 **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 seasons. The development of high yielding production systems for energy crops that can be grown in Florida is considered essential for establishment of a sustainable biomass to energy industry. This is the case because long-term availability of sufficient amounts of reasonably priced biomass will be an important determinant of if and where new biofuel and bioenergy facilities will be built. Because of its size and large number of climatic zones, there will be large regional differences in what energy crops can be used at various locations in Florida and how they will perform. In this project, we are conducting applied research at locations throughout Florida with sweet sorghum, sugarcane, energycane, giant reed, miscanthus, erianthus, and elephantgrass to provide important agronomic practice, yield, water use, and chemical composition information for Florida growers, bioenergy producers, and policy makers. This information will support decision making regarding which crops are adapted to specific environments, which are best suited to particular management practices (e.g., irrigation or none), and which have the desired chemical composition for the intended bioenergy use. Investigators in the project include Dr. Lynn Sollenberger and Dr. John Erickson (agronomists at University of Florida), Dr. Joao Vendramini (agronomist at the Range Cattle Research and Education Center at Ona, FL), and Dr. Robert Gilbert (agronomist at the Everglades Research and Education Center at Belle Glade, FL). Three graduate students all started their graduate programs in August 2009. External collaborators include Speedling, Inc., which provided planting material of miscanthus. **Budget:** $191,981 **University:** UF **External Collaborators:** Speedling, Inc.
Biochemical Conversion	
	Title: Development of Biofuel Production Processes From Synthetic and Biomass Wastes **PI:** Pratap Pullammanappallil **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 **Universities:** University of Florida **External Collaborators:** University of Central Florida
	Title: Assessment and Development of Pretreatment for Sugarcane Bagasse to Commercialize Cellulosic Ethanol Technology **PI:** George Philippidis **Description:** The project's objective is to identify a biomass pretreatment process that can cost-effectively convert sugarcane bagasse to an enzymatically digestible and fermentable mix of sugars as a means for determining the commercialization potential of Florida biomass conversion to ethanol fuel. The key objectives are: (1) Assess the lab-scale efficacy of pretreatment processes on sugarcane bagasse; (2) Scale up the most promising bagasse pretreatment process based on the lab scale results; (3) Optimize the pretreatment process to derive design and operation data for commercial-scale bagasse-to-ethanol facilities; and (4) Integrate the critical unit operations to assess the techno-economic feasibility of the bagasse-to-ethanol technology. The FIU-FCC team constitutes a unique public-private partnership with in-depth knowledge of the technology and its shortcomings (19 years of experience by the PI in this field) and experience in commercial agro-energy operations. **Budget:** $1,918,306 **University:** FIU
	Title: Engineering Biocatalysts for Hemicelluloses Hydrolysis and Fermentation **PI:** James F. Preston **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 **University:** UF **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 **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-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 (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 **University:** UF
Bio gasification	
	Title: Combined Cooling, Heat, Power, and Biofuel from Biomass and Solid Waste **PI:** William Lear **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:** $479,813 **University:** UF **External Collaborators:** Siemens Power Generation, Florida Turbine Technologies, Energy Concepts Co., Alturdyne, Inc., LPP Combustion, Planet Green Solutions. Back to Thrust 1: Overarching
Thermo-Chemical Conversion	
	Title: Production of Liquid Fuels Biomass via Thermo-Chemical Conversion Processes **PI:** Babu Joseph **Co-PI's:** Yogi Goswami, Venkat Bhethanabotla, John Wolan, Vinay Gupta

	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 does not utilize food-grade feed stocks and therefore complements and 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 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 **University:** USF **External Collaborators: Prado & Associates**
	Title: Integrated Florida Bio-Energy Industry **PI:** Ali T-Raissi **Co-PIs:** Nazim Muradov, Amit Gujar, Gary Bokerman **Description:** The aim of this project is to produce liquid hydrocarbon fuels derived from Florida based biomass utilizing a two-step process. In the first step, biomass or biomass-derived pyrolysis oils are gasified with oxygen and steam to synthesis gas (syngas) comprised of mostly hydrogen, carbon monoxide and carbon dioxide gas. For this step, an oxygen source is employed (e.g. oxygen concentrator, electrolytic unit, etc.) for biomass gasification. Use of pure (or nearly pure) oxygen for gasification of biomass allows higher overall process energy conversion efficiency by eliminating nitrogen dilution in the syngas. In the second step, syngas from step 1 is fed into a Fischer Tropsch (FT) synthesis unit and converted to liquid hydrocarbon fuels, *e.g.*, diesel fuel. The process can be employed with any lignocellulosic material including crop residues, forest waste, yard clippings, and energy crops. The technology also provides a means for sequestering carbon in the form of a high-value soil enhancing bio-char (terra preta) by simple modification of the gasification step 1. **Budget:** $648,000 **University:** UCF/FSEC
	Title: Biofuels Through Thermochemical Processes: a Systems Approach to Produce Bio-jet Fuel **PI**: Anjaneyulu Krothapalli **Description:** The program addresses the emerging needs for aviation industry to have cost effective alternative liquid transportation biofuels. The main objectives are to produce bio-jet and bio-diesel fuels from cellulosic biomass and nonedible bio-oils and demonstrate that they have cost structure and product quality comparable to petroleum based fuels. 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. 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. The proposed approach can also convert the more challenging lignocellulosic component. Through molecular manipulations, the proposed approach allows the production of "designer" biofuels. The technology offers a means to tailor product properties through saturation of double bonds to give better shelf life, cleaving long chain hydrocarbons to maximize the yield of the jet cut, controlling aromatics content of the jet cut for better combustion characteristics, and isomerization to improve ignition characteristics and for better cold flow properties of the fuel. Successful deployment of research program in biofuels can mean billions of dollars per year in fuel cost savings for aviation industry. It also opens the door for energy independence and distributed fuel generation capability. An 11 kw Downdraft gasifier is installed and began its operation in April 2010. A prototype steam

	gasification with external heating module has been designed and built. The hydrodynamic testing of the proof of concept dual fluidized bed steam gasification process has been successfully tested. **Budget:** $229,572 **Universities:** FSU **External Collaborators:** NA
THRUST 4: Harnessing Florida's Solar Resources	
Solar Thermal	
	Title: Concentrating Solar Power Program **PI:** Charles Cromer **Co-PI:** R. Reedy **Description:** Solar concentrating systems use mirrors to focus sunlight onto receiver pipes at the focal point of the mirrors and are one of the lowest-cost centralized solar power options. After many years of applications, solar concentrating technology has the ability to produce electricity for about $0.10/kWh in the desert southwest. This technology holds high promise for Florida and could also produce low cost solar electricity assuming it can meet production goals. The objective of this R&D project is to advance concentrating technologies by conducting an analytical study of Florida solar resource in order to predict the performance of the concentrating solar application and then to perform experimental test and evaluation of the predicted results. **Budget:** $52,000 **University:** UCF/FSEC **External Collaborators:** FPL
	Title: Enhanced and Expanded Solar Thermal Test Capabilities **PI:** J. Walters **Co-PI:** R. Reedy **Description:** The project focus was to increase the collector testing reliability, efficiency and capability to meet the market demands for 3rd party independent testing. The project focused on eight (8) projects • Implement interim testing/certification protocol to streamline quality products to market. • Design, install and qualify wind systems for collector test platforms • Convert test platforms to allow all 3 type of collector testing on one platform. • Automate portions of qualification tests for improved reliability and efficiency • Increase capability by adding more test stands • Convert to new control system for improved test reliability and data storage • Develop automated testing protocol to increase efficiency. • Design and implement information control system to improve efficiency in record capture, data capture and report generation. **Budget:** $654,295 **University:** UCF/FSEC **External Collaborators:** Solar thermal manufacturers

	Title: Solar Fuels for Thermochemical Cycles at low pressures **PI:** Jörg Petrasch **Description:** Using concentrated solar energy to produce hydrogen-rich, carbon-neutral energy carriers via two-step thermochemical cycles is an intriguing concept for tomorrow's energy economy. Concentrated solar energy drives high temperature endothermic metal oxide (MO) reduction reactions. Reaction products are used to produce hydrogen from water or CO from CO_2. In turn, hydrogen and CO may be used to synthesize carbon neutral methanol or methane. At atmospheric pressures, temperatures above 2000 K are necessary for the MO reduction reactions, causing a range of material and design issues. This project aims at lowering the MO reduction temperature by reducing the reaction pressure. M/MO redox reactions at low pressures will be experimentally investigated in a state-of-the art high flux solar simulator. Furthermore, undesired product recombination is less likely under rarefied conditions. Associated efforts will be directed at developing chemical kinetics and multi-phase, multi-scale process models. Process temperature reduction and a better understanding of the underlying physicochemical phenomena will move solar thermochemistry towards commercialization and make it attractive for Florida's high-technology and energy industry. **Budget:** $ 100,000 **Universities:** UF **External Collaborators:** NA
	Title: Solar Thermal Power for Bulk Power and Distributed Generation **PI:** David Hahn, James Klausner, Renwei Mei, Joerg Petrasch, and Helena Weaver **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 **University:** UF
	Title: Design, Construction and Operation of CSP Solar Thermal Power Plants in Florida **PI :** Yogi Goswami **Co-PI's:** Lee Stefanakos, David Hahn, Robert Reddy 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 **Universities:** USF, UF, UCF **External Collaborators:** Calnetix Power Solutions Back to Thrust 1: Overarching
	Title: Solar Water Heating Systems Facility **PI:** James Roland, David Block **Description:** The objective of the task was to design with air conditioning (A/C), develop construction drawings, obtain permits and then hire a construction firm to add the walls, windows, doors and A/C to an existing FSEC roof facility. The enclosing of this existing space was done for the purpose of increasing laboratory space and to allow for conducting tests on solar water heating systems and PV inverters. The action was taken following a study which determined this project was the most cost effective means of adding valuable laboratory space. **Budget:** $600,609 **University:** UCF/FSEC
Clean Drinking Water	
	Title: Solar Driven Desalination **PI:** James Klausner and Skip Ingley **Student:** Fadi Alnaimat/ Ph.D **Description**: With the advancement of renewable energy utilization for seawater desalination, solar energy is projected to be a promising energy source for seawater distillation. The current approach is to develop a low temperature solar energy driven distillation process that is based on direct evaporation and condensation of water vapor through a packed bed using an air stream. Transient one-dimensional conservation equations have been developed to analyze the heat and mass transfer within direct-contact evaporators and condensers. Closure models have been specified. The conservation equations are solved numerically using a finite difference scheme to predict water, air/vapor mixture and packed bed temperatures in the evaporator and the condenser. The heat and mass transport model accounts for the transient variations within the packed-bed due to changes in the inlet air and water temperature over the course of the experiment. Set of experiments are conducted and used to validate the transient models. The developed model will be used to predict fresh water production at various operating conditions. The transient computer model will be used to design solar driven desalination plants and analyze the economics of construction and operation. **Budget:** $252,000 **University:** UF
	Title: Clean Drinking Water using Advanced Solar Energy Technologies **PI:** Lee Stefanakos **Co-PI's:** Yogi Goswami, Matthias Batzill, Maya Trotz, Sesha Srinivasan The availability of fresh water is a big problem facing Florida. In many locations, Florida's water is contaminated from leaky underground tanks and agricultural pesticides. Although salt-water desalination is possible, conventional systems are too energy intensive. Solar energy can supply the power, and innovative vacuum and humidification/dehumidification desalination systems can provide adequate fresh water for the state's needs. This team will develop water desalination for small community needs and also in bulk. Another goal is to develop photocatalytic disinfection to remove contaminants and integrate these technologies with solar PV for complete water supply systems. Projects include: Natural Vacuum Solar Flash Desalination: Creating vacuum conditions above liquids increase their evaporation rates. This phenomenon can be integrated into a practical continuous desalination process by repeatedly flashing seawater in vacuumed chambers to produce water vapor that will be condensed producing fresh water. Solar PV Assisted Photocatalysis for Air/Water Disinfection: Improving titanium dioxide photocatalysts for

	purification and disinfection of water and air contaminated with organic, heavy metal and microbiological species, using solar energy. This can be integrated into a practical continuous desalination process by flashing seawater in vacuum chambers to produce water vapor that will be condensed, producing fresh water. **Budget:** $326,756 **Universities:** USF **External Collaborators:** NA
Low Cost PV Manufacturing	
	Title: Enhanced and Expanded PV Systems Testing Capabilities at FSEC **PI:** S. Barkaszi **Co-PI:** R. Reedy **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 and certify 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 PV program. **Budget:** $196,018 **University:** UCF/FSEC
	Title: Development of High Throughput CIGS Manufacturing Process **PI:** N. Dhere **Description:** A reduction in the cost of CIGS and other thin PV film modules is required for large-scale PV applications. The goal of this project is 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. 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. **Budget:** $141,620 **University:** UCF/FSEC Back to Thrust 1: Overarching
	Title: PV Manufacturing Data Base and Florida Applications **PI:** R. Reedy **Co-PI:** D. Block **Description:** The overall goal of this project is to assist in the stimulation of the development of a photovoltaic (PV) manufacturing industry in Florida. The project objective is to conduct a review of the 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 **University:** UCF/FSEC

	Title: Development of Low Cost CIGS Thin Film Hot Carrier Solar Cells **PI:** Gjs Bosman, **Co-PI:** Tim Anderson **Description:** The absorber material α-$CuIn_xGa_{1-x}Se_2$ CIGS falls into the class of solar cells termed thin film photovoltaics. This technology uses a direct bandgap absorber material (CIGS) with a high absorption coefficient. Thus the absorber layer is very thin, which the use of inexpensive substrates (glass, stainless steel, polymer). Continued decrease in the cost of CIGS PV will likely result by increasing the device efficiency and increasing the processing throughput. One segment of this research is focused on hot carrier solar cells for cell conversion efficiency improvement in a low cost, high throughput CIGS system. The rapid thermalizaton 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. To address throughput and materials utilization, a novel chemical vapor deposition approach is being developed that promises lower growth temperature and higher deposition rate. The process uses the chlorides of the Cu and group III metals along with elemental Se in a countercurrent configuration. **Budget:** $450,000 **University:** UF
	Title: Solar Photovoltaic Manufacturing Facility to Enable a Significant Manufacturing Enterprise within the State and Provide Clean Renewable Energy **PI:** Don Morel, USF; **Co-PI's:** Chris Ferekides, USF, Lee Stefanakos, USF, Tim Anderson, UF, Neelkanth Dhere, FSEC **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 **Universities:** USF, UF, UCF/FSEC **External Collaborators:** NovaRay Solar, Bedford, MA; Brightwats, Inc., Ft. Lauderdale, FL; US Department of Energy, National Renewable Energy Lab 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**,** R. Reedy **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 **University:** UCF/FSEC Back to Thrust 1: Overarching
	Title: Research and Develop PV Device Science and Laboratories **PI:** Nicoleta Sorloaica-Hickman, Robert Reedy **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:** $882,507 **University:** UCF/FSEC
	Title: Beyond Photovoltaics: Productionizing of Rectenna Technology for Conversion of Solar radiation to Electrical Energy **PI:** Shekhar Bhansali **Co-PI's:** Lee Stefanakos, Yogi Goswami, Jing Wang **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 **Universities:** USF **External Collaborators:** Sandia National Laboratory
PV Integration	
	Title: PV Energy Conversion and System Integration **PI:** N. Kutkut **Co-PI's:** J. Shen, I. Batarseh, Z. Qu, X. Wu, W. Mikhael, L. Chow **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 **University:** UCF Back to Thrust 1: Overarching
	Title: Non-Contact Energy Delivery for PV System and Wireless Charging Applications **PI:** Jenshan Lin **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 **University:** UF
	Title: An Integrated Sustainable Transportation System **PI:** David Norton **Co-PI:** Shirley Meng **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 **Universities:** UF **External Collaborators:** Solid-State Energy Technology, Inc., Lynntech, Inc., Planar Energy Devices, Inc., CFX Battery, Inc. Back to Thrust 1: Overarching
PV/Storage/Lighting	
	Title: Planning Grant: Hydrogen storage using carbon-based adsorbent materials **PI:** Efstratios Manousakis **Description:** We propose to theoretically investigate 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 propose to carry out a full theoretical investigation to find the optimum conditions. **Budget:** $15,000 **University:** FSU
	Title: PV Power Generation Using Plug-in Hybrid Vehicles as Energy Storage **PI:** J. Shen **Co-PI's:** I. Batarseh, N. Kutkut **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 **University:** UCF **External Collaborators:** City of Tavares, FL
	Title: Integrated PV/Storage and PV/Storage/Lighting Systems **PI:** Franky So, **Co-PI:** Jiangeng Xue, Shirley Meng **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 **University:** UF 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 **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/fuel consumption patterns. The objective of this project is to explore energy and fuel sustainability as well as CO_2 mitigation in Florida by investigating the household-level energy and transportation fuel consumption and by analyzing changes in land use. The project consists of three major steps: 1) calculating the baseline Florida CO_2 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 efficiency 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 helps identify and determine the efficacy of various proposed practical energy incentives for household energy consumption reduction and carbon mitigation. It provides insights into the possible effectiveness of economic and policy tools for sustainable energy consumption and greenhouse gas reduction. **Budget:** $60,844 **University:** FSU

	Title: Planning Grant: Enhanced Thermal Performance and Microstructure Simulation of Nuclear Fuels **PI:** Justin Schwartz **Description:**The objective of this proposal is 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, we will pursue 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 include 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. We will conduct an evaluation of possible coating processes and measure their thermal behavior. We will use these findings to pursue external funding. **Budget:** $15,000 **University:** FSU
	Title: Biocatalytic Lignin Modification for Carbon Sequestration **PI:** Jon Stewart **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 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 **University:** UF
	Title: Carbon Capture and Sequestration **PI:** Sabine Grunwald. **Co-PIs:** Tim Martin, Howard Beck **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 **University:** UF

	Title: Creation of Carbon Sequestration Data, Technologies and Professional Cohorts for Florida **PI:** Mark Stewart, **Co-PIs:** Jeffrey Cunningham, Yogi Goswami, Maya Trotz **Description:** Rising concerns over increasing levels of green house 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 **Universities:** USF **External Collaborators:** TECO; USGS; Environmental Consulting & Technology, Inc.
THRUST 6: Exploring Florida's Ocean Energy Resources	
	Title: Southeast National Marine Renewable Energy Center (SNMREC) **PI:** Susan H. Skemp**, Co-PI:** Howard P. Hanson **Description:** The SNMREC mission is to catalyze ocean-based solutions to the Florida's energy challenge. A primary focus is on determining the potential of Florida's ocean-current resource and on ocean thermal energy conversion in waters offshore. Part of this involves the regulatory process at State and Federal levels for ocean energy infrastructure and operation in the offshore continental shelf, which is neither clearly defined nor have the roles and interdependencies of the individual agencies been clearly articulated. In addition, knowledge to make these decisions is more on a macro- rather than the micro-level necessary to assess individual devices. SNMREC's role 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 areas. **Budget:** $8,750,000.00 **Universities: Florida Atlantic University,** with UCF, FSU, USF, 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 Polytechnic Institute and State University, and Florida Institute of Technology **External Collaborators:** Numerous industry and State and federal government as well as FFRDCs, such as the National Renewable Energy Laboratory, Oak Ridge National Laboratory, Pacific Northwest 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), Florida Department of Environmental Protection, and others as well as numerous industry partners.

	Title: Buoy Array for Ocean Wave Power Generation **PI:** P.I. Z. Qu, **Co-PI**: K. Lin **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. As such, the buoy would simply need to be moored to the ocean floor and have cables to transport power to the shore, making it ideal for use in a multiple-unit wave farm. 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. Mathematical simulations have been developed to help optimize design parameters for use in subsequent prototype designs that will be able to be implemented in a wave pool or saltwater environment. **Budget:** $150,000 **University:** UCF
THRUST 7: Securing our Energy Storage and Delivery Infrastructure	
	Title: Reliable and Resilient Electrical Energy Transmission and Delivery Systems **PI:** Steinar Dale **Co-PIs:** Mischa Steurer, Kamal Tawfiq, Rick Meeker, Horatio Rodrigo **Description:** The project 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 and microgrids, possible expansion of new very-large centralized baseload (nuclear), and incorporation of new power conversion, transmission, measurement, communication and control technologies. In addition, the system must continue to accommodate future demand due to population growth and expanded use of electrical power (including the possibility of more widespread electric transportation), continue to improve ability to survive and recover from extreme events, and deal with increasingly constrained siting options for generation, transmission, and distribution systems. **Budget:** $431,982 **University:** FSU Back to Thrust 1: Overarching
	Title: Microgrids for a Sustainable Energy Future **PI:** Chris S. Edrington **Co-PIs:** Jim Zheng, Mischa Steurer, Dave Cartes **Description:** A microgrid strategy can provide a solution for meeting Florida's sustainable energy needs; this effort focuses on the following: • Reduce the number of system-wide power outages by providing islanding capabilities allowing grids to separate from each other, providing for a more stable and reliable power delivery infrastructure. • Provide a framework in which non-traditional, low-carbon footprint, energy sources such as: wind, solar, and fuel cells can be easily integrated into the existing power system. • Provide for intelligent energy management and increased efficiency via high-penetration levels of power electronics and control strategies. • Provide for streamlined integration of both stationary and non-stationary energy storage devices as well as future energy conversion resources such as: ocean current and tidal. • Directly address greenhouse gas targets.

	Budget: $719,333 **University:** FSU
	Title: Multi-Generation Capable Solar Thermal Technologies **PI:** A. Krothapalli**; Co-PI:** Brenton Greska **Description:** The objective of the proposed research is 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. The development of an indoor solar simulator capable of providing and sustaining 1 kW/m2 over an area of 10 m2 The development of a Rankine cycle-based solar concentrating system that is capable of producing at least 2 kW of electricity adaptation and integration of small-scale absorption-based refrigeration systems that can employ the waste heat from the aforementioned Rankine system. Integration of existing membrane distillation technology for waste heat recovery from either, or both, of the above-mentioned technologies. Demonstration of a multi-generation system that combines all of the above-mentioned technologies. **Budget:** $544,226 **University:** FSU
	Title: Planning Grant: Real-Time Power Quality Study For Sustainable Energy Systems **PI:** Dr. U. Meyer-Baese, **Co-PIs:** Helen LI, Simon Foo, Anke Meyer-Baese, Juan Ordonez **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. Four tasks have been completed and one task is still ongoing. The remaining task will be performed by the CO-PIs and their graduate students at Florida State University. **Budget:** $15,000 **University:** FSU
	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 **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 **Budget:** $15,000 **University:** FSU
	Title: Investigating the Effect of Appliance Interface Design on Energy-use Behavior **PI:** Paul Ward**; Co-PIs:** Ian Douglas, David Eccles Description: The primary objective of this research project is 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 uses 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 **University:** FSU
	Title: Energy Delivery Infrastructure Design and Simulation **PI:** Alex Domijan **Co-PI:** Arif Islam **Description:** The Power Center for Utility Explorations (PCUE) proposes 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 represent dynamic and transient behaviors of microgrids. We use test beds to study integrated systems of revolutionary distributed green generation, improved grid and home efficiency, and automated energy conservation technologies for residential, substation, and distribution scale energy systems **Budget:** $485,184 **University:** USF
	Title: Micro Battery Defense Development **PI:** Chunlei Wang **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 **University:** FIU
	Title: Electrostatic Spray Deposition of Nanostructured Porous Metal Oxide Composite **PI:** Chunlei Wang **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 **University:** FIU
	Title: Fabrication and Investigation of Porous Tin Oxide Anodes for Li-Ion Micro Batteries **PI:** Chunlei Wang **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 **University:** FIU
	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."
	Title: Secure Energy Systems: Vision and Architecture for Analysis and Design **PI:** Pramod Khargonekar **Description:** Individuals, families, private enterprises, and public sector organizations all depend on availability of energy at predictable prices in desired quantities. At the same time, assured energy supply is threatened by natural and/or man-made disruptions, but can be augmented by the intelligent inclusion of a

	web of renewable energy sources such as solar (PV or solar thermal), wind, or biomass. For example, a hurricane can seriously disrupt availability of electricity for days. A terrorist attack can disrupt oil supplies. Thus, it is clear that a thorough understanding of security of an energy system at a given level of granularity is desirable, indeed necessary. Such understanding can be useful to corporate leaders, public officials, military commanders, private investors, and citizens. 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. **Budget:** $220,000 **Universities:** UF
Policy and Other	
	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 **Description:** 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 addresses the FESC's Thrust 6 on "Energy systems and their environmental and economic impacts." This project also directly addresses the IESES's Objective 4 on unique geographical challenges and Objective 5 on sustainable energy engineering, science and the sustainable energy economy. 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 are to: 1. Analyze the environmental and water resources demands and potential impacts, specific to Florida's unique geographical challenges, of fuel cycle systems. 2. Develop an objective environmental impact screening and evaluation tool (i.e. decision support system) for energy planning and policy making by Florida's industry, utilities, and government. 3. Provide outreach to industry, utilities, government to allow for discussion and better-informed decisions on energy strategy, regulation, and permitting. 4. Provide training on "Energy and the Environment" to ensure environmental stewardship without sacrificing energy production. **Budget:** $118,470 **University:** FSU **External Collaborators:** Florida Department of Environmental Protection

	Title: Promoting Energy and Land Use Through Land Use, Transportation and Green Infrastructure Polices **PI:** Tim Chapin; **Co-PIs**: Ivonne Audirac, Chris Coutts, and Greg Thompson, Department of Urban & Regional Planning, and Mark Horner, Department of Geography **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. We continue to work on generating a report similar to the *Tough Choices: Shaping Florida's Future and Facing Florida's Revenue Shortfall* document prepared by the Collins Institute. This report summarizes the literature on the links between urban development patterns and energy sustainability/ climate change and makes recommendations for state policies and programs to address these issues. The intention is to author a report that is easy-to-read, including graphics, and will highlight the key policies and programs the state should pursue to achieve its energy sustainability and climate change goals. **Budget:** $168,185 **University**: FSU
	Title: Marketing Strategies to Incentivize Entrepreneurship and Innovation in the Development of Sustainable and Environmentally Friendly Goods and Services **PI:** Joe Cronin **Description:** The objective of this project is 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 modalities that can be used to deliver sustainability knowledge to consumers (e.g. advertisements, testimonials, expert word-of-mouth communications, public relations, publicity, etc) will be assessed. Specifically, the research will attempt 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 **University:** FSU
	Title: Energy Sustainable Florida Communities **PI:** Richard Fieock**, Co-PIs:** Ivonne Audirac, Keith Ihlanfeldt **Description:** The objective of this proposal is to develop an energy sustainability index to measure local governments' adoption and capacity to implement energy policy innovations in response to the provisions of new energy legislation in Florida. This measure will be applied to investigating factors influencing local

	government energy policy decisions and be disseminated to research and governmental decision-makers. The following tasks are proposed to FSU for funding: archival data collection; survey of local governments; construction of a Florida Sustainable Communities web site; statistical analysis, hold a workshop on sustainable energy governance in local government; preparation of reports; papers journal manuscripts and grant proposals. **Budget:** $125,424 **University:** FSU
	Title: "Political and Economic Institutions Regarding Siting of Energy Facilities: "Hold Out" and "NIMBY" problems, with concurrent developments in undergraduate education. **PI**: R. Mark Isaac**, Co-PI's:** Douglas Norton, Svetlana Pevnitskaya **Description:** The "holdout" problem occurs when one economic agent attempts to construct a portfolio of economic assets (often land) from multiple sellers. When a public good has diffuse public benefits but costs concentrated on a few, a "NIMBY" problem (Not In My Back Yard) may exist. **Budget:** $79,621 **Universities:** FSU
	Title: Development of a Renewable Energy Research Web Portal **PI:** Charles R. McClure, **Co-PIs**: Ian Douglas, Chris Hinnant **Description:** This project will identify, organize, and make 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 primary tasks to be completed in this process include: • Conduct needs assessment of IESES and FESC energy researchers and related experts to determine (1) the most important content to be included in the web portal, and (2) preferences to be considered in the design of and applications for the web portal; • Identify and obtain relevant energy research information from IESES and FESC and other sources as appropriate; • Develop a web portal such that identifies, organizes, and accesses energy research information; • Field test and conduct usability, feasibility, and accessibility testing on web portal; The goal of this project is to provide IESES, FESC researchers, and others in the state of Florida with the research information they need to accomplish statewide energy goals and to help IESES meet the thirteen objectives it has undertaken by providing access to research information. **Budget:** $194,542 **University:** FSU
	Title: Energy and Efficiency Video Public Service Announcements **PI:** Andy Opel, **Co-PIs:** Phil Steinberg, Leslie France-Patterson, Laura Arpan, Ian Weir **Description:**This interdisciplinary team will produce 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 **University:** FSU
	Title: An Experimental Investigation of Economic Incentives of Policies, Institutions and R&D in Environmental Conservation, Sustainability and Renewable Energy **PI:** Svetlana Pevnitskaya**, Co-PI:** Dmitry Ryvkin **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. The methods of experimental economics allow for finding such deviations and their causes, and use the findings to modify theory and design better policies and institutions. In this project we construct a theoretical model of decisions in a dynamic environment with costs of pollution and climate change and employ laboratory experiments with human subjects to study actual behavior and explore responses to changes in the environment, production technologies, investment in clean technology and institutions. **Budget:** $43,217 **University:** FSU
	Title: Planning Grant: Meteorological Factors Affecting Solar Energy Efficiency in the Tropics **PI:** Paul Ruscher**, Co-PIs:** Yaw Owusu, Hans Chapman **Description:** We wish to document the atmospheric factors that both limit and enhance solar energy utilization in this project, particularly those in the tropics. This will benefit Floridians as well as people in developing nations who wish to deploy solar technologies, to help them understand the benefits and limitations that they can expect to achieve. **Budget:** $15,000 **University:** FSU
	Title: Planning Grant: Climate modeling and outreach activities **PI:** Shawn R. Smith, **Co-PI**: Steve Cocke 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 Institute for Energy Systems, Economics, and Sustainability (IESES). The focus of our activities has centered on evaluating the potential offshore wind resource in the northeastern Gulf of Mexico. Preliminary research has been completed using observations from instrumented Air Force towers and confirms the existence of wind power capacity 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. We seek interested collaborators from academia, industry, and government. **Budget:** $15,000 **University:** FSU
	Title: Visiting Scholar in Energy and Land Use Law, Florida State University College of Law **Principal Investigator:** JB Ruhl and Jim Rossi, **Co-PIs:** Uma Outka **Description:** Two-year Visiting Scholar at the College of Law researching 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. **Budget:** $214,603 **University:** FSU
	Title: Economic Impacts of Renewable Energy and Energy Efficiency Policies **Principal Investigator:** Ted Kury **Description:** PURC is engaging in three new research projects that will provide important information for policy makers in Florida. The projects are: *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. Proponents of state and federal policies promoting renewable energy and energy efficiency policies often assert that the policies will have positive impacts on jobs, specifically the so called green jobs. *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. *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:** $150,000.00 **Universities:** UF
Education and Outreach	
	Title: Florida Advanced Technological Education Center (FLATE) **PI:** Marilyn Barger **Description:** FLATE (Florida Advanced Technological Education Center) will partner with FESC to develop statewide curriculum frameworks for technical A.S./A.A.S. degree programs supporting existing and new energy business sectors. FLATE will develop and have processed through the FLDOE 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 **University:** Hillsboro Community College 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 **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:** $497,671 **Universities:** UF **External Collaborators:** Primarily DCA, FSU, UCF (FSEC), USF, and DEP with many others as well

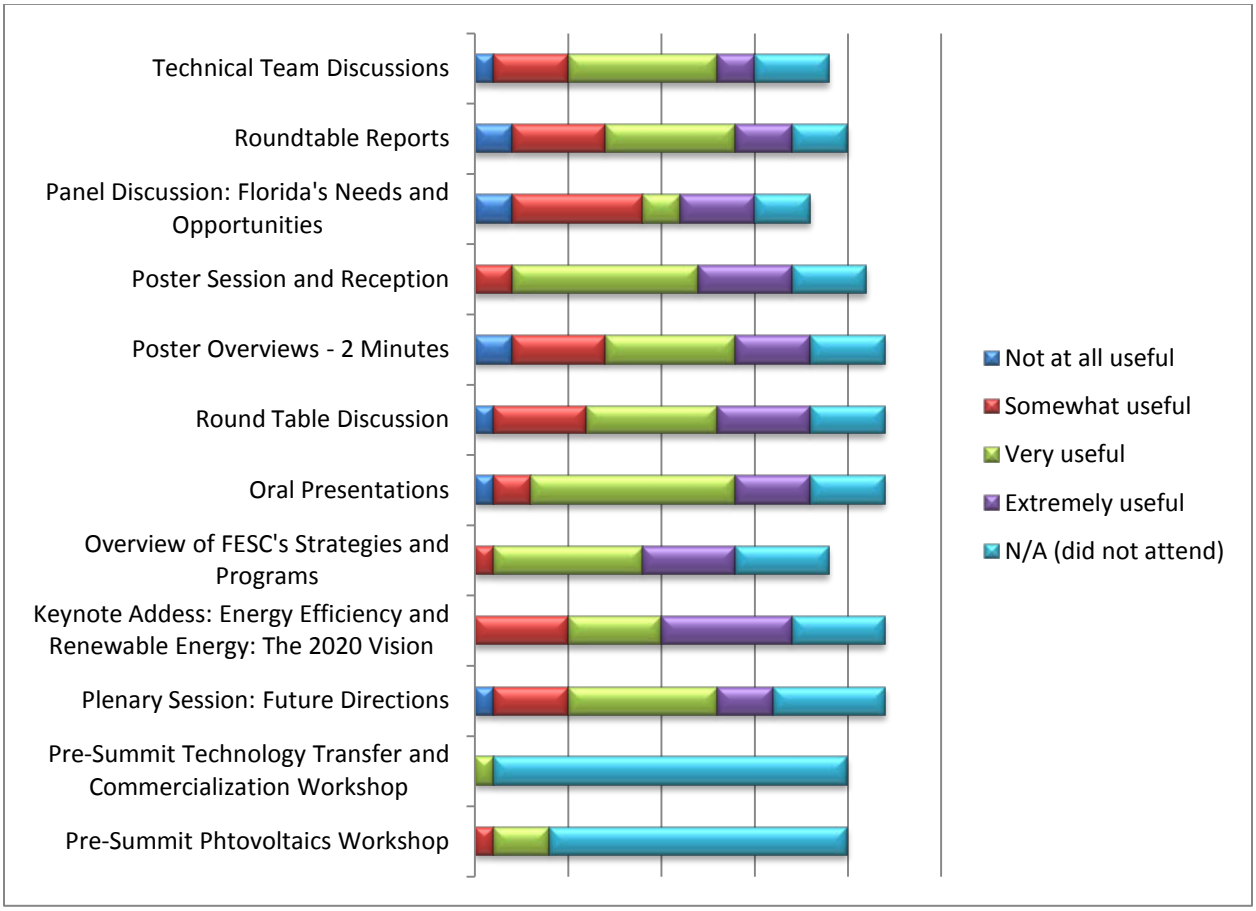
	Title: UFTR Digital Control System Upgrade for Education and Training of Engineers and Operators **PI:** Alireza Haghighat **Faculty Participants:** James Baciak, Edward Dugan, Gabriel Ghita, Glenn Sjoden & DuWayne Schubring **Staff participants:** Brian Shea and Matthew Berglund **Description:** The 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 **Universities:** UF **External Collaborators:** Several engineers from AREVA NP Inc & Siemens Corporation

APPENDIX B - FESC SUMMIT SURVEY RESULTS

Left: FESC Summit participants contemplate an energy-focused strategic plan for Florida.

Below: Results from the 2010 FESC Summit Survey.

*Toward developing and implementing Florida's energy and climate agenda, please rate the **usefulness** of the information presented during the summit. How **useful** was each topic/activity for your needs?*



APPENDIX C – FESC ECONOMIC IMPACT ANALYSIS

FESC Economic Impact Analysis was performed by Dr. Julie Harrington, FSU, based on the Oct. 1, 2009 – Sep 30, 2010 Reporting Period data by using IMPLAN Economic Impact Model (Impact Analysis for Planning). The IMPLAN or Impact Analysis for Planning is a widely accepted and used input-output model. The theoretical framework for IMPLAN was developed by Wassily Leontief, for which he received the Nobel Prize in 1973. IMPLAN was founded in 1993, as an extension of two researchers' work at the University of Minnesota and involving collaborative work with the U.S. Forest Service Land Use Planning Unit in Colorado. It is used extensively by a number of other leading universities, state and local government agencies, and private research groups that evaluate economic impacts across the state and nation.

Economic Impact Assumptions

- FESC faculty/researchers: average =$50/hour; Benefits/fringe included. Average is one month PT (1/12, or 160 hours).
- Post docs: full time (FT) and pay is $30/hour
- All graduate students: 20 hours per week (PT) and pay is $20/hour
- All undergraduate students: 20 hours per week (PT) and pay is $10/hour.
- FESC Sources of funding for 2010:

$84,402,932 in grants, 133 faculty researchers, 41 graduating students (22 PhD's, 19 MS's), 22 undergraduate and 219 graduate students, 27 post-docs, seven startup companies (e.g., fuel cell, sensor turbines, and display monitors, among others) and $0 in venture capital investment. There have been 16 licenses established, with no license revenues generated yet.

Economic Impact Results

Economic Impact of FESC in Florida for 2010			
	Output*	Employment	Income*
FESC	$228,118,002	1,783	$97,689,839

*** in Aug 2010 $**

- The Table presents the economic impacts for 2010 in terms of output, employment and labor income. Output is the dollar value of intermediate and final goods and services produced across the Florida economy. Increases in labor income translate into more economic activities and local and state tax revenues. The employment results are expressed in terms of jobs.
- Economic impacts include: direct, indirect and induced impacts. Direct impacts measure the immediate effects as a result of FESC; i.e., in employment and income. Indirect impacts are those that include changes to production, employment, income, etc., that occur as a result of the direct effects. Induced impacts are those further impacts of spending derived from direct and indirect activities – i.e., household purchases of consumer goods and services.
- The results of the economic impact analysis show that FESC is having a substantial positive economic impact for the State of Florida for 2010. The economic benefits extend to job creation, output and personal income for Floridians. In terms of output, over $228 million is projected to be generated. Personal income is projected to be about $98 million. Overall, FESC is projected to support 1,783 jobs, based on the initial state investment.

APPENDIX D – ACCOUNTABILITY MEASURES – DATA

1. Competitive Grants Applied (Back to top)

During Oct. 1, 2009 to Sep 30, 2010 Period

SUS energy faculty submitted 531 funding proposals amounting to $580,692,518 during the twelve-month period of Oct 1, 2009 through Sep 30, 2010. The information was collected through the databases at each university, published news releases, and faculty input. The database information was reviewed carefully and listings that are not energy related were deleted.

Due to the large amount of data, it is not given in this report; however it is available upon request.